Curriculum Structure & Syllabus

(As per National Education Policy 2020)

of

B. Tech.

In

Computer Science and Engineering

(w.e.f. 2024-25)

Curriculum

Syllabus

Offered By

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
MADAN MOHAN MALAVIYA UNIVERSITY OF TECHNOLOGY (MMMUT)
GORAKHPUR-273 010, UP, INDIA
JULY 2024

Vision

To become a leader of education, research, and innovation in Computer Science and Engineering and to produce under graduates who are globally recognized as innovative and well-prepared computing professionals.

Mission

1. To create, share and disseminate knowledge through research and education in the theory and application of computing
2. To train the students in different aspects of computing discipline for enhancing, augmenting, and updating their technical skills.
3. To inculcate the spirit of analysis, teamwork, innovation, and professionalism among the students

Program Educational Objectives (PEO)

PEO1. To inculcate the knowledge of the fundamentals of the mathematics, science & engineering disciplines for developing the ability to formulate, solve and analyze the problems of Computer Science & Engineering field and to provide them the skills for the pursuit of under-graduate studies, research and development and higher education.

PEO2. To provide an understanding of the prerequisite of the software, technical aspects, and design for coming up with novel engineering solutions and efficient product developments.

PEO3. To assist the students in the pursuit of a successful career by adopting ethical practices and social responsibility.

PEO4. To provide students with the technical as well as soft skills required by the national as well as international organizations.

PEO5. To elevate cognizance in the students toward unending learning and to inculcate ethical and moral ways.

PEO6. To give students the knowledge of the contemporary technologies, practical experiences, and possibilities in the field of Computer Science & Engineering and to provide the multidisciplinary knowledge to develop the team spirit and leadership qualities by working on multidisciplinary projects.

Program Outcomes (PO)

PO1. The students will develop the ability towards the application of fundamental knowledge of computing, mathematics, algorithms and computer science & engineering precepts and rationales for developing the solutions of critical engineering problems (Engineering Knowledge).

PO2. The under graduating students will be able to model and carry out the experiments by using the fundamental knowledge of computer science & engineering discipline and derive the conclusions by analyzing and interpreting the data (Problem Analysis).

PO3. The students will be able to analyze, design, implement and assess a computer-based information system, procedure, module, or program to fulfil the requirements along with the consideration of economic, social, privacy and reliability constraints (Design/Development

of Solutions).

PO4. Design and conduct experiments, analyze and interpret data, and synthesize valid conclusions using research-based knowledge and modern tools (Conduct Investigations of Complex Problems).

PO5. The students will possess the ability to utilize the knowledge of innovative computing equipment's required for engineering tasks (Engineering Tool Usage).

PO6. To impart exhaustive education to the students required to understand and analyze the local and global consequences of computer science & engineering solutions ranging from individuals and organizations to society (The Engineer and Society).

PO7. The students will have awareness towards the professional, ethical practices, legal, security & social consequences, and obligation (Ethics).

PO8. The students will be able to perform efficaciously in multi-disciplinary teams (Individual and Team Work).

PO9. The students will have efficient speaking skills and written/interpersonal communication skills (Communication).

PO10. The students will possess the ability to utilize the knowledge of innovative computing equipment's required for engineering tasks (Project Management and Contemporary Issues).

PO11. Recognize the need for and engage in independent and continuous professional development and lifelong learning in response to technological advancements (Life-Long Learning).

Program Specific Outcomes (PSO)

PSO1. Ability to be lifelong learner to adapt innovation.

PSO2. Ability to learn the best practices regarding ideating, innovating and to be able to attain a successful career with globally employable capabilities.

PSO3. Ability to be open to international cultures and demands

Syllabus And Credit Structure For B.Tech.(CSE)
(Session 2024-2025 and onwards)
Overall Credit Structure For B.Tech.(CSE)

<table>
<tr><th colspan="4">Credit Courses</th></tr>
<tr><td colspan="2">Core Courses (CC)</td><td colspan="2">Electives Courses (EC)</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Min. Credits</td><td rowspan="2">Category</td><td>Min.</td></tr>
<tr><td>Credits</td></tr>
<tr><td>Basic Sciences & Maths (BSM)</td><td>20</td><td rowspan="3">Professional Electives (PE)/ Open Electives (OE)</td><td rowspan="3">36</td></tr>
<tr><td>Engineering Fundamentals (EF)</td><td rowspan="2">24</td></tr>
<tr><td>Professional Skill (PS)</td></tr>
<tr><td rowspan="2">Professional Core (PC)</td><td rowspan="2">48</td><td>Humanities & Social Science</td><td rowspan="2">4</td></tr>
<tr><td>Elective (HSSE)</td></tr>
<tr><td>Management (M)</td><td>4</td><td></td><td></td></tr>
<tr><td>Humanities & Social Science (HSS)</td><td>8</td><td></td><td></td></tr>
<tr><td>Minor Project (P)</td><td>6</td><td></td><td></td></tr>
<tr><td>Industrial Practice (IP) (In Industry)/ Major</td><td rowspan="2">10</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Project (MP) (In University)</td></tr>
<tr><td>Sub-total</td><td>120</td><td>Sub-total</td><td>40</td></tr>
<tr><td>Grand Total</td><td colspan="3">160</td></tr>
<tr><td colspan="4">Non-Credit Courses</td></tr>
<tr><td colspan="3">One Expert Lecture per semester for students (Mandatory).</td><td rowspan="2">Non-Credit</td></tr>
<tr><td colspan="3">(BSM-Ist year), (PC-2nd Year), (T&P-3rd Year)</td></tr>
<tr><td colspan="3">Social work/Training of at least 60 hours during break after first/ second semester</td><td rowspan="2">Non-Credit</td></tr>
<tr><td colspan="3">(Mandatory) (Dean of Extension, Field Outreach and Alumni Relations).</td></tr>
<tr><td colspan="3">Industrial Training during the summer break after fourth semester (Mandatory).</td><td>Non-Credit</td></tr>
<tr><td colspan="3">One -week workshop during the winter break after fifth semester on professional/ industry/ Social/ entrepreneurial orientation (Mandatory) (Dean of Extension, Field Outreach and</td><td rowspan="2">Non-Credit</td></tr>
<tr><td colspan="3">Alumni Relations).</td></tr>
<tr><td colspan="3">Value Added Courses (VAC) / Audit Courses (AC)</td><td rowspan="2">Non-Credit</td></tr>
<tr><td colspan="3">Two of the Value-Added Courses / Audit Courses are compulsory.</td></tr>
<tr><td colspan="3">Extracurricular Activities Courses (ECA)</td><td rowspan="6">Non-Credit</td></tr>
<tr><td colspan="3">Two compulsory courses from the following S. No (ii) to (v) non-credit courses:</td></tr>
<tr><td colspan="3">(i) Induction Program (compulsory)</td></tr>
<tr><td colspan="3">(ii) Skill development</td></tr>
<tr><td colspan="3">(iii) Unity and Discipline (NCC or NSS)</td></tr>
<tr><td colspan="3">(iv) Sports, Cultural and Games</td></tr>
<tr><td colspan="3">(v) Personality Development</td><td></td></tr>
</table>

Minor Degree (MD) from any Department and Micro Specializations (MS) within the Department	
The total number of credits for graduation will be kept to minimum 160. The additional 18-20 credits are required for Minor Degree Courses.	Offered as a Professional
Micro specializations (MS) will be run by the department in order to align to industry careers or higher studies	Electives (PE)

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
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Semester wise Credit Structure for B. Tech. (CSE)

Category/Semesters	I	II	III	IV	V	VI	VII	VIII	Total
Basic Sciences & Math's (BSM)	8	8	0/4	4/0					20*
Humanities & Social Science (HSS)	4	4							08*
Humanities & Social Science Elective (HSSE)					4				04*
Management (M)						4			04*
Engineering Fundamentals (EF)	4	4	8/4	0/4					16*
Professional Skill (PS)	4	4							08*
Professional Core (PC)			12	12	12	12			48*
Professional Electives (PE)/ Open Electives (OE)				4-8	28-32				36*
Minor Project (P)						0	6		06*
Industrial Practice (IP) (in Industry)/ Major Project (MP) (In University)								10	10*
Total Credit	20*	20*	20*	20-24*	16*-32*	16*-32*	6-30*	10-30*	160*
	80-84*				76-80*				
Total Courses Offered	05*	05*	05*	05*-06*	04*-08*	04*-08*	00-06*	00-05*	36*

**Minor variation is allowed as per need of the respective disciplines.*

First Year, Semester I

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	BSM	BSM-110	Engineering Mathematics-I	3	1	0	4
2.	BSM	BSM-131/181	Engineering Physics	3	0	2	4
3.	EF	BCS-110/160	Introduction to C Programming	3	0	2	4
4.	PS	BCS-111	Web Designing-1	2	0	4	4
5.	HSS	BHS- 101/151	Universal Human Values: Understanding Harmony	3	1	0	4
			Total	**14**	**2**	**8**	**20**
6.	ECA-I		Induction Program	-	-	-	0

Group-1: CSE, IT, CH, CE; Group-2: ECE, ECE (IOT), ME, EE.

First Year, Semester II

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	BSM	BSM-160	Engineering Mathematics II	3	1	0	4
2.	BSM	BSM-140/BSM-190	Environmental Science and Green Chemistry	3	0	2	4
3.	EF	BEE- 110 / BEE-160	Basic Electrical Engineering	3	0	2	4
4.	PS	BCS-161	Web Designing-2	2	0	4	4
5.	HSS	BHS- 102/152	Technical Writing and Professional Communication	2	1	2	4
			Total	**13**	**2**	**10**	**20**
6.	VAC/AC	BCS-162	Design Thinking in Information & Understanding	0	0	2	0
7.	ECA-II			-	-	-	0

Second Year, Semester III

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	EF	BCS-210A	Discrete Structure	3	1	0	4
2.	EF	BCS-211	Digital Logic and Design	3	0	2	4

3.	PC	BCS-212A	Object Oriented Programming through JAVA	3	0	2	4
4.	PC	BCS-213	Theory of Computation	3	1	0	4
5.	PC	BCS-214	Principles of Data Structures	3	0	2	4
			Total	**15**	**2**	**6**	**20**
6.	VAC	AUC-101	Constitution of India	2	0	0	0
7.	AC	AUC-119	Fundamentals of Artificial Intelligence	2	0	0	0
8.	ECA-III			-	-	-	0

Second Year, Semester IV

S. No.	Category	Paper Code	Subject	L	T	P	Credit
1	EF	BSM-212/262	Operational Research	3	1	0	4
2	PC	BCS-261	Design & Analysis of Algorithms	3	0	2	4
3	PC	BCS-262	Computer Organization and Architecture	3	0	2	4
4	PC	BCS-263	Database Management Systems	3	0	2	4
	Students may choose either PE-1 or PE-2 or Both PE-1 and PE-2.						
5	PE	PE 1		3	0/1	2/0	4
6	PE	PE 2		3	0/1	2/0	4
	Total			**15-18**	**1-3**	**6-10**	**20-24**
7	VAC/AC	AUC-(102 to 119) IKS-(101 to 104)		2	0	0	0
8	ECA-IV			-	-	-	0

Third Year, Semester V

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	HSSE	BHS 301/351	Engineering and Managerial Economics	3	1	0	4
2.	PC	BCS-305	Principles of Operating Systems	3	0	2	4
3.	PC	BCS-306	Principles of Compiler Design	3	0	2	4
4.	PC	BCS-307	Computer Networks	3	0	2	4
Student may choose maximum up to 04 courses from the list of PE category courses (PE-1 to PE-9).							
5	PE	PE 1		3	0/1	2/0	4
6	PE	PE 2		3	0/1	2/0	4
7	PE	PE 3		3	0/1	2/0	4
8	PE	PE 4		3	0/1	2/0	4
9	PE	PE 5		3	0/1	2/0	4
10	PE	PE 6		3	0/1	2/0	4
11	PE	PE 7		3	0/1	2/0	4
12	PE	PE 8		3	0/1	2/0	4
13	PE	PE 9		3	0/1	2/0	4
			Total	**12-24**	**01-8**	**0-16**	**16-32**
14	ECA-V			-	-	-	0

Third Year, Semester VI

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	M	BMS-301\351	Principles Of Industrial Management	3	1	0	4
2.	PC	BCS-355	Software Engineering	3	0	2	4
3.	PC	BCS-361	Image and Video Processing	3	0	2	4
4.	PC	BCS-356	Parallel & Distributed Programming	3	0	2	4
5.	P	BCS-371	Minor Project-I	0	0	0	0
Student may choose maximum up to 04 courses from the list of PE category courses (PE-1 to PE-9).							

6	PE	PE 1		3	0/1	2/0	4
7	PE	PE 2		3	0/1	2/0	4
8	PE	PE 3		3	0/1	2/0	4
9	PE	PE 4		3	0/1	2/0	4
10	PE	PE 5		3	0/1	2/0	4
11	PE	PE 6		3	0/1	2/0	4
12	PE	PE 7		3	0/1	2/0	4
13	PE	PE 8		3	0/1	2/0	4
14	PE	PE 9		3	0/1	2/0	4
Total				**12-24**	**01-08**	**0-16**	**16-32**
15	ECA-VI			-	-	-	0

Fourth Year, Semester VII

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	P	BCS-441	Minor Project-II	0	0	12	6
	Student may choose maximum up to 06 courses from the list of PE category courses (PE-1 to PE-9).						
2	PE		PE 1	3	0/1	2/0	4
3	PE		PE 2	3	0/1	2/0	4
4	PE		PE 3	3	0/1	2/0	4
5	PE		PE 4	3	0/1	2/0	4
6	PE		PE 5	3	0/1	2/0	4
7	PE		PE 6	3	0/1	2/0	4
8	PE		PE 7	3	0/1	2/0	4
9	PE		PE 8	3	0/1	2/0	4
10	PE		PE 9	3	0/1	2/0	4
Total				**0-18**	**0-6**	**12-30**	**6-30**
11.	ECA-VII			-	-	-	0

Fourth Year, Semester VIII

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	IP	ICS-444	Industrial Practice (IP)	0	0	20	10
	Without Industrial Practice (IP)						
2.	MP	ICS-481	Major Project (MP)	0	0	20	10
Student may choose maximum up to 05 courses from the list of PE category courses (PE-1 to PE-9).							
2	PE	PE 1		3	0/1	2/0	4
3	PE	PE 2		3	0/1	2/0	4
4	PE	PE 3		3	0/1	2/0	4
5	PE	PE 4		3	0/1	2/0	4
6	PE	PE 5		3	0/1	2/0	4
7	PE	PE 6		3	0/1	2/0	4
8	PE	PE 7		3	0/1	2/0	4
9	PE	PE 8		3	0/1	2/0	4
10	PE	PE 9		3	0/1	2/0	4
Total				**0-15**	**0-5**	**20-30**	**10-30**

List of Professional Electives (PE)

1.	PE 1	ECS-103	Introduction to Data Science	3	1	0	4
		ECS-104	Introduction to Artificial Intelligence	3	1	0	4
		ECS-105	Cryptography and Network Security	3	1	0	4
		ECS-106	Computer Graphics for Virtual Reality	3	1	0	4
		ECS-107	Fundamental of Blockchain Technology and Applications	3	1	0	4
		ECS-108	Introduction to object -oriented Programming using C++	3	0	2	4
		ECS-109	Global Positioning System	3	1	0	4
2	PE 2	ECS- 201	Fundamentals of Cyber Security and Forensics	3	0	2	4
		ECS- 202	Concept of AI and Applications	3	1	0	4
		ECS-203	Principles of Data Science and Analytics using python	3	1	0	4

		ECS-204	Introduction to Distributed Ledger Technology	3	1	0	4
3.	PE3	ECS-303	Computing using Python	3	0	2	4
		ECS-304	Introduction to Machine Learning	3	0	2	4
		ECS-305	Practical Cyber Security for Cyber Security Practitioners	3	0	2	4
		ECS-306	Computer Graphics and Game Programming	3	0	2	4
		ECS-307	Private and Consortium Blockchain for Enterprise	3	1	0	4
		ECS-308	Data Structures and Algorithms using C	3	0	2	4
		ECS-309	Principle of Remote Sensing	3	0	2	4
4.	PE4	ECS-401	Digital Forensics	3	0	2	4
		ECS-402	Introduction to Deep Learning	3	0	2	4
		ECS-403	Data Engineering and Big Data Analytics	3	1	0	4
		ECS-404	Ethereum Smart Contracts and Distributed Systems	3	1	0	4
5.	PE 5	ECS-503	Data Visualization	3	1	0	4
		ECS-504	Artificial Intelligence: Knowledge Representation and Reasoning	3	1	0	4
		ECS-505	Cyber Security and Privacy	3	1	0	4
		ECS-506	Concepts of Virtual and Augmented Reality	3	1	0	4
		ECS-507	Smart Contracts and Decentralized Applications	3	1	0	4
		ECS-508	Introduction to Software Engineering	3	1	0	4
		ECS-509	Spatial Information Technology	3	0	2	4
6.	PE 6	ECS-601	Intrusion Detection and Prevention Systems	3	0	2	4
		ECS-602	Generative AI	3	0	2	4
		ECS-603	Data Science for Predictive Maintenance	3	1	0	4

		ECS-604	Security, Privacy, and Legal Aspects in Blockchain	3	1	0	4
7.	PE 7	ECS-703	Statistical Learning for Reliability Analysis	3	1	0	4
		ECS-704	Natural Language Processing	3	0	2	4
		ECS-705	Introduction to Security of Cyber-Physical Systems	3	1	0	4
		ECS-706	Scientific and Engineering Data Visualization	3	1	0	4
		ECS-707	Introduction to Solidity Language	3	0	2	4
		ECS-708	Software Product Management	3	1	0	4
		ECS-709	Web Technology for Spatial Information Mapping	3	0	2	4
8.	PE 8	ECS-801	Advanced Cyber Operations and Forensic Analytics	3	0	2	4
		ECS-802	Multi-modal AI	3	0	2	4
		ECS-803	Advanced Machine Learning and Predictive Modeling	3	1	0	4
		ECS-804	Case studies of Industrial Application in blockchain	3	1	0	4
9.	PE 9	ECS-903	Reinforcement Learning	3	0	2	4
		ECS-913	Deep Learning	3	0	2	4
		ECS-904	Optimization and Machine Learning	3	1	0	4
		ECS-914	Deep Learning and Neural Network	3	0	2	4
		ECS-905	Ethical Hacking	3	0	2	4
		ECS-915	Computer Forensics	3	0	2	4
		ECS-906	Interactive 3D Graphics	3	0	2	4
		ECS-916	Sensors and actuators in AR/VR system	3	0	2	4
		ECS-907	Blockchain for Social Impact: Democracy & Governance	3	1	0	4
		ECS-917	Blockchain Security and Next Generation Applications	3	1	0	4

		ECS-908	Software Testing and Quality Assurance	3	1	0	4
		ECS-918	Agile Software Processes	3	1	0	4
		ECS-909	Satellite Image Processing	3	1	0	4
		ECS-919	Spatial Data Quality Assessment	3	1	0	4

Note: Detailed syllabus of Value-Added Courses (VAC)/ Audit Courses (AC) is attached as in **Annexure-01.

Note: Detailed syllabus of Extra Curricular Activity (ECA) Courses is attached as **Annexure-02

** **Note:** Detailed information about different Micro Specialization courses, along with their details, is attached in **Annexure-03**.

** **Note:** Detailed information about different Minor Degree courses, along with their details, is attached in **Annexure-04**.

List of Value-Added Courses (VAC)/ Audit Courses (AC).

Sl. No.	Subjects	Codes
1	Constitution of India	AUC101
2	Indian Culture and Heritage	AUC102
3	Indian Architecture	AUC103
4	Indian Festivals	AUC104
5	Vaidic Mathematics	AUC105
6	Astronomy	AUC106
7	Arts of India	AUC107
8	Intellectual Property Right	AUC108
9	Human Rights	AUC109
10	Logical Research	AUC110
11	Professional Ethics	AUC111
12	Environmental Law	AUC112
13	Health Law	AUC113
14	National Cadet Corps	AUC114
15	Basics of Human Health and preventive medicines	AUC115
16	Constitution of India and Environment Governance: Administration And Adjudication	AUC 116
17	Directive Principles of State Policy and Fundamental Duties: Constitutional Imperative	AUC 117
18	Introduction To Intellectual Property to Engineers And Technologists	AUC 118
19	Fundamentals of Artificial Intelligence	AUC119
20	Indian Knowledge Through Classical Languages	IKS 101

21	Indian Knowledge System: Concepts And Applications In Science	IKS 102
22	Indian Knowledge System: Concepts And Applications in Engineering	IKS 103
23	Indian Knowledge System	IKS 104

Note: Detailed syllabus of Value-Added Courses (VAC)/ Audit Courses (AC) is attached as in **Annexure-01.

List of Extra Curricular Activity (ECA) Courses

ECA-II

S. No.	Branch	Category	Subject Name	Subject Code	Hours/ Week	Credit
1.	Open to all Branches	ECA	Skill Development-I	ECA-151	2	0
2.	Open to all Branches	ECA	Unity and Discipline (NCC)-I	ECA-171	2	0
3.	Open to all Branches	ECA	Unity and Discipline (NSS)-I	ECA-172	2	0
4.	Open to all Branches	ECA	Games & Sports-I	ECA-181	2	0
5.	Open to all Branches	ECA	Cultural, Art & Literary-I	ECA-182	2	0

ECA-III

S. No.	Branch	Category	Subject Name	Subject Code	Hours/ Week	Credit
1.	Open to all Branches	ECA	Skill Development-II	ECA-201	2	0
2.	Open to all Branches	ECA	Unity and Discipline (NCC)- II	ECA-221	2	0
3.	Open to all Branches	ECA	Unity and Discipline (NSS)-II	ECA-222	2	0
4.	Open to all Branches	ECA	Games & Sports-II	ECA-231	2	0
5.	Open to all Branches	ECA	Cultural, Art & Literary-II	ECA-232	2	0

ECA-IV

S. No.	Branch	Category	Subject Name	Subject Code	Hours /Week	Credit
1.	Open to all Branches	ECA	Skill Development-III	ECA-251	2	0
2.	Open to all Branches	ECA	Unity and Discipline (NCC)- III	ECA-271	2	0
3.	Open to all Branches	ECA	Unity and Discipline (NSS)- III	ECA-272	2	0
4.	Open to all Branches	ECA	Games & Sports-III	ECA-281	2	0
5.	Open to all Branches	ECA	Cultural, Art & Literary-III	ECA-282	2	0

ECA-V						
S. No.	Branch	Category	Subject Name	Subject Code	Hours/Week	Credit
1.	Open to all Branches	ECA	Skill Development-IV	ECA-301	2	0
2.	Open to all Branches	ECA	Unity and Discipline (NCC)- IV	ECA-321	2	0
3.	Open to all Branches	ECA	Unity and Discipline (NSS)-IV	ECA-322	2	0
4.	Open to all Branches	ECA	Games & Sports-IV	ECA-331	2	0
5.	Open to all Branches	ECA	Cultural, Art & Literary-IV	ECA-332	2	0
ECA-VI						
S. No.	Branch	Category	Subject Name	Subject Code	Hours/ Week	Credit
1.	Open to all Branches	ECA	Skill Development-V	ECA-351	2	0
2.	Open to all Branches	ECA	Games & Sports-V	ECA-381	2	0
3.	Open to all Branches	ECA	Cultural, Art & Literary-V	ECA-382	2	0
ECA-VII						
S. No.	Branch	Category	Subject Name	Subject Code	Hours/ Week	Credit
1.	Open to all Branches	ECA	Skill Development-VI	ECA-401	2	0
2.	Open to all Branches	ECA	Games & Sports-VI	ECA-431	2	0
3.	Open to all Branches	ECA	Cultural, Art & Literary-VI	ECA-432	2	0

Note: Detailed syllabus of Extra Curricular Activity (ECA) Courses is attached as* ***Annexure-02

Annexure-03

Micro-specialization 1: Cyber Security and Forensics

Category	Subject Code	Name of Subject	L	T	P	Credit
PE2	ECS-201	Fundamentals of Cyber Security and Forensics	3	1	0	4
PE4	ECS-401	Digital Forensics	3	0	2	4
PE6	ECS-601	Intrusion Detection and Prevention Systems	3	0	2	4
PE8	ECS-801	Advanced Cyber Operations and Forensic Analytics	3	0	2	4
Total						16

Micro-specialization 2: Artificial Intelligence and Machine Learning

Category	Subject Code	Name of Subject	L	T	P	Credit
PE2	ECS-202	Concept of AI and Applications	3	1	0	4
PE4	ECS-402	Introduction to Deep Learning	3	0	2	4
PE6	ECS-602	Generative AI	3	0	2	4
PE8	ECS-802	Multi-modal AI	3	0	2	4
Total						16

Micro-specialization 3: Data Analytics

Category	Subject Code	Name of Subject	L	T	P	Credit
PE2	ECS-203	Principles of Data Science and Analytics using Python	3	1	0	4
PE4	ECS-403	Data Engineering and Big Data Analytics	3	1	0	4
PE6	ECS-603	Data Science for Predictive Maintenance	3	1	0	4

PE8	ECS-803	Advanced Machine Learning and Predictive Modeling	3	1	0	4
Total						16

Micro-specialization 4: Blockchain Technology for Industrial Applications

Category	Subject Code	Name of Subject	L	T	P	Credit
PE2	ECS-204	Introduction to Distributed Ledger Technologies	3	1	0	4
PE4	ECS-404	Ethereum Smart Contracts and Distributed Systems	3	1	0	4
PE6	ECS-604	Security, Privacy, and Legal Aspects in Blockchain	3	1	0	4
PE8	ECS-804	Case studies of Industrial Application in blockchain	3	1	0	4
Total						16

Detailed of micro- specialization courses within the CSE Department are as follows:

Annexure-04
Minor Degree Course

Minor Degree 1: Data Science

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE1	ECS-103	Introduction to Data Science	3	1	0	4
PE3	ECS-303	Computing using Python	3	0	2	4
PE5	ECS-503	Data Visualization	3	1	0	4
PE7	ECS-703	Statistical Learning for Reliability Analysis	3	1	0	4
PE9	ECS-903	Reinforcement Learning	3	0	2	4/
	ECS-913	Deep Learning	3	0	2	4
Total						20

Minor Degree 2: Artificial Intelligence & Machine Learning

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE1	ECS-104	Introduction to Artificial Intelligence	3	1	0	4
PE3	ECS-304	Introduction to Machine Learning	3	0	2	4
PE5	ECS-504	Artificial Intelligence: Knowledge	3	1	0	4

		Representation and Reasoning				
PE7	ECS-704	Natural Language Processing	3	0	2	4
PE9	ECS-904	Optimization and Machine Learning	3	1	0	4/
	ECS-914	Deep Learning and Neural Network	3	0	2	4
Total						20

Minor Degree 3: Cyber Security & Cyber Physical Systems (CPS)

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE1	ECS-105	Cryptography and Network Security	3	1	0	4
PE3	ECS-305	Practical Cyber Security for Cyber Security Practitioners	3	0	2	4
PE5	ECS-505	Cyber Security and Privacy	3	1	0	4
PE7	ECS-705	Introduction to Security of Cyber-Physical Systems	3	1	0	4
PE9	ECS-905	Ethical Hacking	3	0	2	4/
	ECS-915	Computer Forensics	3	0	2	4
Total						20

Minor Degree 4: Computer Graphics and Virtual Reality

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE1	ECS-106	Computer Graphics for Virtual Reality	3	1	0	4
PE3	ECS-306	Computer Graphics and Game Programming	3	0	2	4
PE5	ECS-506	Concepts of Virtual and Augmented Reality	3	1	0	4
PE7	ECS-706	Scientific and Engineering Data Visualization	3	1	0	4
PE9	ECS-906	Interactive 3D Graphics	3	0	2	4/
	ECS-916	Sensors and actuators in AR/VR system	3	0	2	4
Total						20

Minor Degree 5: Blockchain and Cryptocurrency

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE1	ECS-107	Fundamental of Blockchain Technology and Applications	3	1	0	4
PE3	ECS-307	Private and Consortium Blockchain for Enterprise	3	1	0	4
PE5	ECS-507	Smart Contracts and Decentralized Applications	3	1	0	4

PE7	ECS-707	Introduction to Solidity Language	3	0	2	4
PE9	ECS-907	Blockchain for Social Impact: Democracy & Governance	3	1	0	4/
	ECS-917	Blockchain Security and Next Generation Applications	3	1	0	4
Total						20

Minor Degree 6: Software Engineering

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE1	ECS-108	Introduction to object oriented Programming using C++	3	0	2	4
PE3	ECS-308	Data Structures and Algorithms using C	3	0	2	4
PE5	ECS-508	Introduction to Software Engineering	3	1	0	4
PE7	ECS-708	Software Product Management	3	1	0	4
PE9	ECS-908	Software Testing and Quality Assurance	3	1	0	4/
	ECS-918	Agile Software Processes	3	1	0	4
Total						20

Minor Degree 7: Spatial Information Technology

Category	Subject Code	Name of Subject	L	T	P	Total Credit
PE1	ECS-109	Global Positioning System	3	1	0	4
PE3	ECS-309	Principle of Remote Sensing	3	0	2	4
PE5	ECS-509	Spatial Information Technology	3	0	2	4
PE7	ECS-709	Web Technology for Spatial Information Mapping	3	0	2	4
PE9	ECS-909	Satellite Image Processing	3	1	0	4/
	ECS-919	Spatial Data Quality Assessment	3	1	0	4
Total						20

SKILLS-ENHANCEMENT COURSES FOR EXIT
(COMPUTER SCIENCE & ENGINEERING)

2-Months internship for 6-Credits **OR** Two courses mentioned below of 4 to 6 credits.

A. After First Year: UG Certificate (Engg.).

The candidate should pass the following two additional courses (ITI Level) **OR** any two suitable skill- based courses to qualify for **UG Certificate (Engg.).**

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	Skill Enhancement	BCS-154	Problem Solving Through Python Programming	2	0	2	3
2.	Skill Enhancement	BCS-155	Computer Troubleshooting & Maintenance	2	0	2	3

OR

Equivalent skills-enhancement courses from MOOC/SWAYAM.

B. After Second Year: UG Diploma (Engg.).

The candidate should pass the following two additional courses **OR** any two suitable skill-based courses to qualify for **UG Diploma (Engg.).**

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	Skill Enhancement	BCS-264	Data Analytics using Python	2	0	2	3
2.	Skill Enhancement	BCS-265	Mobile Application Development	2	0	2	3

C. After Third Year: B. Voc. (Engg.).

The candidate should pass the following two additional courses **OR** any two suitable skill-based courses to qualify for **B. Voc. (Engg.).**

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	Skill Enhancement	BCS-310	Artificial Intelligence in Modern Healthcare Systems	2	0	2	3

2.	Skill Enhancement	BCS-311	Secure DevOps	2	0	2	3

Syllabus

First Year I Semester

BSM-110		**Engineering Mathematics I**
Course category	:	Basic Sciences & Math's (BSM)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	:	The course is aimed to develop the basic mathematical skills of engineering students that are imperative for effective understanding of engineering subjects.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. CO1. Use of basic differential operators in various engineering problems. CO2. .Understand the concepts of limit theory and nth order differential equations and their applications to our daily life CO3. Solve linear system of equations using matrix algebra. CO4. Know about qualitative applications of Gauss, Stoke's and Green's theorem. CO5. To know the applications of double and triple integration in finding the area and volume. CO6. To inculcate the habit of mathematical thinking and lifelong learning.

Topics Covered

UNIT-I **9L**

Differential Calculus: Limit, Continuity and Differentiability, Mean value theorems. Leibnitz theorem, Partial derivatives, Euler's theorem for homogenous function, Total derivative, Change of variable. Taylor's and Maclaurin's theorem. Expansion of function of two variables, Jacobian,
Extrema of function of several variables.

UNIT-II **9L**

Linear Algebra: Symmetric, Skew-symmetric matrices, Hermitian, Skew Hermitian Matrices, orthogonal and unitary matrices and basic properties, linear independence and dependence of vectors, Rank of Matrix, Inverse of a Matrix, Elementary transformation, Consistency of linear system of equations and their solution, Characteristic equation, Eigenvalues, Eigen-vectors,
Cayley-Hamilton theorem, Diagonalization of matrices.

UNIT-III **9L**

Multiple Integrals: Double and triple integrals, change of order of integration, change of variables. Application of multiple integrals to surface area and volume. Beta and Gamma functions, Dirichlet integral.

UNIT-IV **9L**

Vector Calculus: Gradient, Divergence and Curl. Directional derivatives, line, surface and volume integrals. Applications of Green's, Stoke's and Gauss divergence theorems (without Proofs).

TEXTBOOKS/ REFERENCE

1. B.S. Grewal: Higher Engineering Mathematics; Khanna Publishers
2. Erwin kreyszig: Advanced Engineering Mathematics, John Wiley & Sons.
3. R. K. Jain and Iyenger: Advanced Engineering Mathematics, Narosa Publications.
4. B.V. Ramana: Higher Engineering Mathematics, Tata Mc. Graw Hill Education Pvt. Ltd.,

BSM 131/181		**ENGINEERING PHYSICS**
Course category	:	Basic Sciences and Maths (BSM)
Pre-requisite Subject	:	Physics at 12thStandard
Contact hours/week	:	Lecture: 3, Tutorial: 0 , Practical: 2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and one Minor test and One Major Theory Examination
Course Objectives	:	Understanding of the principles and concept of Optics, Quantum Mechanics, Fiber Optics, Electrodynamics and Physics of Advanced Materials.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attributes after completing this course. 1. Understand the basics principles of Optics and its applications in Engineering and Technology. 2. Compare and understand the uses of various applications of interference and diffraction in the different fields of Engineering. 3. Know the knowledge of polarization and their applications in Photonics. 4. Understand the principles of Quantum Mechanics and their applications in Engineering and Technology. 5. Know the principles of Electrodynamics and their applications in Engineering and Technology. 6. Understand the basic properties of advanced materials and their engineering applications.
Topics Covered		
UNIT-I: Optics		**9**

Interference: Interference of light, Interference in thin films, Newton's rings. Refractive index and wavelength determination.

Diffraction: Fresnel and Fraunhofer class of diffraction. Resultant of n-hormonic waves, single, double and N- slit diffraction, Diffraction grating, Grating spectra, Dispersive power.

Polarization: Phenomena of double refraction, Nicol prism, Production and analysis of plane, circular and elliptical polarized light, Retardation Plate, Polarimeter.

UNIT – II: Quantum Mechanics	**9**

Quantum Mechanics: de Broglie waves, Davisson-Germer experiment, Concept of Phase and Group velocities, Uncertainty principle and its applications, Derivation of time independent and time dependent Schrodinger wave equations. Postulates of quantum mechanics, Significance of wave function, Application of Schrodinger wave equation for a particle in one dimensional infinite potential well.

UNIT-III: Electrodynamics	**9**

Scalar and Vector fields, Gradient, Divergence and curl, Concept of displacement current, Maxwell's equation in differential and integral forms, Physical significance of each equation.

Maxwell's equation in free space, Velocity of electromagnetic wave, Transverse nature of the electromagnetic wave, Poynting vector, Maxwell's equations in dielectric and conducting medium, and skin depth.

UNIT-IV: Physics of Advanced Materials	**9**

Concept of energy bands in solids, Semiconducting materials, Concept of direct and indirect band gap in semiconductors, Carrier concentration and conductivity in semiconductors, Optoelectronic Materials, Superconducting Materials, Temperature dependence of resistivity in superconducting materials, Effect of magnetic field (Meissner effect), Type I and Type II superconductors, London Equations, BCS theory (Qualitative), Introduction of nanoscience, Nanotechnology and its applications.

EXPERIMENTS

1. To determine the specific resistance of a given wire using Carrey Foster's Bridge.
2. To determine the wavelength of sodium light using Newton's Ring experiment.
3. To determine the wavelength of spectral lines of white light using plane diffraction grating.
4. To determine the specific rotation of cane sugar solution using polarimeter.
5. To study the variation of magnetic field along the axis of current carrying circular coil.
6. To study the Hall's effect and to determine Hall coefficient in n type Germanium.
7. To study the energy band gap of Germanium using four probe method.
8. To determine the height of Tower by Sextant.

Books & References

1. Optics- Ajoy Ghatak, Tata McGraw-Hill
2. Optics- N. Subrahmanyam, Brij Lal, M.N. Avadhanulu, S. Chand
3. Quantum Mechanics: Theory and Applications- Ajoy Ghatak, Tata McGraw-Hill
4. Fiber optics and laser Principles and Applications-Anuradha De, New Age International
5. Optical Fibers and its application as sensors by R. K. Shukla, New Age International.
6. Introduction to Electrodynamics by David J. Griffiths, Pearson
7. Physics of Semiconductor Devices, by S. M. Sze, Wiley
8. Concepts of Modern Physics by Arthur Beiser, Tata MCGraw Hill.
9. Introduction to Solid State Physics by C. Kittel, Wiley.
10. Engineering Physics by B. K. Pandey and S. Chaturvedi, 3e Cengage Learning Pvt. Limited, India.

11. Engineering Physics by H. K. Malik and A. Singh Tata MCGraw Hill.
12. Advanced Practical Physics Vol. I and Vol. II by D. K. Dwivedi, Victorius Publishers, New Delhi.

BCS-110/160	:	**Introduction to C Programming**
Course category	:	Engineering Fundamental (EF)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	:	The course covers the basics of programming and demonstrates fundamental programming techniques, customs and terms including the most common library functions and the usage of the pre-processor. The salient features of course objectives are given below. 1. To develop C Programs using basic programming constructs 2. To develop C programs using arrays and strings 3. To develop applications in C using functions and structures
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course CO1. Basic terminology used in computer programming. CO2. Programs development in C Language by writing, compiling, and debugging. CO3. Design of programs involving simple statements, conditional statements, iterative statements, array, strings, functions, recursion, structure, and union. CO4. Difference between call by value and call by reference. CO5. Dynamic memory allocations and use of pointers. CO6. Basic operations on a file.

Topics Covered

UNIT-I **9L**

Basics of programming: Approaches to Problem Solving, Concept of Algorithm and Flow Charts, Types of Computer Languages: Machine Language, Assembly Language and High-Level Language, Concept of Assembler, Compiler, Linker, and Loader. Data types, Storage Classes: Auto, Extern, Register and Static. Operators, Expressions, Operator Precedence and Associativity.

Fundamentals of C Programming: Structure of C Program, Writing and Executing the First C Program, Components of C Language, Standard I/O, Formatted I/O. Conditional Program Execution: Applying if and switch Statements, Nesting if and else. Program Loops and Iterations: Use of while, do while and for Loops, Multiple Loop Variables, Use of break and continue Statements, goto Statement.

UNIT-II **9L**

Arrays: One Dimensional, Multidimensional Array and Their Applications, Declaration and Manipulation of Arrays.

Strings: String Variable, String Handling Functions, Array of Strings.

Functions*:* Designing Structured Programs, Functions in C, User Defined and Standard Functions, Formal vs. Actual Arguments, Function Category, Function Prototype, Parameter Passing, Recursive Functions. Storage Classes revisited.

UNIT-III **9L**

Pointers: Pointer Variable and its Importance, Pointer Arithmetic Pointers and Arrays, Pointer and Character Strings, Pointers and Functions, Array of Pointers, Pointers to Pointers.

Structure: Declaration and Initialization of Structures, Structure as Function Parameters, Structure Pointers.

Union: Declaration and Initialization of Unions, Union as Function Parameters, Union Pointers

UNIT-IV **9L**

Dynamic Memory Allocation: malloc, calloc, realloc, free functions.

File Management: Defining and Opening a File, Closing a File, Input/ Output Operations in Files. The Pre-processor Directives, Macros. Command Line Arguments. Introduction to Graphics Programming.

LIST OF EXPERIMENTS-

1. Write programs to print statements in sequential order using simple printf, scanf input/output functions.
2. Write programs to implement if-else condition (simple as well as nested) on suitable problems.
3. Write a program to implement switch-case conditional logic on suitable examples.
4. Write programs to implement for, while and do-while loop control statements on suitable problems.
5. Write programs to implement 1D & 2D array concepts on suitable problems such as sorting of elements, searching of element, matrix addition, subtraction, multiplication etc.
6. Write programs to implement string related concepts such as sorting of a string, finding its length, reversing, concatenation, comparing two strings etc.
7. Write programs to implement concept of user defined functions (call by value, call by reference, recursive calling etc.) on suitable examples.
8. Write programs to implement concepts of pointer.
9. Write programs to implement the concept of structure and union.
10. Write programs to implement dynamic memory allocation functions (calloc, malloc, free, realloc)
11. Write programs to implement file handling concepts such as reading from a file, writing to a file using file related functions (fclose, fopen, sscanf, sprint, fread, fwrite, getc, putc, getw, putw etc.)

TEXTBOOKS

1. Jeri R. Hanly and Elliot B. Koffman, Problem Solving and Program Design in C, 7th Edition, Pearson.
2. Schildt, Herbert, Complete Reference with C, Tata McGraw Hill.
3. Kerninghan and Ritchie, The C programming Language, 2nd Edition, Prentice Hall.
4. Richard Bird, Introduction to Functional Programming using Haskell, 2nd Edition, Prentice-Hall International, 1998.

REFERENCE BOOKS

1. Greg Michaelson, An Introduction to Functional Programming Through Lambda Calculus, Dover Edition, Addition Wesley Publication.
2. Samuel P. Harbison, and Guy L. Steele Jr., C-A Reference Manual, Fifth Edition, Prentice Hall, 2002.

BCS-111		**Web Designing-1**
Course category	:	Professional Skill (PF)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 2, Tutorial: 0, Practical: 4
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	:	Web designing-I syllabus contains a basic introduction to familiarize students with the basics of designing a website to its tools, software applications and themes. Here are the key topics covered under the introduction to web designing. 1. How to design a website 2. Creating different themes for different layouts 3. How to design the look and feel of a website 4. How to create and design banners, advertisements, etc
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course CO1. Understand principle of Web page design and about types of websites. CO2. Visualize and Recognize the basic concept of HTML and application in web designing. CO3. Recognize and apply the elements of Creating Style Sheet (CSS). CO4. Understanding the basic concept of Java Script and its application.

		CO5. Understanding the basic concept Angular JS. CO6. Learning about the tools and techniques of web design covers using software applications

Topics Covered

UNIT-I **6L**

HTML: Introduction to web site, Domains and Hosting, Responsive Web Designing, Types of Websites: Static and Dynamic, HTML5, Basic structure of an HTML document, HTML Tags: Heading, Paragraphs, Line Breaks, Text, Lists, Tables, Frames, Hyperlinks, Images, Multimedia, Forms, and their controls.

UNIT-II **6L**

Creating Style Sheet (CSS): Creating Style Sheet, CSS Properties, CSS Styling, CSS Id and Class, Box Model, CSS Advanced: Grouping, Dimension, Display, Positioning, Floating, Align, Pseudo class, Navigation Bar, Image Sprites, Attribute sector, CSS Colour. Basics of responsive web design using Bootstrap.

UNIT-III **6L**

Java Script: Introduction to Java Script, Variables, Operators, Conditions Statements, Loops, Popup Boxes, Events, Arrays, Objects, Functions in JS, Form Validation and regex, JSON.

UNIT-IV **6L**

Angular Java Script: Introduction to AngularJS, MVC Architecture, Expressions and Data Biding, Directives, Controllers, Filters, Forms, Modules, Introduction to Single page application.

LIST OF EXPERIMENTS-

1. To create a simple html file to demonstrate the use of different tags.
2. To create an html file to link to different html page which contains images, tables, and also link within a page.
3. To create an html page with different types of frames such as floating frame, navigation frame & mixed frame.
4. To create a registration form as mentioned below.
5. Procedure: Create an html page named as “registration.html”
    i. set background colors
    ii. use table for alignment
    iii. provide font colors& size
6. To create an html file by applying the different styles using inline, external & internal style sheets.
7. Create a sample HTML form using bootstrap.
8. To write a Javascript program to define a user defined function for sorting the values in an array.

9. To create an html page to explain the use of various predefined functions in a string and math object in java script.
10. To create an html page to explain the use of various predefined functions in a array & Date object in Javascript.
11. To create an html page to demonstrate exception handling in javascript
12. To display the calendar using javascript code by getting the year from the user.
13. To create a html registration form and to validate the form using javascript code.
14. To create a html file. To open new window from the current window using javascript.
15. To create an html page to change the background color for every click of a button using javascript.
16. To create an html page with 2 combo boxes populated with month & year, to display the calendar for the selected month & year from combo box using javascript.
17. To create a html page to display a new image & text when the mouse comes over the existing content in the page.
18. Create a single page application using concepts of Angular JS.

TEXTBOOKS/REFERENCES

1. Steven M. Schafer, "HTML, XHTML, and CSS Bible, 5ed", Wiley India
2. Ian Pouncey, Richard York, "Beginning CSS: Cascading Style Sheets for Web Design", Wiley India
3. Douglas Crockford, JavaScript: The Good Parts: The Good Parts. O'Reilly Media, Inc.
4. Brad Green, Shyam Seshadri, AngularJS, O'Reilly Media, Inc

BHS- 101/151		**Universal Human Values: Understanding Harmony**
Course category	:	HSS
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lectures: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	:	: The objectives of this course are to: - 1. Develop a holistic perspective in students based on self-exploration about themselves (human being), family, society and nature/existence. 2. Develop understanding (or developing clarity) in students about

		harmony in the human being, family, society and nature/existence. 3. Strengthen self-reflection in students. 4. Develop commitment and courage in students to act.
Course Outcomes	:	The students will be able to demonstrate the following knowledge, skills, and attitudes upon completion of the course: - CO1. Ability to understand the interconnectedness of humanity and nature as well as the importance of values in interpersonal relationships. CO2. Ability to recognize their role as global citizens and understand the importance of actively contributing to the betterment of society through responsible actions. CO3. Ability to engage in critical reflection on their own values and beliefs, challenging assumptions and biases to foster personal growth and development. CO4. Ability to appreciate and respect diversity thereby promoting communication and conflict resolution skills, promoting dialogue and understanding in resolving interpersonal and intergroup conflicts

Topics Covered

UNIT-I **9L**

Introduction to Values: origin, definition, meaning, and types of values; Values in Education System; difference between Values, Morals, and Ethics; Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and 'Experiential Validation' as the process for self-exploration; Continuous Happiness and Prosperity- A look at basic human aspirations; Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority; Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario; Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

UNIT-II **9L**

Understanding human being as a co-existence of the sentient 'I' and the material 'Body'; Understanding the needs of Self ('I') and 'Body' - happiness and physical facility; Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer); Understanding the characteristics and activities of 'I' and harmony in 'I'; Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail; Programs to ensure Sanyam and Health

UNIT-III **9L**

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship; Understanding the meaning of Trust; Difference between intention

and competence; Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship; Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals; Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family**.**

UNIT-IV **9L**

Understanding the harmony in the Nature; Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature; Understanding Existence as Co-existence of mutually interacting units in all-pervasive space; Holistic perception of harmony at all levels of existence; Natural acceptance of human values; Definitiveness of Ethical Human Conduct; Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order; Competence in professional ethics.

TEXTBOOKS/ REFERENCES

1. Andrews, C. (2006). Slow is beautiful. New Society Publishers.
2. Gandhi, M. K. (1909). Hind Swaraj or Indian Home Rule. Navjeevan Trust.
3. Gandhi, M. K. (2009). An Autobiography or The Story of My Experiments with Truth (Mahadev Desai, Trans.). Navjeevan Mudranalay. (Original work published 1925).
4. Gaur, R. R., Sangal, R., & Bagaria, G. P. (2010). A Foundation Course in Human Values and Professional Ethics. Excel Books.
5. Govindrajan, M., Senthilkumar, S., & Natarajan, M. S. (2013). Professional Ethics and Human Values. Prentice Hall India.
6. Kumarappa, J. C. (2017). Economy of Permanence. Sarva Seva Sangh Prakashan.
7. Naagarazan, R. S. (2022). A Textbook on Professional Ethics and Human Values. New Age International.
8. Rolland, R. (2010). Life of Vivekanad (4th Ed.). Advait Ashram.
9. Schumacher, E. F. (1973). Small is beautiful. A study of Economics as if people mattered. Blond & Briggs.
10. Suresh, J., & Raghavan, B. S. (2003). Human Values and Professional Ethics. S Chand.

First Year II Semester Syllabus

BSM-160		**Engineering Mathematics II**
Course category	:	Basic Sciences & Maths (BSM)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major

		Theory Examination
Course Objectives	:	The course is aimed to develop the basic mathematical skills of engineering students that are imperative for effective understanding of engineering subjects
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course CO1. To solve the ordinary differential equations. CO2. To solve the partial differential equations using Lagrange and charpit's method. CO3. To solve and understand the properties of Bessel`s and Legendre`s differential equation. CO4. Application of partial differential equation in real life problems CO5. To solve ODE and PDE with the help of Laplace transform CO6. To inculcate the habit of mathematical thinking and lifelong learning.

Topics Covered

UNIT-I **9L**

Ordinary Differential Equations I: Linear differential equations with constant coefficients ($n^{th}order$), complementary function and particular integral. Simultaneous linear differential equations, solution of second order differential equations by changing dependent and independent variables, Method of variation of parameters, Applications of differential equations to engineering problems

UNIT-II **9L**

Ordinary Differential Equations II: Series solution of second order differential equations with variable coefficient (Frobeneous method). Bessel and Legendre equations and their series solutions, Properties of Bessel function and Legendre polynomials.

UNIT-III **9L**

Partial Differential equations: Partial differential equations of the first order, Lagrange's solution, Charpit's general method of solution, Partial differential equations of the second order: Constant coefficient and reducible to constant coefficient, Classification of linear partial differential equations of second order**.**

UNIT-IV **9L**

Laplace Transform: Laplace Transform, Laplace transform of derivatives and integrals. Unit step function, Laplace transform of Periodic function. Inverse Laplace transform, Convolution theorem, Applications to solve simple linear and simultaneous differential equations and Partial Differential Equations.

TEXTBOOKS/ REFERENCES

1. B.S. Grewal: Higher Engineering Mathematics; Khanna Publishers
2. Erwin kreyszig: Advanced Engineering Mathematics, John Wiley & Sons.
3. R. K. Jain and Iyenger: Advanced Engineering Mathematics, Narosa Publications.
4. B.V. Ramana: Higher Engineering Mathematics, Tata Mc. Graw Hill Education Pvt. Ltd.
5. M.D. Raisinghania, Ordinary and Partial Differential Equations. S Chand Publications.

BSM-140/BSM-190		**Environmental Science and Green Chemistry**
Course category	:	Basic Sciences & Maths (BSM)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial : 0 , Practical: 2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	:	Understanding the principles and concepts of Chemistry viz. Chemical Bonding, acidity and basicity, Atmospheric Chemistry & Water Chemistry, Spectroscopic analytical methods and Green Chemistry and solving industrial problems using solid foundation in Chemistry.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course: CO1. To develop the concepts of basic chemistry. CO2. To make the students aware of global environmental issues e.g. global warming & Greenhouse effect, Ozone depletion, pollution and its prevention and understand various aspects of atmospheric chemistry. CO3. To understand the analytical and conceptual skills required for environmental chemistry research. CO4. To understand water treatment for all types of uses and need to protect environment. CO5. To understand the specifications of pure water and its purification techniques. CO6. To develop the knowledge about Green Chemistry and Green Technology.

Topics Covered

UNIT-I **9L**

Basic Chemical Concepts

Periodic properties of elements, Ionization potential, electron affinity and electronegativity; mole concept,

molarity and normality, Chemical Bonding – MO Theory, MO diagram of diatomic molecules, hydrogen bonding, electrophiles, nucleophiles, inductive effect and mesomeric effect. Reaction Mechanism. Acidity and basicity - Concept of pH.

UNIT-II **9L**

Atmospheric chemistry & Water Chemistry

The atmosphere of Earth, layers of atmosphere and temperature inversion, Air pollution, Global warming and Greenhouse effect. Acid rain and Ozone layer depletion. Chemical and photochemical Smog. Sources of water, conservation of water, impurities in water and their effects. WHO guideline and BIS guideline for drinking water. Hardness of water, Softening of water by Zeolite process, Lime Soda process, Ion exchange process and Reverse osmosis.

UNIT-III **9L**

Spectroscopic analytical methods

Absorbance, Transmittance and Beer-lamberts Law. Basic principles of UV-Visible spectroscopy, Fluorescence spectroscopy, Infrared spectroscopy, NMR Spectroscopy. Use of these instrumental techniques for monitoring of environmental pollution.

Environmental problems posed by the use of non-biodegradable polymers widely used in day-to-day life. Incineration as the key method for disposal of polymeric waste. Bio-degradable polymers.

UNIT-IV **9L**

Green Chemistry

Green Chemistry and Green Technology: New trends in Green chemistry; Green Chemistry Methodologies-Microwave heating, ultrasound technique. Green Chemical Synthesis Pathways; Green reagents, Green solvents.

LIST OF EXPERIMENTS:

1. Determination of temporary and permanent hardness in water sample using EDTA as standard solution.
2. Determination of alkalinity in the given water sample.
3. Determination of chloride content in the given water sample by Mohr's method.
4. Determination of percentage of available chlorine in bleaching powder sample.
5. Determination of iron content in the given sample using K3[Fe(CN)6] as an external indicator.
6. Determination of Electrical conductivity/TDS of a given water sample using conductivity meter.
7. Determination of dissolved Carbon Dioxide of given water sample.
8. Determination of the biochemical oxygen demand of sewage influent.
9. To calculate the lambda max of the given compound by using UV-Visible spectrophotometer.
10. Determination of nickel / cobalt / copper solutions by UV–visible spectrometry.
11. Examples of Green Synthesis /Reactions.
12. Determination of Turbidity of Water

13. Iodoform test
14. Synthesis of a polymer Bakelite or Polyacrylic acid.

TEXTBOOKS/ REFERENCES

1. A Text Book of Environment and Ecology, Shashi Chawla, Tata McGraw Hill
2. Environmental Studies, Raj Kumar Singh, Tata McGraw Hill
3. Engineering Chemistry, Wiley India
4. Engineering Chemistry, Tata McGraw Hill
5. Organic Chemistry, Morrison & Boyd, 6th edition, Pearson Education
6. Fundamentals of Environmental Chemistry, Manahan, Stanley E., Boca Raton: CRC Press LLC.
7. Environment and Ecology, R K Khandal, Wiley India
8. An Introductory Text on Green Chemistry: For Undergraduate Students, lndu Tucker Sidhwani, Rakesh K. Sharma, Wiley
9. A text book of Green Chemistry, Shankar Prasad Deo and Nayim Sepay, Techno World Publication.
10. Introduction to Green Chemistry, John Andraos, Albert S. Matlack, CRC Press

BEE-110/160		**Basic Electrical Engineering**
Course category	:	Engineering Fundamentals (EF)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	:	1. To demonstrate and understand the basic knowledge of electrical quantities such as current, voltage, power, energy, and frequency to understand the impact of technology in a global and societal context. 2. To demonstrate and understand the basic concepts of analysis of simple DC and AC circuits used in electrical engineering and apply the basic concepts in Electrical engineering for multi-disciplinary tasks.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course: CO1. Understand the basic properties of electrical elements, and solve problem based on basic electrical circuits & DC network theorems. CO2. Understand the fundamental behaviour of AC circuits and solve AC circuit problems. CO3. Apply the knowledge gained to explain the behaviour of the circuit at series & parallel resonance of circuit & the effect of

		resonance. CO4. Classify different electrical measuring equipment's and understanding their principles. CO5. Understand the basic concepts of magnetic circuits. CO6. Explain construction and working principle of transformer.
Topics Covered		
UNIT-I **9L** **D C Circuit Analysis and Network Theorems:** Circuit Concepts: Concepts of network, Active and passive elements, Voltage and current sources, Concept of linearity and linear network, Unilateral and bilateral elements, R, L and C as linear elements, Source transformation, Kirchhoff's laws, Loop and nodal methods of analysis, Star-delta transformation, Network theorems: Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem.		
UNIT-II **9L** **Introduction to AC Circuits:** AC fundamentals, Analysis of single phase series, parallel and series-parallel RLC Circuits, Resonance in series and Parallel circuit. Three Phase AC Circuits: Three phase system-its necessity and advantages, Star and delta connections, Balanced supply and balanced load, Line and phase voltage/current relations, three- phase power, and its measurement.		
UNIT-III **9L** **Measuring Instruments:** Fundamentals of measurement & instrumentation, Units, Dimensions and Standards. Error Analysis, types of errors & its analysis. Measuring instruments, construction and working principles of PMMC, Moving Iron and Electro-dynamometer type voltmeters & ammeters, Use of shunts and multipliers.		
UNIT-IV **9L** **Magnetic Circuits and Transformers:** Magnetic circuit concepts, analogy between electric & magnetic circuits, B-H curve, Hysteresis, and eddy current losses. Single Phase Transformer: Principle of operation, Construction, EMF equation, Power losses, Efficiency, O.C & S.C Test and Introduction to auto transformer.		
LIST OF EXPERIMENTS 1. Verification of Kirchhoff's Law. 2. Verification of Norton's Theorem.		

3. Verification of Thevenin's Theorem.
4. Verification of Superposition Theorem.
5. Verification of Maximum Power Transfer Theorem.
6. Verification of Series R-L-C circuit.
7. Verification of Parallel R-L-C circuit.
8. Measurement of Power and Power factor of three phase inductive load by two wattmeter method.
9. To perform O.C. and S.C. test of a single-phase transformer.

TEXTBOOKS/ REFERENCES

1. Fundamentals of Electric Circuits, C.K. Alexander and M.N.O. Sadiku; TATA McGraw-Hill.
2. Principles of Electrical Engineering, V. Del Toro; Prentice Hall International.
3. Electrical and Electronics Technology, Edward Hughes; Pearson.
4. Basic Electrical Engineering, D P Kothari, I.J. Nagarath; Tata McGraw Hill
5. Electrical Technology, B. L. Thareja and A. K. Thareja; S. Chand.

BCS-161		**Web Designing-2**
Course category	:	Professional Skill (PF)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 2, Tutorial: 0, Practical: 4
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	:	The Advanced Web Design course is designed to prepare students for professional web design work. The class will be a mix of theoretical/soft skills and more practical front-end techniques. The objective is listed below. 1. To design web sites which use HTML tables, forms, frames, and Cascading Style Sheets. 2. To learn the advantages of HTML tables, forms, frames Cascading Style Sheets and CSS box model and when they are best utilized. 3. To provide definitions and explanations for a large number of technical terms and acronyms related to web site design. 4. To apply the techniques and features of imagemaps to web site navigation. 5. To understand the issues related to web graphics (size versus resolution) as well as how to create, optimize, and display graphic images. 6. Be able to create and edit simple animated web graphics.
	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

Course Outcomes		CO1. Understand principle of Web application design. CO2. Understand principle of Application Programming Interface (API). CO3. Apply the knowledge of Node JS on web application development. CO4. Host the web application on web server. CO5. learn how to employ meta tags and HTML cookies to improve the experience of web site visitors. CO6. be able to create, validate, transform and display XML files.

Topics Covered

UNIT-I **6L**

Introduction to Node JS, Setup Dev Environment, Node JS Modules, Node Package Manager.

UNIT-II **6L**

Creating Web server, File System, Debugging Node JS Application, Events, Express.JS, Serving Static Resources.

UNIT-III **6L**

Basics of MySQL, Query building, Database connectivity using Node JS

UNIT-IV **6L**

Introduction to Nginx server, Introduction to AWS EC2, Web application hosting on AWS.

LIST OF EXPERIMENTS

1. Create API to authentication using Node JS.
2. Create API for session management in Node JS.
3. Create a web application to search an employee from an employee database.
4. Create a web application to generate salary receipt of an employee of an organization.
5. Create a web application for leave management of employees of an organization.
6. Host the employee web application on AWS EC2 server.

TEXTBOOKS/ REFERENCE BOOKS

1. Ethan Brown, Web Development with Node and Express: Leveraging the JavaScript Stack, O'Reilly Media, Inc.
2. David Stokes, MySQL and JSON: A Practical Programming Guide, Oracle Press

BHS- 102/152		**TECHNICAL WRITING AND PROFESSIONAL COMMUNICATION (TW&PC)**
Course category	:	HSS
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lectures: 2, Tutorial: 1, Practical: 2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	:	The objectives of this course are to: - The course aims- 1. To sensitize the students to understand the role and importance of communication for personal and professional success. 2. To enable the learners to enhance their writing skills in techno-cultural and professional echo-system. 3. To equip learners to differentiate technical writing from general writing. 4. To equip them with technical writing skills. 5. To enable learners to exhibit knowledge, skills, attitude and judgment in and around human communication that facilitate their ability to work collaboratively with others in an interpersonal environment.
Course Outcomes	:	The students will be able to demonstrate the following knowledge, skills, and attitudes upon completion of the course: -Overcome the problems she/he shall faces in oral and written CO1. Communication. CO2. Acquire knowledge of and methods for using technical communication, such as reports, proposals, technical letters, etc. CO3. Use and Practice compositions correctly. CO4. Give presentations in different sessions and make self-appraisal. CO5. Learn and understand the various facets of Communication Skills, such as (LSRW) Listening, Speaking, Reading, and writing, and identify, formulate, and solve real-life problems with a positive attitude; also inculcate, the habit of learning and developing communication and soft skills.
Topics Covered		
UNIT-I **6 L** **Language Vs communication:** Communication as coding and decoding – signs, symbols & pictograph –		

verbal and non–verbal symbols – Language & communication; Types of Communication- functional, situational, verbal, and non-verbal, interpersonal, group, interactive, public, Mass Communication. Thinking and Articulation, critical, creative aspects of articulation.

Skills of Language Acquisition: Natural Language Acquisition Skills: Listening, Speaking, Reading& Writing {LSRW}; Language Acquisition Through Training: Listening, Speaking, Reading, Writing, Grammar & Vocabulary {LSRWGV}

Phrase, Clause & Sentence in Professional Drafting-Simplicity, Clarity and Conciseness of a Presentation, Differentiating between Professional and Creative Writing, Blending of Artistic/Professional Writing, Avoiding gender, racial, and other forms of bias in Professional Writing. Pré-writing, Drafting, and Re-writing.

UNIT-II **6L**

Technical Paper Writing: Professional Paper Elements-Front Matter of a Paper, Main Text of a Paper, End Matter of a Paper: Organizing References and Bibliography, Order of a thesis and Paper Elements, Concluding Remarks. **Methods of Research Paper Writing:** Identification of Author and His Writing-Author's name and Affiliation, Joint Authorship of a Paper, Identification of Writing- Title, Keywords, Synopsis, Preface and Abstract. Drafting Research Article & Methodology.

Thesis/Dissertation Writing: Thesis Elements-Front Matter of a Thesis, Main Text of a Thesis, End Matter of a Thesis, Specimen—Thesis and Research Paper, Chapters and Sections-Introductory Chapters and Sections, Statement of the Problems, Plan and Scope, Core Chapters and Sections- Theoretical Analysis and Synthesis, Basic Assumption and Hypothesis.

Professional Presentation & Seminar Delivery Tools: Designing the Presentation; Establishing the Objectives. Making Professional PowerPoint Presentations, Signaling Structure of Presentation through Sentences and Crisp Phrases, Preparing Notes for Professional/Technical Presentation, Text Animation, White Board, Flip Charts, Diagrams, Preparing Cards. Seminar Presentations: Purpose modes and methods. Nascent Emerging Platforms for On-line Presentations viz. Zoom, Webex, Team& Meet etc.

UNIT-III **6L**

Professional Drafting: Letters vs. e-mails, Formal and Informal emails, Parts of e-mails, Types of e-mails, Managing tone of E-mails and business Letters, Examples of Letters and E-mail, Professional Correspondence through E-mail, Job Applications and cover Letters. Introduction to DOs (Demi- Official Letters)

Career & Correspondence: Developing a Professional C.V, Bio Data & Resume. Report Writing, Kinds of Reports, Length of Report, Parts of a Report, Terms of Reference, Collection of Facts, Outlines of Report, Examples of Report, Technical Proposal, Elements of Proposal, Examples of Proposal, drafting of proposal.

UNIT-IV **6L**

Conducting Professional Meeting: Pre-meeting Preparation, During Meeting: Action Taken Report (ATR) & New Agenda Points, Post Meeting Follow ups. Notice, Circular, Agenda & Meeting Minutes.

Introduction to Generation–Z, Cyber Identity & Professional Netiquettes for Netizens: DraftingE- mails,

Blogs on social media, Videoconferencing. Managing Profiles on social media. What to Write and Share on social media. Telephone Etiquettes & Phubbing.

LIST OF EXPERIMENTS:

1. Introduction to Vowel and Consonant Sounds
2. Monophthongs and Diphthongs
3. Syllable, Word Stress & Intonation
4. Harnessing Non-verbal Communication Skills in Cross-Cultural Environment for the establishment of an ideal Ecosystem to ensure Professional Success
5. Developing Speech, and Proofreading the Same
6. Argumentative Skills & Group Dynamics
7. Preparing CV, Biodata & Resume
8. Types of Interview and Interview Skills
9. GD, PI & Telephonic Interview
10. Presentation Skills, Extempore, Debate and Video Conferencing
11. Netiquettes while Writing Blogs on social media.
12. Ethical Usages of Generative AI

TEXTBOOKS/ REFERENCES

1. Acharya Anita. (2012) Interview Skills- Tips & Techniques. Yking Books, Jaipur.
2. Basu, B. N., (2008) Technical Writing. PHI Learning Pvt. Ltd.., New Delhi.
3. Chauhan, N. K & Singh, S. N. (2013) Formal Letters, Pankaj Publication International, New Delhi.
4. Chhabra T.N. (2018) Business Communication. Sun India Publication New Delhi.
5. Dubey Arjun et.al. (2016) Communication for Professionals. Alfa Publications, Delhi.
6. Gibaldi, Joseph (2021). The MLA Handbook for Writers of Research Papers. Ed. IXth, Modern Language Association of America, NY, US.
7. Gurumani, N. (2010) Scientific Thesis Writing and Paper Presentation, MJP Publishers, Chennai.
8. Hamilton Richard. (2009) Managing Writers. Penguin, India.
9. Mc Graw S. J. (2008) Basic Managerial Skills for All. Ed. 08th, Prentice Hall of India, New Delhi.
10. Murphy & Hildebrandt. (2008) Effective Business Communication. Tata McGraw Hill New Delhi.
11. Pandey, S.P., Singh, S. N. & Kumar, Raman, (2023) Exploring Digital Humanities: Challenges & Opportunities, MacBrain Publishing House, New Delhi.

BCS - 162		**Design Thinking in Information & Understanding**
Course category	:	Audit Course (AC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 0, Tutorial: 0, Practical: 2
Number of Credits	:	0
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major

		Theory Examination
Course Objectives	:	The course is designed to give an in-depth understanding on various aspects of innovation, creativity, evolving business models, incubation and entrepreneurship and come up with exposure to design thinking for designing innovative products. By learning how to practice and champion design thinking in any role you're in. 1. Continuously produce breakthrough ideas 2. Catalyze design thinking in your daily routine 3. Unlock the innovative capacity of your team 4. Build a lifelong practice of creative problem-solving
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course. CO1. Explain the fundamentals of Design Thinking and innovation. CO2. Analyse the model action plan. CO3. Describe the principles of innovation and idea generation for product design. CO4. Apply design thinking techniques for given tasks and in solving problems in various sectors. CO5. Evaluate innovation strategies and evolving business models by integrating design thinking principles in startups, software development, and organizational processes. CO6. Develop and validate sector-specific solutions through prototyping, usability testing, and interpretation of results using design thinking and computational thinking approaches.

Topics Covered

UNIT-I

Introduction to Design Thinking: Introduction to elements and principles of Design, Importance of Design Thinking, why design thinking skills matter, Fundamental design components. Principles of design. Introduction to design thinking, history of Design Thinking, Design Thinking Framework -Design Thinking Methods - Empathise –Define – Ideate – Prototype – Test- Software Development Methodology.

Design thinking: Design thinking process (empathize, analyze, idea & prototype), implementing the process in driving inventions, design thinking in social innovations. Tools of design thinking - person, customer, journey map, brainstorming, product development.

UNIT-II

Innovation: Art of innovation, Difference between innovation and creativity, role of creativity and innovation in organizations. Creativity to Innovation. Teams for innovation, Measuring the impact and value of creativity, Innovation Management-Changing Management Paradigms-Design Thinking related to Science and art-Design, Thinking in Business-Linking Design Thinking Solution to Business Challenges

Product Design: Problem formation, Introduction to product design, Product strategies, Product value,

Product planning, Product specifications.

UNIT-III

Design thinking for strategic Innovation: An exercise in design thinking – implementing design thinking for better process. Implementation of design thinking process in various Industries. How Is Design Thinking Relevant to Software Development? Design thinking for Startups,

UNIT-IV

Design thinking in various sectors: Case studies in Information Technology, Finance, Education, Management and Retail sector. Analyze and Prototyping, Usability testing, Organizing and interpreting results. Design thinking in relation to computational thinking, Design Thinking Careers and Scope.

LIST OF EXPERIMENTS

1. Study the Design Thinking process and its stages (Empathize–Define–Ideate–Prototype–Test).
2. Collect and analyze user data to understand real-world issues and define user-centered requirements.
3. Define problem statement using "How Might We" and root cause analysis.
4. Generate ideas using brainstorming and select feasible solution.
5. Evaluate innovation value and impact of selected idea.
6. Develop product/service strategy and value proposition.
7. Create low-fidelity/digital prototype.
8. Conduct usability testing and analyze feedback.
9. Prepare business model and implementation plan.
10. Implement complete Design Thinking cycle for a sector-based problem.

Based on above: Students must practice and develop at least one project from the following:

a) Result Management System
b) Inventory Control System
c) Fast Food Billing System
d) Bank Loan System
e) Blood Bank System
f) Railway Reservation System
g) ATM System
h) Video Library Management System
i) E-Ticketing System
j) Share Online Trading System
k) Resource Management System
l) Court Case Management System
m) Online Doctor Appointment & Telemedicine System
n) E-Learning Experience Enhancement Platform
o) Smart Waste Management System
p) EV Charging Station Locator System

q) Smart Agriculture Monitoring System
r) Women Safety Mobile Alert System
s) Food Delivery Optimization System
t) Startup Idea Validation Platform

TEXTBOOKS/ REFERENCE BOOKS

1. Change by Design, Tim Brown, Harper Bollins (2009)
2. Design Thinking in the Classroom by David Lee, Ulysses Press

REFERENCE BOOKS

1. Design the Future, Shrrutin N Shetty, Norton Press
2. Universal principles of design- William lidwell, kritina holden, Jill butter.
3. The era of open innovation – Chesbrough.H
4. Product Design and Manufacturing, A. K. Chitale and R.C. Gupta, Prentice Hall

SKILL-BASED COURSES TO QUALIFY FOR UG CERTIFICATE (ENGG.) IN COMPUTER SCIENCE & ENGINEERING:

BCS-154		**Problem Solving Through Python Programming**
Course category	:	UG Certificate (Engg.)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 2, Tutorial : 0 , Practical: 2
Number of Credits	:	3
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	:	1. To introduce the fundamentals of programming and develop logical thinking using algorithms and flowcharts. 2. To familiarize students with Python syntax, data types, input/output operations, and the structure of a Python program. 3. To provide a thorough understanding of Python operators, control structures, and loop constructs for decision making and iterative problem-solving. 4. To develop skills in modular programming using functions, recursive functions, and command-line arguments in Python. 5. To enable students to perform array operations using Python's list and NumPy libraries for scientific computing. 6. To introduce file handling and exception handling techniques for building robust and error-resilient Python applications.

Course Outcomes	:	Upon completion of the course, students will be able to CO1. Understand basic programming concepts including algorithms, flowcharts, Python syntax, and data types. Understand basic programming concepts including algorithms, flowcharts, Python syntax, and data types. CO2. Apply Python operators and control flow constructs such as decision making and loops in program development. CO3. Demonstrate the use of arrays and functions, including recursion and command-line arguments, for modular programming. CO4. Implement array manipulations and numerical operations using the NumPy library. CO5. Perform file operations including reading, writing, and manipulating text and binary files using Python. CO6. Apply exception handling techniques to manage errors and ensure robust program execution.

Topics Covered

UNIT-I **6L**

Introduction to Programming– Computer Systems, Computer Languages, Algorithms and Flowcharts
Introduction to Python Language: Introduction to Python Language, Features of Python, Comments in Python.
Tokens- Keywords, Identifiers, Constants, Variables, Python Input and Output Statements.
Basic Data Types: int, float, Boolean, complex and string and its operations.
Collection Data Types: List, Tuples, Sets and Dictionaries. Data Type conversions.

UNIT-II **6L**

Operators in Python: Arithmetic operators, Assignment operators, Comparison operators, Logical operators, Identity operators, Membership operators, Bitwise operators, Precedence of operators, Expressions.
Control Flow and Loops: Indentation, if statement, if-else statement, nested if else, chained conditional if- elif -else statement, Loops: while loop, for loop using ranges, Loop manipulation using break, continue and pass.

UNIT-III **6L**

Arrays: Definition**,** Advantages of Arrays, Creating an Array, Operations on Arrays, and List, Importing the Array Module, Indexing and Slicing on Arrays,
Working with arrays using numPy - Creating arrays using numpy,
Functions: Defining a function, Calling a Function, Passing parameters and arguments, Python Function

arguments. Recursive functions, command-line arguments.

UNIT-IV **6L**

File Handling in Python: Introduction to files, Text files and Binary files, Access Modes, Writing Data to a File-write() and writelines(), Reading Data from a File-read(), readline() and readlines().

Error Handling in Python: Introduction to Errors and Exceptions: Compile-Time Errors, Logical Errors, Types of Exceptions, Python Exception Handling Using try, except and finally statements.

LIST OF EXPERIMENTS:

1. Even or Odd Checker
2. Simple Interest Calculator
3. Palindrome String Checker
4. List Operations (Sum, Max, Search)
5. Student Grade Calculator
6. File Handling: Read and Write a File
7. Simple Class: Bank Account Simulation
8. Calculator using Functions
9. Factorial of a number using loop
10. Find Max, Min, Mean, and Std Deviation

TEXTBOOKS/ REFERENCES

1. R.NageswaraRao,"Core Python Programming", Dreamtech.
2. Python Programming: A Modern Approach, Vamsi Kuramanchi,Pearson.
3. Core Python Programming,W.Chun,Pearson.
4. Introduction to Python,Kenneth A. Lambert, Cengage.
5. Learning Python, Mark Lutz,Orielly.

BCS-155		**Computer Troubleshooting & Maintenance**
Course category	:	UG Certificate (Engg.)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 2, Tutorial : 0 , Practical: 2
Number of Credits	:	3
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination

Course Objectives	:	1. Understand the structure and function of key computer hardware components including CPU, RAM, ROM, motherboard, and peripheral devices. 2. Demonstrate the ability to configure and update BIOS/UEFI settings and install operating systems and device drivers. 3. Perform disk partitioning, formatting, and system configuration tasks for optimal performance and stability. 4. Identify and resolve common hardware and software problems using diagnostic tools and troubleshooting techniques. 5. Apply preventive maintenance practices to ensure long-term computer functionality and performance. 6. Understand fundamental networking concepts and troubleshoot basic connectivity issues in local and internet-based environments.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course CO1. Identify and describe the key hardware components of a computer system including processor, memory, motherboard, and I/O devices. CO2. Configure BIOS/UEFI settings and install operating systems along with necessary drivers and external devices. CO3. Perform disk management operations such as formatting, partitioning, and defragmentation to optimize system performance. CO4. Troubleshoot common hardware and software issues including boot errors, driver conflicts, and system crashes using diagnostic tools. CO5. Apply regular maintenance practices including antivirus setup, cleaning, and hardware care to enhance system longevity. CO6. Demonstrate basic networking skills including identifying components, setting up small networks, and resolving internet connectivity problems.

Topics Covered

UNIT-I **6L**

Introduction to PC Hardware:

Introduction to computer components: input/output devices, storage, and memory types (RAM, ROM). Overview of CPU: types and generations (Intel Pentium IV, Dual Core, etc.). Motherboard architecture: components, chipsets, connectors, and slots. Understanding buses, ports (USB, HDMI, VGA), and expansion cards.

UNIT-II **6L**

BIOS Installation and Configuration:
Introduction to BIOS and UEFI. BIOS settings: boot sequence, security settings, hardware configuration. Installing and configuring operating systems (Windows). Installing and updating device drivers. Disk management: formatting, partitioning, defragmentation. Setting up peripherals: printers, scanners, modems.

UNIT-III **6L**

Troubleshooting:
Common hardware issues and solutions: boot failures, power issues, overheating. Software issues: driver conflicts, blue screen errors, system crashes. POST (Power-On Self-Test) diagnostics and interpretation. System performance enhancement: antivirus, clean up tools, software updates. Identification and replacement of faulty components (RAM, HDD, motherboard). Preventive maintenance: cleaning, environment control, regular updates.

UNIT-IV **9L**

Networking Fundamentals:
Basics of networking: LAN, WAN, WLAN, and internet. Network components: switches, routers, hubs, modems. Connecting to the internet: broadband, dial-up, ISDN. Setting up small home/office networks. Troubleshooting network issues: IP conflicts, connectivity loss, DNS errors. Applications of the internet: email, file transfer, cloud computing.

LIST OF EXPERIMENTS:

1. Disassemble a personal computer and assemble the same system again. Boot the system and observe the procedure of assembling a computer system.
2. Observe various connectors, ports back and front side of the computer. Write their purpose and specifications. (e.g., Power, PS/2 keyboard and mouse, Serial and parallel, USB, VGA, LAN, Audio & microphone, Firewire, HDMI, games, SATA etc.)
3. Identify BIOS settings, demonstrate starting BIOS, identify how to disable unused devices to decrease security risks. Change booting of computer with different secondary storage CD, HDD, USB etc.
4. Perform low level and high-level formatting of Hard Disk. Format the given Hard Disk using any one technique and create three partitions, two for operation systems and one for data. Install OS of different types. Also search for various data recovery software apply on pen drive/HDD.
5. Observe different types of printers (dot matrix, inkjet & laser, multifunction). Install driver and interface the printers with PC/Laptop on any operating system (connect the printer to one PC directly using USB/Serial/Parallel ports as per the availability; test the functioning of the printer.)
6. Learn the interfacing, installation and working of various devices such as scanner, projector, web cam etc. Connect all these devices with the given PC, install & test them.

7. Recognize common symptoms associated with diagnosing and troubleshooting PCs and utilize Windows built-in diagnostic tools.
TEXTBOOKS/ REFERENCES 1. PC Hardware: The Complete Reference – Craig Zacker & John Rourke 2. Troubleshooting, Maintaining and Repairing PCs – Stephen J. Bigelow 3. Computer Networking: Principles, Protocols and Practice – Olivier Bonaventure 4. Manufacturer Manuals & Online Documentation (for BIOS, Drivers, etc.

2nd Year 3rd Semester

BCS-210A	:	**DISCRETE STRUCTURE**
Course category	:	EF3
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous Assessment through One Minor Test, Teacher Assessment (Quiz, Tutorial, Assignment, Attendance) and One Major Theory.
Course Objectives	:	The key objectives of this course are – **1.** To understand the fundamentals of discrete mathematical structures and logic. **2.** To develop analytical and problem-solving skills using algebraic structures and recurrence relations. **3.** To apply graph theory and discrete mathematics concepts in computer science and engineering applications.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.
CO1. Apply set theory, relations, functions and lattices to solve discrete mathematics problems. CO2. Analyze propositional and predicate logic using truth tables, quantifiers, and inference rules. CO3. Use mathematical induction and combinatorial principles to solve counting and proof problems. CO4. Analyze algebraic structures including semigroups, monoids, groups, rings, and fields. CO5. Solve recurrence relations using characteristic equations and generating functions.		

CO6. Illustrate the principles and concepts of graph theory for solving problems related to computer science.

Topics Covered

UNIT-I **9L**

Set Theory and Relations - Sets, Relations, Operations on relations, Composite relations, Equivalence relation, Functions, Classification of functions, Operations on functions.

POSET & Lattices: POSET, Hasse Diagram, Definition & Properties of Lattices - Bounded, Complemented, Distributed, Modular and Complete Lattice.

UNIT-II **9L**

Theory of Logics: Proposition, Truth tables, Tautology, Satisfiability, Contradiction, Algebra of proposition, Theory of Inference. Predicate Logic: First order predicate, well-formed formula of predicate, quantifiers, Inference theory of predicate logic.

Induction And Combinatorics - Peano's Axioms, Mathematical Induction, Pigeon-Hole Principle - Principle of Inclusion and Exclusion.

UNIT-III **9L**

Algebraic Structures- Semi-Groups, Monoids, Groups, Subgroups and Their Properties, Cyclic Groups, Cosets, Lagrange's Theorem, Normal Subgroups, Permutation and Symmetric Groups, Homomorphism of Groups. Introduction to Rings and Fields.

UNIT-IV **9L**

Recurrence Relations- Recurrence Relations: Homogeneous and Inhomogeneous Recurrences and their solutions - Solving Recurrences Using Generating Functions.

Graph Theory- Definitions and Representation of Graph, Subgraphs, Multigraph, Regular Graph, Bipartite Graph, Planar Graph, Isomorphism and Homeomorphism of graphs, Euler and Hamiltonian paths, Graph coloring, Operations on Graphs - Vertex and Edge Cuts - Vertex and Edge Connectivity.

TEXT BOOKS

1. C.L. Liu and D.P. Mohapatra, " Elements of Discrete Mathematics: A Computer Oriented Approach", McGraw Hill, Third Edition, 2012.
2. Kenneth H. Rosen, "Discrete Mathematics and Its Applications" McGraw Hill, Seventh Edition, 2012 (Indian Adaptation by Kamala Krithivasan, IIT Madras).
3. Liptschutz, Seymour, “Discrete Mathematics”, McGraw Hill.
4. Narsingh, “Graph Theory With application to Engineering and Computer Science.”, PHI.

REFERENCE BOOK

1. Thomas Koshy, "Discrete Mathematics with Applications", Elsevier, 2009.
2. Gary Haggard, John Schlipf, and Sue Whitesides, “Discrete Mathematics for Computer Science”, Cengage Learning Publisher, 2005.
3. R. Balakrishnan and K. Ranganathan, "A Text Book of Graph Theory", Springer.

BCS-210	:	**DISCRETE STRUCTURE (Only for Session 2025-26)**
Course category	:	EF3
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous Assessment through One Minor Test, Teacher Assessment (Quiz, Tutorial, Assignment, Attendance), Viva-voce, and One Major Theory.
Course Objectives	:	It contains a basic introduction to familiarize students with the basics of software Engineering. Here are the key objectives covered in this course 1. Convert logical statements from informal language to propositional (and quantified) logic expressions. 2. Apply formal methods of symbolic propositional logic, such as calculating validity of formulae and computing normal forms. 3. Use the rules of inference to construct proofs in propositional logic.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

CO7. Define, as well as explain with examples, the basic terminology of functions, relations, and sets.
CO8. Perform the operations associated with sets, functions, and relations.
CO9. Relate practical examples to the appropriate set, function, or relation model, and interpret the associated operations and terminology in context.
CO10. Ability to distinguish between the notion of discrete and continuous mathematical structures
CO11. Ability to construct and interpret finite state diagrams and DFSA
CO12. Application of induction and other proof techniques towards problem solving

Topics Covered

UNIT-I **9L**

Set Theory and Logic - Sets, Functions, Relations, Equivalence Relation,Poset. Functions Logic: Propositional Logic, Truth Tables, Tautologies, Resolution Proof System, Predicate Logic.

UNIT-II **9L**

Induction And Combinatorics - Peano's Axioms - Mathematical Induction - Pigeon-Hole Principle -

Principle Of Inclusion And Exclusion - Review Of Permutations And Combinations - Distribution Problems - Derangements - Bijection Principle.

UNIT-III **9L**

Algebraic Structures- Semi-Groups, Monoids, Groups, Subgroups And Their Properties -Cyclic Groups - Cosets - Permutation Groups - Lagrange's Theorem - Cayley's Theorem -Normal Subgroups - Homomorphism of Groups - Quotient Groups –Introduction To Rings And Fields.

UNIT-IV **9L**

Linear Algebra And Recurrence Relations- Linear Algebra: Vector Space, Basis, Dimension, Orthogonally. Recurrence Relations: Homogeneous And Inhomogeneous Recurrences And Their Solutions - Solving Recurrences Using Generating Functions.

Graph Theory- Definitions And Basic Results - Representation Of A Graph By A Matrix And Adjacency List - Trees - Cycles - Properties - Paths And Connectedness - Subgraphs - Graph Isomorphism - Operations On Graphs - Vertex And Edge Cuts - Vertex And Edge Connectivity.

TEXTBOOKS

1. C.L.Liu and D.P.Mohapatra, " Elements of Discrete Mathematics: A Computer Oriented Approach", Mcgraw Hill, Third Edition, 2012.
2. Kenneth H. Rosen, "Discrete Mathematics and Its Applications" Mcgraw Hill, Seventh Edition, 2012 (Indian Adaptation By Kamala Krithivasan, Iit Madras).

REFERENCE BOOK

1. R. Balakrishnan and K. Ranganathan, "A Text Book Of Graph Theory", Springer
2. Thomas Koshy, "Discrete Mathematics with Applications", Elsevier, 2009.
3. Gary Haggard, John Schlipf, and Sue Whitesides, “Discrete Mathematics for Computer Science”, Cengage Learning Publisher, 2005.
4. B. Bollobás, “Modern Graph Theory”, Springer, New York 1998

BCS-211	:	**DIGITAL LOGIC AND DESIGN**
Course category	:	EF4
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Continuous Assessment through One Minor Test, Teacher Assessment (Quiz, Tutorial, Assignment, Attendance), Practical Work & Viva-voce, and One Major Theory & One Practical Examinations.
Course Objectives	:	This course helps the students in gaining the knowledge of basic principles of digital circuit design and different number systems. This course helps in building a solid foundation to undertake future courses such as computer organization and architecture. 1. Discuss basic building blocks of logic design 2. Learn how circuits are designed in a real computer system 3. Introduce different number systems 4. Learn current trends in circuit design 5. Make student familiar with issues and trade-offs in the design of digital circuits
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

CO1. Design a finite state machine and sequential logic design.
CO2. Synthesize a logic design from a natural language description of a problem.
CO3. Realize a complete arithmetic and logic unit.
CO4. Generate a realization of combinational logic in a programmable gate array.
CO5. Simulate a complete design to evaluate functional correctness and timing.
CO6. Conduct an experiment to learn the logic design and prototyping process in order to acquire requisite hands-on skills

Topics Covered

UNIT-I **9L**

Binary Codes - Weighted and Non-Weighted - Binary Arithmetic Conversion Algorithms - Error Detecting and Error Correcting Codes - Canonical and Standard Boolean Expressions - Truth Tables.

UNIT-II **9L**

K-Map Reduction - Don't Care Conditions - Adders / Subtractors- Carry Look-Ahead Adder - Code Conversion Algorithms - Design of Code Converters - Equivalence Functions. Binary/Decimal Parallel Adder/ Subtractor for Signed Numbers - Magnitude Comparator - Decoders / Encoders - Multiplexers / Demultiplexers- Boolean Function Implementation using Multiplexers.

UNIT-III **9L**

Sequential Logic - Basic Latch - Flip-Flops (SR, D, JK, T and Master-Slave) - Triggering of Flip-Flops - Counters - Design Procedure - Ripple Counters - BCD and Binary - Synchronous Counters

UNIT-IV **9L**

Registers - Shift Registers - Registers with Parallel Load - Memory Unit - Examples of RAM, ROM, PROM, EPROM - Reduction of State and Flow Tables - Race-Free State Assignment - Hazards.

TEXTBOOKS

1. Morris Mano, Digital Design, Prentice Hall of India, 2001
2. Raj Kamal, Digital Systems Principles and Design, Pearson Education, First Edition, 2007
3. Charles H. Roth, Jr. and Larry L. Kinney, Fundamentals of Logic Design, CL Engineering, Seventh Edition, 2013.

REFERENCE BOOKS

1. W. H. Gothmann, Digital Electronics -An Introduction to Theory and Practice, Prentice Hall of India, 2000
2. Donald D. Givone, Digital Principles and Design, Tata McGraw –Hill, Thirteenth Impression, 2003.

BCS-212A	:	**OBJECT ORIENTED PROGRAMMING THROUGH JAVA**
Course category	:	PC
Prerequisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	**:** Continuous Assessment through One Minor Test, Teacher Assessment (Quiz, Tutorial, Assignment, Attendance), Practical Work & Viva-voce, and One Major Theory & One Practical Examination.
Course Objectives	:	The course is designed to help undergraduate students understand the fundamentals of Object-Oriented Programming using Java and develop simple desktop and web-based applications. After completing the course, students will be able to: 1. Understand the basics of Java programming and Object-Oriented concepts. 2. Develop Java programs using classes, objects, inheritance, and interfaces. 3. Handle exceptions and implement multithreading in Java applications. 4. Design simple GUI applications using Swing and AWT components. 5. Connect Java applications with databases using JDBC. 6. Understand modern Java development concepts and components.
Course Outcomes	:	After successful completion of the course, students will be able to:

After successful completion of the course, students will be able to:

CO1: Write, compile, debug, and execute Java programs.
CO2: Apply object-oriented concepts in software development.

CO3: Develop GUI-based applications using Java Swing.
CO4: Use exception handling, threads, and file handling in applications.
CO5: Connect Java applications with databases using JDBC.
CO6: Understand modern Java tools and components used in application development.

Topics Covered

UNIT – I: Introduction to Java and OOP Concepts **9L**

Introduction to Object-Oriented Programming, Features of Java, JVM, JDK and JRE, Structure of Java Program, Variables, Data Types and Operators, Input and Output in Java, Control Statements and Loops, Arrays and Strings Handling, Classes and Objects, Methods and Constructors, Inheritance and Polymorphism, Packages and Interfaces

UNIT – II : Modern Java Programming Concepts **9L**

Exception Handling**,** Multithreading and Thread Life Cycle**,** File Handling and Streams**,** Collection Framework Basics (ArrayList, LinkedList, HashMap)**,** Lambda Expressions and Functional Interfaces**,** Introduction to Java 8 Features**,** Date and Time API**,** Introduction to Java Modules and API, Basic Event Handling**,** Introduction to AWT and Swing**,** Common Swing Components**,** Layout Managers

UNIT – III : GUI, Database Connectivity and Web Components **9L**

GUI development using Swing, menus, dialog boxes, and forms; applet basics and event-driven programming; JDBC architecture, drivers, and MySQL connectivity; CRUD operations using JDBC; client-server applications, Java networking, RMI, servlets, servlet life cycle, and simple web application development.

UNIT – IV: Advanced Java Components and Application Development **9L**

Introduction to Java Beans**,** Bean Development Kit (BDK)**,** JAR Files and Packaging**,** Introduction to Maven and Gradle**,** Basics of REST APIs**,** Introduction to Spring Framework**,** Spring Boot Overview**,** Java Full Stack Development Overview**,** Deployment Basics

LABORATORY EXPERIMENTS

1. Programs using operators, loops, arrays, and strings.
2. Programs using classes, objects, constructors, and inheritance.
3. Programs based on interfaces and packages.
4. Programs for exception handling and multithreading.
5. Programs using file handling and collections.
6. GUI applications using Swing components.
7. Database connectivity using JDBC and MySQL.
8. Simple servlet-based web application.
9. Programs using Java 8 features such as Lambda Expressions.
10. Mini project based on Java application development.

TEXT BOOKS

1. Herbert Schildt, “Java: The Complete Reference, 13th edition”, McGraw Hill.
2. E. Balagurusamy, “Programming with Java”, McGraw Hill.
3. Y. Daniel Liang, “Introduction to Java Programming”, Pearson.

4. T. Budd, “Understanding Object-Oriented Programming with Java”, Pearson Education

REFERENCE BOOKS

1. Deitel & Deitel, “Java: How to Program”, Pearson.
2. Margaret Levine Young, “TheComplete Reference Internet", TMH.
3. Dustin R.Callway, “InsideServlets", Addison Wesley.
4. Mark Wutica, “Java Enterprise Edition", QUE.
5. Steven Holzner, “Java2 Black book", Dreamtech

BCS-212	:	**OBJECT ORIENTED PROGRAMMING THROUGH JAVA (Only for Session 2025-26)**
Course category	:	PC
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Continuous Assessment through One Minor Test, Teacher Assessment (Quiz, Tutorial, Assignment, Attendance), Practical Work & Viva-voce, and One Major Theory & One Practical Examinations.
Course Objectives	:	This course helps the students in gaining the knowledge of basic principle of design and analysis of algorithms. This course helps to undertake future courses that assume as a background in data structures and algorithm design. 1. To introduce the object-oriented programming concepts. 2. To understand object-oriented programming concepts and apply them in solving problems. 3. To introduce the principles of inheritance and polymorphism; and demonstrate how they relate to the design of abstract classes. 4. To introduce the implementation of packages and interfaces. 5. To introduce the concepts of exception handling and multithreading. 6. To introduce the design of Graphical User Interface using applets and swing controls
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

CO1. Able to implement, compile, test and run JAVA programs comprising more than one class and to address a particular software problem.
CO2. Able to solve real world problems using OOP techniques.
CO3. To identify different components of client server architecture on Internet computing.
CO4. Knowledge of how to develop and deploy applications and applets in JAVA.
CO5. Knowledge of how to develop and deploy GUI using JAVA Swing and AWT.
CO6. Design, develop and implement interactive web applications.

Topics Covered

UNIT-I **9L**

Introduction to the principles of object-oriented programming, Core Java: Introduction, Operator, Data types, Variables, Control Statements, Arrays, Methods & Classes, Constructors, String Handling, Inheritance, Package and Interface.

UNIT-II **9L**

Exception Handling, Multithread programming, I/O, Java Applet, Networking, Event handling, Introduction to AWT, AWT controls, Layout managers.

UNIT-III **9L**

Java Swing: Creating a Swing Applet, Labels, Text fields, Buttons, Tabbed Panes, JDBC: Connectivity Model, JDBC/ODBC Bridge, JAVA SQL package, connectivity to Remote Database, Remote method

invocation (RMI).

UNIT-IV **9L**

Java Beans: Application Builder tools, The Bean Developer Kit (BDK), JAR files, Introspection, developing a simple bean, using Bound properties, The Java Beans API, Session Beans, Entity Beans, Introduction to Java Servlet: Servlet Basics, Servlet API basic, Life cycle of a Servlet, Running Servlet.

EXPERIMENTS

1. Basic programs of simple statements, conditional statements, iterative statement, and arrays.
2. Programs having object-oriented concepts like Inheritance and Interface.
3. Programs for Exception Handling and Event Handling.
4. Programs of Threads and Multithreading.
5. Programs related to Applets and Swings.
6. Program including JAVA Beans and Servlets.

TEXTBOOKS

1. Herbert Schildt, Java: The Complete Reference, 9th edition, McGraw Hill Education (India) Pvt. Ltd.
2. T. Budd, Understanding Object-Oriented Programming with Java, Pearson Education
3. Balagurusamy E, "Programming in JAVA", TMH

REFERENCE BOOKS

1. Deitel & Deitel, JAVA: How to Program, Pearson education
2. Margaret Levine Young, "The Complete Reference Internet", TMH.
3. Dustin R. Callway, "Inside Servlets", Addison Wesley.
4. Mark Wutica, "Java Enterprise Edition", QUE.
5. Steven Holzner, "Java2 Black book", Dreamtech.

BCS-213	:	**THEORY OF COMPUTATION**
Course category	:	PC
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous Assessment through One Minor Test, Teacher Assessment (Quiz, Tutorial, Assignment, Attendance), Practical Work & Viva-voce, and One Major Theory & One Practical Examinations.
Course Objectives	:	This course helps the students in gaining the knowledge of basic concept of machines: finite automata, pushdown automata, linear bounded automata, and Turing machines. 1. Discuss basic theory and applications of finite automata 2. Learn how the concepts introduced in this course are applicable in the design of efficient algorithms 3. Introduce Turing machines as a general model of computation 4. Learn the limits of computation

Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

CO1. Analyze and design finite automata, pushdown automata, Turing machines, formal languages, and grammars.
CO2. Demonstrate the understanding of key notions, such as algorithm, computability, decidability, and complexity through problem solving.
CO3. Prove the basic results of the Theory of Computation. State and explain the relevance of the Church- Turing thesis.
CO4. To solve various problems of applying normal form techniques, push down automata and Turing Machines
CO5. To Construct context free grammar for various languages
CO6. To Design Finite Automata's for different Regular Expressions and Languages

Topics Covered

UNIT-I **9L**

Alphabets, Strings and Languages, Automata and Grammars, Deterministic Finite Automata (DFA)-Formal Definition, Simplified Notation: State Transition Graph, Transition Table, Language of DFA, Nondeterministic Finite Automata (NFA), NFA with Epsilon Transition, Equivalence of NFA and DFA, Minimization of Finite Automata, Myhill-Nerode Theorem

UNIT-II **9L**

Regular Expression (RE), Definition, Operators of Regular Expression and their Precedence, Algebraic Laws for Regular Expressions, Kleen‟s Theorem, Regular Expression to FA, DFA to Regular Expression, Arden Theorem, Non Regular Languages, Pumping Lemma for Regular Languages. Application of Pumping Lemma, Closure Properties of Regular Languages, Decision Properties of Regular Languages, FA with Output: Moore and Mealy Machine, Equivalence of Moore and Mealy Machine, Applications and Limitation of FA.

UNIT-III **9L**

Context Free Grammar (CFG) and Context Free Languages (CFL): Definition, Examples, Derivation, Derivation Trees, Ambiguity in Grammer, Inherent Ambiguity, Ambiguous to Unambiguous CFG, Useless Symbols, Simplification of CFGs, Normal Forms for CFGs: CNF and GNF, Closure Proper ties of CFLs, Decision Properties of CFLs: Emptiness, Finiteness and Membership, Pumping Lemma for CFLs. Push Down Automata (PDA): Description and Definition, Instantaneous Description, Language of PDA, Acceptance by Final State, Acceptance by Empty Stack, Deterministic PDA, Equivalence of PDA and CFG, CFG to PDA and PDA to CFG, Two Stack PDA

UNIT-IV **9L**

Turing Machines (TM): Basic Model, Definition and Representation, Instantaneous Description, Language Acceptance by TM, Variants of Turing Machine, TM as Computer of Integer Functions, Universal TM, Church‟s Thesis, Recursive and Recursively Enumerable Languages, Halting Problem, Introduction to Undecidability, Undecidable Problems about TMs. Post Correspondence Problem (PCP), Modified PCP, Introduction to Recursive Function Theory.

TEXTBOOKS

1. Micheal Sipser, "Introduction to the Theory of Computation", Thomson Learning

REFERENCE BOOKS

1. Hopcroft, Ullman, "Introduction to Automata Theory, Languages and Computation", Pearson Education
2. Peter Linz, "An Introduction to Formal Language and Automata", Narosa Publishing house
3. H R. Lewis and Christos H. Papadimitriou, "Elements of the theory of Computation", PHI Ltd

BCS-214	:	**PRINCIPLES OF DATA STRUCTURES**
Course category	:	PC
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Continuous Assessment through One Minor Test, Teacher Assessment (Quiz, Tutorial, Assignment, Attendance), Practical Work & Viva-voce, and One Major Theory & One Practical Examinations.
Course Objectives	:	This course helps the students in gaining the knowledge of basic principles of Data Structures. The principal objectives of this course are: 1. To provide the knowledge of basic data structures and their implementations. 2. To understand importance of data structures in context of writing efficient programs. 3. To develop skills to apply appropriate data structures in problem solving.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

CO1. Learn the basic types for data structure, implementation, and application.
CO2. Know the strength and weakness of different data structures.
CO3. Use the appropriate data structure in context of solution of given problem.
CO4. Develop programming skills which require to solve given problem.
CO5. Apply Algorithm for solving problems like sorting, searching, insertion and deletion of data
CO6. Solve problem involving graphs, trees and heaps.

Topics Covered

UNIT-I **9L**

Introduction: Basic Terminology, Elementary Data Organization, Structure Operations, Complexity and Time-Space Trade-off.

Arrays: Definition, Representation and Analysis, Single and Multi-Dimension Array, Address Calculation, Application of Arrays, Character, String in C, Character String Operation, Arrays Parameters, Ordered List, Sparse Matrices and Vectors

Stacks: Array Representation and Implementation of Stack, Operations on Stacks: Push &Pop, Array

Representation of Stack, Linked Representation of Stack, Operations Associated with Stacks, Application of Stack, Conversion of Infix to Prefix and Postfix Expressions, Evaluation of Postfix Expressions using Stack, Application of Recursion in Problem like Tower of Hanoi.

UNIT-II **9L**

Queues: Array and Linked Representation and Implementation of Queues, Operations on Queue: Create, Add, Delete, Full and Empty, Circular Queues, D-Queues and Priority Queues.

Linked List: Representation and Implementation of Singly Linked Lists, Two-Way Header List, Traversing and Searching of Linked List, Overflow and Underflow, Insertion and Deletion to / from Linked Lists, Insertion and Deletion Algorithms, Doubly Linked List, Linked List in Array, Polynomial Representation and Addition, Generalized Linked List, Garbage Collection and Compaction.

UNIT-III **9L**

Trees: Basic Terminology, Binary Trees, Binary Tree Representation, Algebraic Expressions, Complete Binary Tree, Extended Binary Trees, Array and Linked Representation of Binary Trees, Traversing Binary Trees, Threaded Binary Trees, Traversing Threaded Binary Trees, Huffman Algorithm.

Binary Search Trees: Binary Search Tree (BST), Insertion and Deletion in BST, Complexity of Search Algorithm, Path Length, AVL Trees, B-Trees.

UNIT-IV **9L**

Searching and Hashing: Sequential Search, Binary Search, Comparison and Analysis, Hash Table, Hash Functions, Collision Resolution Strategies, Hash Table Implementation.

Sorting: Insertion Sort, Bubble Sorting, Quick Sort, Two Way Merge Sort, Heap Sort, Sorting on Different Keys, Practical Consideration for Internal Sorting.

Graphs: Terminology & Representations, Graphs &Multi-Graphs, Directed Graphs, Sequential Representations of Graphs, Adjacency Matrices, Traversal, Connected Component and Spanning Trees, Minimum Cost Spanning Trees.

EXPERIMENTS

Write C/C++ Programs to illustrate the concept of the following:

1. Implementation of searching and sorting techniques.
2. Implementation of list using array and linked list.
3. Implementation of push and pop operation on stack
4. Implementation of polish notation and its conversion
5. Write a program to solve the problems using iteration/recursion
6. Program for recursion removal using stack
7. Program for insertion /deletion operation on various queue & Implementation of priority queue for process scheduling
8. Program for storing data as tree structure and implementation of various traversal techniques
9. Program for storing data as graph structure and implementation of various traversal techniques
10. Program for finding shortest path in graph

TEXT BOOKS

1. Horowitz and Sahani, Fundamentals of Data Structures, Galgotia Publication, New Delhi.
2. R. Kruse et al, Data Structure and Pragram Design in C, Pearson Education Asia Delhi
3. A. M. Tenenbaum, Data Structures using C & C++, PHI, India
4. K Loudon, Mastering Algorithms with C, Shroff Publication and Distributor Pvt. Ltd.
5. Bruno R Preiss, Data Structure and Algorithms with Object Oriented Design Pattern in C++, John Wiley & Sons
6. Adam Drozdek, "Data Structures and Algorithms in C++", Thomson Asia Pvt. Ltd. Singapore

REFERENCE BOOKS

1. Lewis, H.R., Denenberg, L., Data Structures and their Algorithms. Published by AddisonWesley, UK, 1991
2. Oluwadare, S.A., Agbonifo, O.C., Fundamentals of Data structures and Algorithms. Lecture Notes, 2013

2nd Year 4th Semester

BSM-212/262	:	**OPERATIONAL RESEARCH**
Course category	:	Basic Sciences & Maths
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and One Minor tests and One Major Theory Examination
Course Objectives	:	The course is aimed to develop the mathematical skills and analyzing different situations in the industrial scenario having limited resources and obtain the optimal solution with and without constraints.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.
CO1. Identify and develop operational research models from the verbal description of the real system. CO2. Able to build and solve Transportation Models and Assignment Models. CO3. Knowledge of formulating mathematical models for quantitative analysis of managerial problems in industry CO4. Aware with the basic concepts and tools of game theory and can apply these tools to real-life situations. CO5. Understand different queuing situations and find the optimal solutions using models for different situations. CO6. Able to design new simple models, like: CPM, PERT to improve decision making.		
Topics Covered		

UNIT-I **9L**

Linear Programming (LP): Formulation of mathematical models for various types of L.P. problems, graphical methods of solving L.P. problems, Limitations of L.P. methods. Simplex method, artificial variable technique-the big-M method, two phase Simplex method, revised simplex method, degeneracy, duality in L.P.

UNIT-II **9L**

Transportation and Assignment Problems: Transportation model formulation, and solution of transportation problems (Optimal), Assignment model, formulation and solution of assignment problems, sequencing problems.

UNIT-III **9L**

Game Theory and Network Techniques: Game theory, solution of games with and without saddle point, rules of dominance, arithmetic, and algebraic methods for 2x2 games, solution of 2xn or m x 2 games. PERT & CPM Models: Characteristics & uses, drawing of network, removal of redundancy in network, computing EST, LFT, critical path, project completion time, Free Slack, Total slack, and independent slack, Project crashing.

UNIT-IV **9L**

Queuing Theory: Elements of Queuing model, Pure-birth and Pure-death models, Empirical queuing models – M/M/1: ∞/FCFS, M/M/1: N/FCFS and M/M/C: ∞/FCFS models and their steady state performance analysis.

TEXT BOOKS

1. Hillier, F. S., & Lieberman, G. J. Introduction to operations research- concepts and cases. New Delhi: Tata McGraw Hill (Indian print).
2. Taha, H. A. Operations research-an introduction. New Delhi: Pearson Prentice Hall.
3. Ravindran, A., Phillips, D. T., and Solberg, J. J. Operations research- principles and practice. New Delhi: Wiley India (P.) Ltd. (Indian print).
4. Kanti Swaroop, P K Gupta and Manmohan, Operations Research, Sultan Chand & Sons
5. Gross, D., Shortle, J. F., Thompson, J. M., & Harris, C. M. Fundamentals of queueing theory. Wiley India (P.) Ltd. (Indian print).

BCS-261	:	**DESIGN & ANALYSIS OF ALGORITHMS**
Course category	:	PC
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1/0 & Practical: 0/2
Number of Credits	:	4
Course Assessment methods	:	Continuous Assessment through One Minor Test, Teacher Assessment (Quiz, Tutorial, Assignment, Attendance), Practical Work & Viva-voce, and One Major Theory & One Practical Examinations.
Course Objectives	:	This course helps the students in gaining the knowledge of basic principle of design and analysis of algorithms. This course helps to undertake future courses that assume as a background in data structures and algorithm design. 1. Discuss basic theory and practice of algorithms 2. Design and implement new algorithms 3. Become familiar with fundamental data structures and with the way these data structures can best be implemented 4. Become accustomed to the description of algorithms in both functional and procedural styles
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

CO1. Define the basic concepts of algorithms and analyze the performance of algorithms.
CO2. Discuss various algorithm design techniques for developing algorithms.
CO3. Discuss various searching, sorting and graph traversal algorithms.
CO4. Understand NP completeness and identify different NP complete problems.
CO5. Discuss various advanced topics on algorithm
CO6. Able to Compare between different data structures and pick an appropriate data structure for a design situation.

Topics Covered

UNIT I **9L**

Introduction: Algorithms, Analyzing Algorithms, Complexity of Algorithms, Growth of Functions, Performance Measurements, Sorting and Order Statistics - Shell Sort, Quick Sort, Merge Sort, Heap Sort, Comparison of Sorting Algorithms, Sorting in Linear Time. Divide And Conquer strategy with Examples such as Sorting, Matrix Multiplication, Convex Hull and Searching.

UNIT II **9L**

Greedy Methods with Examples such as Optimal Reliability Allocation, Knapsack, Minimum Spanning Trees – Prim's and Kruskal's Algorithms, Single Source Shortest Paths – Dijkstra's and Bellman Ford Algorithms.

Dynamic Programming with Examples such as Multistage Graphs, Knapsack, All Pair Shortest Paths - Warshal's and Floyd's Algorithms, Resource Allocation problem

UNIT III **9L**

Backtracking, Branch and Bound with Examples such as Travelling Salesman Problem, Graph Coloring, N-Queen Problem, Hamiltonian Cycles and Sum of Subsets

Advanced Data Structures***:*** Red-Black Trees, B – Trees, Binomial Heaps, Fibonacci Heaps

UNIT IV **9L**

Selected Topics: String Matching, Text Processing- Justification of Text, Theory of NP-Completeness, Approximation Algorithms and Randomized Algorithms, Algebraic Computation, Fast Fourier Transform

EXPERIMENTS

1. To analyze time complexity of Insertion sort.
2. To analyze time complexity of Quick sort.
3. To analyze time complexity of Merge sort.
4. To Implement Largest Common Subsequence.
5. To Implement Matrix Chain Multiplication.
6. To Implement Strassen's matrix multiplication Algorithm, Merge sort and Quick sort.
7. To implement Knapsack Problem.
8. To implement Activity Selection Problem.
9. To implement Dijkstra's Algorithm.
10. To implement Warshall's Algorithm.
11. To implement Bellman Ford's Algorithm.
12. To implement Naïve String Matching Algorithm.
13. To implement Rabin Karp String Matching Algorithm
14. To implement Prim's Algorithm.
15. To implement Kruskal's Algorithm.

TEXT BOOKS

1. Thomas H. Coreman, Charles E. Leiserson and Ronald L. Rivest, Introduction to Algorithms, PHI
2. RCT Lee, SS Tseng, RC Chang, and YT Tsai, "Introduction to the Design and Analysis of Algorithms", McGraw Hill 2005
3. Ellis Horowitz and Sartaj Sahni, *Fundamentals of Computer Algorithms*, Computer Science

Press, Maryland 1978
4. Berman, Paul," Algorithms", Cengage Learning, PHI
5. Aho, Hopcraft, Ullman, "The Design and Analysis of Computer Algorithms" Pearson Education,
2008

REFERENCE BOOKS

1. Berlion, P. Izard, P., Algorithms-The Construction, Proof and Analysis of Programs, 1986. Johan Wiley & Sons
2. Ellis Horowitz, Sartaj Sahni, and Sanguthevar Rajasekaran, *Computer Algorithms*, W. H. Freeman, NY, 1999
3. Goodman, S.E. & Hedetnien, introduction to Design and Analysis of Algorithms, 1997 MGH
4. Knuth, D. E, Fundamentals of Algorithms: The Art of Computer Programming Vol, 1985

BCS-262	:	**COMPUTURE ORGANIZATION & ARCHITECTURE**
Course category	:	PC
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1/0 & Practical: 0/2
Number of Credits	:	4
Course Assessment methods	:	Continuous Assessment through One Minor Test, Teacher Assessment (Quiz, Tutorial, Assignment, Attendance), Practical Work & Viva-voce, and One Major Theory & One Practical Examinations.
Course Objectives	:	This course helps the students in gaining the knowledge of Computer Organization and Architecture. The principal objectives of this course are: 1. To understand the structure, function and characteristics of computer systems. 2. To understand the design of the various functional units and components of computers. 3. To explain the function of each element of a memory hierarchy, 4. To identify and compare different methods for computer I/O.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

CO1. To study the design of arithmetic and logic unit and implementation of fixed point and floating-point arithmetic operations
CO2. To study the two types of control unit techniques and the concept of Pipelining
CO3. To study the hierarchical memory system including cache memories and virtual memory
CO4. To study the different ways of communicating with I/O devices and standard I/O interfaces
CO5. Elaborate advanced concepts of computer architecture, Parallel Processing, interprocessor communication and synchronization
CO6. Describe the operations and language of the register transfer, micro operations and input- output

organization.

Topics Covered

UNIT I **9L**

Basics: Functional Blocks in a Computer System, Floating point representation - Precision and Accuracy, Computer Arithmetic, Addressing Modes, Instruction Set and Instruction Execution Flow, Instruction Format, Instruction Set Design, Data Transfer & Manipulations operations, Arithmetic and Logic operations, Shift Micro-Operation.

UNIT II **9L**

Design of Arithmetic Circuits: Addition & Subtraction of Signed Numbers, Multiplication, Integer Division, Fast Adder and Fast multipliers, Floating Point Operations, Decimal Arithmetic Unit, Decimal Arithmetic Operations, Arithmetic and Instruction Pipeline, its Performance.

Control Design: Hardwired control design, Micro Programmed Control Unit, Micro-instruction design

UNIT III **9L**

Characteristics of memory system, Memory hierarchy, Cache Memory- Cache memory principles, Elements of cache design- cache address, size, mapping functions, replacement algorithms, write policy, Internal Memory- Main Memory (RAM and ROM Chips), semiconductor memory, External Memory- Hard Disk organization, RAID, Virtual Memory concept.

UNIT IV **9L**

I/O modules- Module function and I/O module structure, Programmed I/O, Polling I/O, Interrupt driven I/O, DMA function, Synchronous and Asynchronous serial data communication, Computer peripherals like keyboard, mouse, printer, scanner, and display devices.

TEXT BOOKS

1. Computer System Architecture - M. Mano
2. Carl Hamacher, Zvonko Vranesic, Safwat Zaky Computer Organization, McGraw-Hill, Fifth Edition, Reprint 2012
3. John P. Hayes, Computer Architecture and Organization, Tata McGraw Hill, Third Edition, 1998.

REFERENCE BOOKS

1. William Stallings, Computer Organization and Architecture-Designing for Performance, Pearson Education, Seventh edition, 2006.
2. Behrooz Parahami, "Computer Architecture", Oxford University Press, Eighth Impression, 2011.
3. David A. Patterson and John L. Hennessy, "Computer Architecture-A Quantitative Approach", Elsevier, a division of reed India Private Limited, Fifth edition, 2012.

BCS-263	:	**DATABASE MANAGEMENT SYSTEMS**

Course category	:	PC
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1/0 & Practical: 0/2
Number of Credits	:	4
Course Assessment methods	:	Continuous Assessment through One Minor Test, Teacher Assessment (Quiz, Tutorial, Assignment, Attendance), Practical Work & Viva-voce, and One Major Theory & One Practical Examinations.
Course Objectives	:	This course helps the students in gaining the knowledge of basic principle of Database Management Systems and to undertake future courses that assume as a background in Database Management Systems. 1. Discuss basic theory and practice of database management systems 2. Design and implement new databases 3. Become familiar with fundamentals of database management systems and with the way these can best be implemented 4. Become accustomed to the description of database management systems in both functional and procedural styles
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

CO1.Define the basic concepts of database management systems.
CO2. Discuss various database design techniques for developing database systems.
CO3. Discuss various techniques for having control over concurrent database transactions.
CO4. Discuss various advanced topics on database management systems
CO5. Understand various transaction processing, concurrency control mechanisms and database protection mechanisms.
CO6. Demonstrate an understanding of normalization theory and apply such knowledge to the normalization of a database.

Topics Covered

UNIT I **9L**

Introduction: An Overview of Database Management System, Database System vs File System, Database System Concept and Architecture, Data Model Schema and Instances, Data Independence and Database Language and Interfaces, Data Definitions Language, DML, Overall Database Structure.

Data Modeling using Entity Relationship Model: ER Model Concepts, Notation for ER Diagram, Mapping Constraints, Keys, Concepts of Super Key, Candidate Key, Primary Key, Generalization, Aggregation, Reduction of An ER Diagrams to Tables, Extended ER Model, Relationship of Higher Degree.

UNIT II **9L**

Relational Data Model and Language: Relational Data Model Concepts, Integrity Constraints, Entity Integrity, Referential Integrity, Keys Constraints, Domain Constraints, Relational Algebra, Relational Calculus, Tuple and Domain Calculus.

Introduction on SQL: Characteristics of SQL, Advantage of SQL. SQL Data Type and Literals. Types of SQL Commands. SQL Operators and their Procedure. Tables, Views and Indexes. Queries and Sub Queries. Aggregate Functions. Insert, Update and Delete Operations, Joins, Unions, Intersection, Minus, Cursors, Triggers, Procedures in SQL/PL SQL

UNIT III **9L**

Database Design &Normalization: Functional Dependencies, Normal Forms, First, Second, Third Normal Forms, BCNF, Inclusion Dependence, Loss Less Join Decompositions, Normalization using FD, MVD, and JDS, Alternative Approaches to Database Design.

UNIT IV **9L**

Transaction Processing Concept: Transaction System, Testing of Serializability, Serializability of Schedules, Conflict & View Serializable Schedule, Recoverability, Recovery from Transaction Failures, Log Based Recovery, Checkpoints, Deadlock Handling.

Distributed Database: Distributed Data Storage, Concurrency Control, Directory System.

Concurrency Control Techniques: Concurrency Control, Locking Techniques for Concurrency Control, Time Stamping Protocols for Concurrency Control, Validation Based Protocol, Multiple Granularity, Multi Version Schemes, Recovery with Concurrent Transaction, Case Study of Oracle.

List of Experiments

1. Write SQL queries using SQL operators
2. Write SQL query using character, number, date and group functions
3. Write SQL queries for relational algebra
4. Write SQL queries for extracting data from more than one table
5. Write SQL queries for sub queries, nested queries
6. Write program using PL/SQL
7. Concepts for ROLL BACK, COMMIT & CHECK POINTS
8. Create VIEWS, CURSORS and TRGGERS & write ASSERTIONS.
9. Create FORMS and REPORTS
10. Design of tables by normalization and dependency analysis
11. Writing application software with host language interface

TEXT BOOKS

1. Date C J, An Introduction to Database Systems, Addison Wesley
2. Korth, Silbertz, Sudarshan, Database Concepts, McGraw Hill
3. Elmasri, Navathe, Fundamentals of Database Systems, Addison Wesley
4. O"Neil, Databases, Elsevier Pub.
5. Leon& Leon, Database Management Systems, Vikas Publishing House
6. Bipin C. Desai, An Introduction to Database Systems, Galgotia Publications
7. Majumdar & Bhattacharya, Database Management System, TMH
8. Ramkrishnan, Gehrke, Database Management System, McGraw Hill
9. Kroenke, Database Processing Fundamentals, Design and Implementation, Pearson Education.
10. J. D. Ulman, Principles of Database and Knowledge base System, Computer Science Press.
11. Maheshwari Jain. DBMS: Complete Practical Approach, Firewall Media, New Delhi

REFERENCE BOOKS

1. Ramon a. Mato-Toledo, Pauline K. Cushman, Database Management Systems, Schaums Outline series, TMH, New Delhi Special Indian Edition 2007
2. Ivan Bayross, Mastering Database Technologies, BPB Publications, New Delhi - First Indian Edition 2006, Reprinted 2011

ECS-103	:	**INTRODUCTION TO DATA SCIENCE**
Course category	:	**PE1**
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1 & Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.
Course Objectives	:	1. To provide the knowledge and expertise to become a proficient data scientist. 2. Demonstrate an understanding of statistics and machine learning concepts that are vital for data science. 3. Produce Python code to statistically analyse a dataset.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

CO1. To explain how data is collected, managed, and stored for data science.
CO2. To understand the key concepts in data science, including their real-world applications and the toolkit used by data scientists.
CO3. To implement data collection and management scripts using MongoDB.
CO4. Critically evaluate data visualisations based on their design and use for communicating stories from data.
CO5. Evaluate outcomes and make decisions based on data
CO6.Effectively communicate results

Topics Covered

UNIT I **9L**

Introduction to Data Science, Different Sectors using Data science, Purpose and Components of Python in Data Science. Applications of Data Science, Data Science and Ethical Issues- Discussions on privacy, security, ethics- A look back at Data Science- Next-generation data scientists.

UNIT II **9L**

Data Analytics Process, Knowledge Check, Exploratory Data Analysis (EDA), EDA- Quantitative technique, EDA- Graphical Technique, Data Analytics Conclusion and Predictions.

UNIT III **9L**

Feature Generation and Feature Selection (Extracting Meaning from Data)- Motivating application: user (customer) retention- Feature Generation (brainstorming, role of domain expertise, and place for imagination)- Feature Selection algorithms.

UNIT IV **9L**

Data Visualization- Basic principles, ideas and tools for data visualization, Examples of inspiring (industry) projects- Exercise: create your own visualization of a complex dataset.

TEXT BOOKS

1. Data Science from Scratch: First Principles with Python, Joel Grus, O'Reilly Media (2015).
2. An introduction to Data Science, Jeffrey Stanton.
3. Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython 2nd edition, William

McKinney, O'Reilly Media (2017)

4. Business Analytics: The Science of Data - Driven Decision Making, U Dinesh Kumar, John Wiley & Sons.
5. Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools, Davy Cielen, John Wiley & Sons.
6. Data Science from Scratch, Joel Grus, O'Reilly Publisher Media.

REFERENCE BOOKS

1. Mining of Massive Datasets. v2.1, Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. , Cambridge University Press.
2. Python Data Science Handbook, Jake VanderPlas, Shroff Publisher/O'Reilly Publisher Media.
3. Data Analysis with Open Source Tools, Philipp Janert, Shroff Publisher/O'Reilly Publisher Media.

ECS-104	:	**INTRODUCTION TO ARTIFICIAL INTELLIGENCE**
Course category	:	**PE1**
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1 & Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.
Course Objectives	:	1. To review and strengthen important mathematical concepts required for AI & ML. 2. Introduce the concept of learning patterns from data and develop a strong theoretical foundation for understanding state of the art Machine Learning algorithms.
Course Outcomes	:	

CO1. Explain AI fundamentals and represent knowledge using predicate logic and rules.
CO2.Differentiate between procedural and declarative knowledge and apply logic programming basics.
CO3. Describe machine learning types and classify problems into regression and classification.
CO4.Implement and optimize linear regression using gradient descent.
CO5. Apply logistic regression for classification and handle multi-class and overfitting issues.
CO6. Understand and implement clustering algorithms with their real-world applications.

Topics Covered

UNIT I **9L**

Defining Artificial Intelligence, Defining AI techniques, Using Predicate Logic and Representing Knowledge as Rules, Representing simple facts in logic, Computable functions and predicates, Procedural vs Declarative knowledge, Logic Programming, Mathematical foundations: Matrix Theory and Statistics for Machine Learning.

UNIT II **9L**

Idea of Machines learning from data, Classification of problem –Regression and Classification, Supervised and Unsupervised learning.

UNIT III **9L**

Linear Regression: Model representation for single variable, Single variable Cost Function, Gradient Decent for Linear Regression, Gradient Decent in practice.

UNIT IV **9L**

Logistic Regression: Classification, Hypothesis Representation, Decision Boundary, Cost function, Advanced Optimization, Multi-classification (One vs All), Problem of Overfitting.
Discussion on clustering algorithms and use-cases cantered around clustering and classification.

Text Books/References:

1. Saroj Kaushik, Artificial Intelligence, Cengage Learning, 1st Edition 2011.
2. Anindita Das Bhattacharjee, "Practical Workbook Artificial Intelligence and Soft Computing for beginners, Shroff Publisher-X team Publisher.
3. Yuxi (Hayden) Liu, "Python Machine Learning by Example", Packet Publishing Limited, 2017.
4. Tom Mitchell, Machine Learning, McGraw Hill, 2017.
5. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2011.
6. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2011.

ECS-105	:	**CRYPTOGRAPHY AND NETWORK SECURITY**
Course category	:	**PE1**
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1 & Practical: 0
Number of Credits	:	4

Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.
Course Objectives	:	
Course Outcomes	:	After successful completion of the course, the learners would be able to:

CO1. Explain security attacks, services, mechanisms.
CO2. Describe modern block cipher designs including DES, AES.
CO3. Understand principles of public key cryptography, RSA, Diffie-Hellman.
CO4. Apply message authentication, hash functions, and analyze their security against attacks.
CO5. Explain digital signature algorithms, authentication protocols.
CO6. Describe IP security architecture, including authentication headers.

Topics Covered

UNIT I **9L**

Introduction to security attacks - services and mechanism, Introduction to cryptography - Conventional Encryption: Conventional encryption model, Classical encryption techniques - substitution ciphers and transposition ciphers – cryptanalysis, Steganography.

UNIT II **9L**

Stream and block ciphers - Modern Block Ciphers: Block ciphers principals - Shannon's theory of confusion and diffusion - Feistel structure - data encryption standard (DES) - strength of DES – differential and linear crypt analysis of DES - block cipher modes of operations - triple DES – AES.

UNIT III **9L**

Principles of public key crypto systems - RSA algorithm, Security of RSA - key management, Diffie-Hellman key exchange algorithm, Introductory idea of Elliptic curve cryptography, Elgamal encryption, Message Authentication and Hash Function, Authentication requirements & functions, message authentication code, birthday attacks, security of hash functions. MD5 message digest algorithm - Secure hash algorithm (SHA).

UNIT IV **9L**

Digital Signatures - authentication protocols - digital signature standards (DSS) - proof of digital signature algorithm - Authentication Applications: Kerberos and X.509 - directory authentication service - electronic mail security-pretty good privacy (PGP) - S/MIME, IP Security: Architecture - Authentication header - Encapsulating security payloads – combining security associations - key management.

Text Books:

1. William Stallings, "Crpyptography and Network security Principles and Practices", Pearson/PHI.
2. Wade Trappe, Lawrence C Washington, " Introduction to Cryptography with coding theory", Pearson.

Reference Books

1. W. Mao, "Modern Cryptography – Theory and Practice", Pearson Education.
2. Charles P. Pfleeger, Shari Lawrence Pfleeger – Security in computing – Prentice Hall of India.
3. Sean Smith, "The Internet of Risky Things", Sean Smith, Shroff Publisher/O'Reilly Publisher.

ECS-106	:	**COMPUTER GRAPHICS FOR VIRTUAL REALITY**
Course category	:	**PE1**
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1 & Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.
Course Objectives	:	1. To introduce the use of the components of a graphics system and become familiar with building approach of graphics system components and algorithms related with them. 2. To learn the basic principles of 3-dimensional computer graphics. 3. Provide an understanding of mapping from a world coordinates to device coordinates, clipping, and projections.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

CO1. To list the basic concepts used in computer graphics.
CO2. To implement various algorithms to scan, convert the basic geometrical primitives, transformations, Area filling, clipping.
CO3. To define the fundamentals of animation, virtual reality and its related technologies.
CO4. To design an application with the principles of virtual reality.
CO5. To understand a typical graphics pipeline
CO6. To design an application with the principles of virtual reality

Topics Covered

UNIT I **9L**

Graphics system and models: applications of computer graphics, graphics system, physical and synthetic images, imaging systems, graphics architectures, Geometric objects and transformations: scalars, points and vectors, three-dimensional primitives, coordinate systems and frames, frames in OpenGL, matrix and vector classes, modelling a colored cube, affine transformations - translation, rotation and scaling, transformations in homogeneous coordinates, concatenation of transformations, transformation matrices in OpenGL, interfaces to 3D applications, quaternion.

Vertices to fragments: basic implementation strategies, four major tasks, clipping - line clipping, polygon clipping, clipping of other primitives, clipping in three dimensions, polygon rasterization, hidden-surface removal, antialiasing, display considerations.

UNIT II **9L**

Discrete techniques: buffers - digital images - writing into buffers - mapping methods - texture mapping - texture mapping in OpenGL - texture generation - environment maps - reflection map - bump mapping - compositing techniques - sampling and aliasing. Advanced rendering: going beyond pipeline rendering - ray tracing - building a simple ray tracer - the rendering equation - radiosity - Renderman -

parallel rendering
-volume rendering - Isosurfaces and marching cubes - mesh simplification - direct volume rendering - image-based rendering.

UNIT III **9L**

Principles of public key crypto systems - RSA algorithm, Security of RSA - key management, Diffie-Hellman key exchange algorithm, Introductory idea of Elliptic curve cryptography, Elgamal encryption, Message Authentication and Hash Function, Authentication requirements & functions, message authentication code, birthday attacks, security of hash functions. MD5 message digest algorithm - Secure hash algorithm (SHA).

UNIT IV **9L**

Fractals: modelling - Sierpinski Gasket - coastline problem - fractal geometry - fractal dimension - recursively defined curves - Koch curves - c curves - dragons - space filling curves - turtle graphics - grammar based models - Graftals - volumetric examples - k-midpoint subdivision - fractal Brownian motion
-fractal mountains - iteration in the complex plane - Mandelbrot set.
Virtual reality modelling language: introduction, exploring and building a world, building object, lighting, sound and complex shapes, animation and user interaction, colors, normals and textures, nodes references. Special applications: stereo display programming, multiport display systems, multi-screen display system, fly mode navigation, walk through navigation, virtual track ball navigation.

TEXT BOOKS

1. Rajesh K. Maurya, Computer Graphics with Virtual Reality System, John Wiley & Sons.
2. Edward Angel, "Interactive Computer Graphics: A Top-Down Approach Using OpenGL", Addison- Wesley.
3. Foley James D, Van Dam, Feiner and Hughes, "Computer Graphics: Principles and Practice", Pearson Education.

REFERENCE BOOK

1. Computer Graphics with Virtual Reality System, 3Ed, Rajesh K. Maurya, Wiley India

ECS-107	:	**FUNDAMENTAL OF BLOCKCHAIN TECHNOLOGY AND APPLICATIONS**
Course category	:	**PE1**
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1 & Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.
Course Objectives	:	It contains a basic introduction to familiarize students with the basics of advanced programming techniques. Here are the key objectives covered in this course. 1. To understand the concepts of blockchain technology 2. To understand the consensus and hyper ledger fabric in blockchain technology

		3. Analyze the architecture and consensus mechanisms of Bitcoin. 4. Evaluate smart contract languages in automating and enforcing digital agreements. 5. Explore privacy-enhancing technologies in blockchain vulnerabilities.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

CO1. State the basic concepts of block chain
CO2. Paraphrase the list of consensus and Demonstrate and Interpret working of Hyper ledger Fabric
CO3. Implement SDK composer tool and explain the Digital identity for government
CO4. Compare and contrast different blockchain platforms.
CO5. Identify appropriate blockchain platforms for specific use cases.
CO6. Testing and debugging blockchain applications

Topics Covered

UNIT I **9L**

History: Digital Money to Distributed Ledgers -Design Primitives: Protocols, Security, Consensus, Permissions, Privacy: Block chain Architecture and Design-Basic crypto primitives: Hash, Signature, Hash chain to Block chain-Basic consensus mechanisms.

UNIT II **9L**

Requirements for the consensus protocols-Proof of Work (PoW)-Scalability aspects of Block chain consensus protocols: Permissioned Block chains-Design goals-Consensus protocols for Permissioned Block chains, Zcash and Zk-SNARKS for anonymity preservation, attacks on Blockchains – such as Sybil attacks, selfish mining, 51% attacks.

UNIT III **9L**

Decomposing the consensus process-Hyper ledger fabric components-Chain code Design and Implementation: Hyper ledger Fabric II:-Beyond Chain code: fabric SDK and Front End-Hyper ledger composer tool, Using smart contracts to enforce legal contracts, comparing Bitcoin scripting vs. Ethereum Smart Contracts

UNIT IV **9L**

Block chain in Financial Software and Systems (FSS): -Settlements, -KYC, -Capital markets-InsuranceBlock chain in trade/supply chain: Provenance of goods, visibility, trade/supply chain finance, invoice management/discounting. Blockchain for Government: Digital identity, land records and other kinds of record keeping between government entities, public distribution system / social welfare systems: Block chain Cryptography: Privacy and Security on Block chain.

Textbooks:

1. Mark Gates, “Block chain: Ultimate guide to understanding block chain, bit coin, crypto currencies, smart contracts and the future of money”, Wise Fox Publishing and Mark Gates 2017.
2. Salman Baset, Luc Desrosiers, Nitin Gaur, Petr Novotny, Anthony O'Dowd, Venkatraman Ramakrishna, “Hands-On Block chain with Hyper ledger: Building decentralized applications with Hyperledger Fabric and Composer”, 2018.

3. Bahga, Vijay Madisetti, “Block chain Applications: A Hands-On Approach”, ArshdeepBahga, Vijay Madisetti publishers 2017.

ECS-108	:	**INTRODUCTION TO OBJECT ORIENTED PROGRAMMING USING C++**
Course category	:	**PE1**
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0 & Practical: 2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, practical work, record, viva voce and one minor test and one major examination.
Course Objectives	:	1. Provide a comprehensive understanding of C++ programming fundamentals. 2. Introduce object-oriented concepts including classes, objects, encapsulation, abstraction, inheritance, and polymorphism. 3. Develop the ability to design modular and reusable software using C++ features. 4. Enable students to apply operator overloading, templates, exception handling, and STL in problem-solving. 5. Teach dynamic memory management, pointers, file handling, and modern C++ features.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

CO1. Understand the procedural and object-oriented paradigms and the basics of C++ syntax.
CO2. Design and implement classes, objects, constructors, destructors, and encapsulation-based applications.
CO3. Apply inheritance, polymorphism, operator overloading, and virtual functions in C++ programs.
CO4. Use pointers, references, dynamic memory, and object pointers effectively.
CO5. Develop generic programming solutions using function templates, class templates, and STL containers.
CO6. Implement file operations and exception handling using C++ streams and error mechanisms.

Topics Covered

UNIT I **9L**

Evolution of C++ from C, differences between C and C++, procedural vs OOP paradigm, structure of a C++ program, tokens, variables, identifiers, data types, type casting, reference variables, cout and cin, manipulators, arithmetic operators, relational operators, logical operators, bitwise operators, assignment operators, scope resolution operator, namespace, if and switch statements, loops (for, while, do-while), break, continue, range-based loops, function prototypes, inline functions, default arguments, const arguments, function overloading, call-by-value, call-by-reference using references and pointers.

UNIT II **9L**

Topics include: classes and objects, data members, member functions, access specifiers (private, public, protected), memory layout of objects, constructors (default, parameterized, copy), constructor overloading, constructor delegation, destructor, array of objects, objects as function arguments, returning objects, static data members, static member functions, friend functions, friend classes, encapsulation, abstraction, abstract classes, and access modifiers.

UNIT III **9L**

Topics include: single inheritance, multilevel inheritance, multiple inheritance, hierarchical inheritance, hybrid inheritance, visibility modes, constructor invocation in inheritance, virtual base class, function overriding, virtual functions, pure virtual functions, abstract classes, compile-time polymorphism, runtime polymorphism, operator overloading (unary, binary, insertion <<, extraction >>, assignment operator), and rules for operator overloading.

UNIT IV **9L**

Topics include: pointer arithmetic, pointers to objects, this pointer, dynamic memory allocation using new and delete, dangling pointers, memory leaks, smart pointers (unique_ptr, shared_ptr), file handling using ifstream, ofstream, fstream, reading and writing text files, reading and writing binary files, file error handling, try-catch-throw exception handling, multiple catch blocks, rethrowing exceptions, user-defined exceptions, function templates, class templates, STL containers (vector, list, stack, queue, map), iterators, STL algorithms (sort, find, count), and modern C++ topics including auto keyword, range-based loops, nullptr.

Textbooks:

1. E. Balagurusamy, Object-Oriented Programming with C++, 8th ed. McGraw Hill, 2020.
2. R. Lafore, Object-Oriented Programming in C++, 4th ed. Sams Publishing, 2002.
3. H. Schildt, C++: The Complete Reference, 4th ed. McGraw-Hill Professional, 2002.

Reference Books:

1. Stroustrup, B . (2013). The C++ Programming Language (4th ed.). Addison-Wesley.
2. Lippman, S. B., Lajoie, J., & Moo, B. E. (2012). C++ Primer (5th ed.). Addison-Wesley.
3. Josuttis, N. M. (2012). The C++ Standard Library: A Tutorial and Reference (2nd ed.). Addison-Wesley.

List of Experiments

1. Basic I/O, operators, control statements in C++.
2. Programs on functions, inline functions, overloading.
3. Class & object creation; access modifiers.
4. Constructor overloading & copy constructor.
5. Static members and friend functions.
6. Array of objects & object as function argument.
7. Inheritance: single, multilevel, multiple.
8. Virtual functions and runtime polymorphism.
9. Operator overloading: unary, binary, << and >>.
10. Pointers, pointer to object, dynamic memory.
11. File operations: text & binary files.
12. Exception handling programs.
13. Function and class templates.
14. STL programming using vectors, lists, stacks, queues, maps.

15. Use of modern C++: auto, lambda, range-for, smart pointers.
16. Mini project demonstrating full OOP.

ECS-109	:	**GLOBAL POSITIONING SYSTEM**
Course category	:	**PE1**
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1 & Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.
Course Objectives	:	
Course Outcomes	:	

CO1. Explain the fundamental concepts of geodesy, Earth's shape, gravity field, and atmospheric influence on geodetic measurements.
CO2. Describe the architecture of GPS, including satellite constellation, signal structure, coordinate systems (WGS-84), and timing systems.
CO3. Identify and analyze GPS signal errors and biases affecting positioning accuracy.
CO4. Apply GPS orbital and navigational principles to determine precise positions using field observations and GPS receivers.
CO5.Process GPS data and integrate it with GIS platforms for spatial analysis and mapping applications.

Topics Covered

UNIT I **9L**
Introduction to geodesy and its development, Earth and its size and shape, earth and its motions- annual, spin, precession, nutation, polar motion, Earth and its gravity field – anomaly, gravity potential, geoid and deflection to vertical, Earth and its atmosphere – physical properties, wave propagation through atmosphere, temporal variations, gravitational field of the atmosphere,

UNIT II **9L**
Introduction of Global Positioning System, Satellite constellation, GPS signals and data, pseudo range and carrier phase measurements; Signal structure; GPS coordinate systems: WGS-84, GPS time; GPS Errors and biases.

UNIT III **9L**
GPS orbital Geometry and Navigational solution; GPS receiver, GPS antenna. Radio and its types, Radio Antenna, Surveying with GPS; Planning and field observations;

UNIT IV **9L**
Data post-processing; GIS and GPS integration; Other satellite based navigational systems: GLONASS, GALILEO, modernization plans of navigational satellites. GPS Applications

Text &Reference Books:

1. Understanding GPS/GNSS: Principles and Applications (Authors: Elliott D. Kaplan and Christopher Hegarty), 3rd Edition, 2011, Publisher: Artech House
2. Gps Satellite Surveying, by Alfred Leick, Repoport, Tatarikov, 4th Edition, Wiley

Publishing House.
3. Global Positioning System: Theory and Practice (Authors: B. Hofmann-Wellenhof, H. Lichtenegger, J. Collins), 5th Edition, 2001, Publisher: Springer.
4. Global Positioning System: Theory and Applications, by Branford W. Parkinson.

ECS-201	:	**Fundamentals of Cyber Security and Forensics**
Course category	:	PE2
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials, course-based project, one minor test and one major examination
Course Objectives	:	1. To provide foundational understanding of cyber security concepts, attacks, and defence mechanisms. 2. To familiarize learners with principles of cryptography and secure communication. 3. To introduce fundamentals of digital forensics and incident response. 4. To develop analytical skills for identifying, analysing, and reporting cyber incidents.
Course Outcomes	:	After successful completion of this course, students will be able to:

CO1. Understand the fundamental concepts of cyber security including the CIA triad, threats, vulnerabilities, malware, and different types of cyber-attacks.
CO2. Apply cryptographic algorithms, hashing techniques, digital signatures, and secure communication protocols to safeguard digital systems.
CO3. Analyze access control models, password management strategies, and multi-factor authentication mechanisms for securing information environments.
CO4. Evaluate digital forensic processes such as acquisition, preservation, examination, analysis, and reporting using standard forensic tools.
CO5. Create forensic investigation reports by performing disk imaging, email tracing, log examination, and mobile artefact extraction.
CO6. Design legally compliant and ethically sound forensic investigation frameworks aligned with IT Act 2000, ISO 27001, and NIST Cybersecurity standards.

Topics Covered

UNIT-I **9L**

Introduction to Cyber Security: Overview of Cyber Security, CIA Triad-Confidentiality, Integrity, Availability, Threats, Vulnerabilities, Types of Attacks, Malware-Virus, Worm, Trojan, Ransomware,

Spyware, Social Engineering-Phishing, Vishing, Smishing, DoS/DDoS, MITM, Password Attacks, Security Policies, Cyber Hygiene, Indian Cyber Laws-IT Act 2000 & Amendments, Introduction to ISO 27001, NIST Cybersecurity Framework.

UNIT-II **9L**

Cryptography & Secure Systems: Introduction to Cryptography-Symmetric & Asymmetric Encryption, Hashing & Digital Signatures, Public Key Infrastructure (PKI), Certificates, Secure Communication Protocols-SSL/TLS, HTTPS, Access Control Models-DAC, MAC, RBAC, Password Security, Multifactor Authentication.

UNIT-III **9L**

Digital Forensics: Introduction to Cyber Forensics & its Importance, Types of Forensics-Computer, Network, Mobile, Cloud, Incident Response Process-Preparation, Identification, Containment, Eradication, Recovery, Forensic Principles-Chain of Custody, Acquisition, Preservation, Examination, Analysis, Reporting, File Systems & Data Storage Basics, Live vs Dead Forensics, Tools Overview: FTK, Forensic Explorer, EnCase, Cellebrite, XRY MSAB, Network Miner, Wireshark, Nmap, MD-video, MD-Drone.

UNIT-IV **9L**

Forensic Investigation Methods & Case Studies: Disk Forensics-Imaging, Bit-by-bit Copy, Hash Verification, Email Forensics: Header Analysis, Email Tracing, Network Forensics-Logs, TCP/UDP Analysis, Packet Capture, Windows Forensics: Registry, Event Logs, User Artefacts, Mobile Forensics: Extraction Types, SIM/IMEI, App Data, Introduction to Anti-Forensics Techniques

Text Books

1. Nina Godbole & Sunit Belapure, Cyber Security, Wiley India.
2. Nelson, Phillips & Steuart, Guide to Computer Forensics and Investigations, Cengage Learning.
3. Computer Forensics, Computer Crime Investigation by John R,Vacca, Firewall Media, New Delhi.
4. William Stallings, Cryptography and Network Security: Principles and Practice, Pearson.
5. Marjie T. Britz, Computer Forensics and Cyber Crime, Pearson.

Reference Books

1. John Sammons, The Basics of Digital Forensics, Elsevier.
2. Jason Luttgens, Matthew Pepe, Kevin Mandia, Incident Response & Computer Forensics, McGraw-Hill.
3. Brian Carrier, File System Forensic Analysis, Addison-Wesley.
4. EC-Council, Computer Forensics: Investigating Data and Image Files, Cengage Learning.
5. NIST Special Publications (SP 800 Series) – Cybersecurity & Forensics Guidelines.
6. ISO/IEC 27001 Standards Documentation – Information Security Management System (ISMS).

ECS-202	:	**Concepts of AI and Applications**
Course category	:	PE2
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials, course-based project, one minor test and one major examination
Course Objectives	:	1. Understand the fundamentals, evolution, and application domains of Artificial Intelligence. 2. Learn classical problem-solving methods, logic-based reasoning, and knowledge representation techniques. 3. Apply supervised and unsupervised learning algorithms and evaluate their performance. 4. Use Python libraries for implementing AI and ML models. 5. Appraise the application of AI in real-world scenarios and understand associated ethical issues
Course Outcomes	:	After successful completion of this course, students will be able to:

CO1. Understand the history, objectives, domains, and applications of Artificial Intelligence.
CO2. Demonstrate foundational principles including problem solving, search methods, reasoning, and knowledge representation.
CO3. Implement machine learning algorithms and evaluate model performance using Python libraries.
CO4. Explain agent–environment interactions, decision support systems, and expert systems.
CO5. Apply AI techniques to real-world applications and analyze associated ethical and sustainability issues.

Topics Covered

UNIT-I **9L** Basics of Artificial Intelligence: Definition of AI, history and evolution, domains and mundane tasks, types of AI: Weak AI and Strong AI. Introduction to ELIZA, ALICE, Turing Test, Human–Computer Interaction, myths and misconceptions, trends and applications of AI, Heuristic approaches: informed and uninformed search—DFS, BFS, A, A* algorithms; Hill Climbing, Classical problem solving: Water Jug Problem, Constraint Satisfaction Problems (CSP), State-space searching, knowledge representation basics, game playing and ply concepts.

UNIT-II **9L**
Foundations of Artificial Intelligence: Knowledge representation and reasoning, knowledge-based systems, Propositional logic: syntax, semantics, inference rules, Predicate logic: syntax, semantics, unification, Resolution in propositional and predicate logic, Forward and backward chaining, Semantic networks, frames, ontologies, rule-based systems

UNIT-III **9L** Machine Learning Methods: Supervised learning: Regression, Logistic Regression, KNN, Naïve Bayes, Artificial Neural Network, Unsupervised learning: K-means clustering, Hierarchical clustering (Agglomerative, Divisive), Model evaluation: MAE, MSE, RMSE, R^2, accuracy, precision, recall, F1-score, AUC/ROC, t-SNE for visualization, Python libraries for data analysis: NumPy, Pandas, Matplotlib, Seaborn, Plotly, Scikit-learn, Role of data in AI; agent–environment systems; decision

support system; expert systems.

UNIT-IV **9L**

Applications of Artificial Intelligence: AI in healthcare, education, agriculture, environment, Smart cities, smart homes, transportation, digital manufacturing, Ethical dilemmas in AI: bias, fairness, privacy, AI in decision making risks, accountability, Global policy regulations, sustainable AI, environmental impacts, Case study on AI applications in a chosen field.

Textbooks

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach**,**4th Edition, Pearson, 2020.
2. Elaine Rich, Kevin Knight, and Shivashankar B. Nair, Artificial Intelligence, 3rd Edition, Tata McGraw-Hill, 2009.

Reference books

1. Tom M. Mitchell, Machine Learning, 2nd edition, Publisher: McGraw-Hill, 2017.
2. George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Pearson, 2008.
3. Anthony S. Williams, Hands-On Artificial Intelligence with Python, 2nd Edition, Packt Publisher, 2020.

ECS-203	:	**Principles of Data Science and Analytics using python**
Course category	:	PE2
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials, and one minor test and one major examination.
Course Objectives	:	1. To introduce fundamental concepts, workflow, and tools of data science. 2. To apply basic statistical and analytical methods for data understanding. 3. To gain hands-on experience with Python programming and essential libraries. 4. To perform exploratory data analysis and feature extraction for data-driven insights.
Course Outcomes	:	After successful completion of this course, students will be able to:
CO1. Explain the basic concepts, tools, and workflow of data science.		

CO2. Apply descriptive statistical techniques to summarize and interpret data.
CO3. Develop Python programs for data handling and analysis.
CO4. Utilize core Python libraries for data processing and visualization.
CO5. Perform exploratory data analysis and feature extraction for data modelling.
CO6. *Implement* feature engineering techniques, including encoding, normalization, feature selection, and dimensionality reduction to prepare data for analytical and machine learning pipelines.

Topics Covered

UNIT-I **9L**

Introduction to Data Science: Definition, scope, lifecycle, and roles in data science. Data Types: Structured, semi-structured, and unstructured data. Descriptive Statistics: Measures of central tendency (mean, median, mode), measures of dispersion (range, variance, standard deviation). Probability Concepts and Distributions: Normal, Binomial, and Poisson distributions. Correlation and Covariance.

UNIT-II **9L**

Python Basics: Data types, operators, variables, and expressions. Control Structures: Conditional statements, loops. Functions and Modules. Data Structures: Lists, tuples, dictionaries, sets. File Handling: Reading and writing data files. Working with CSV and JSON data formats. Introduction to Jupyter Notebook and notebook-based workflow.

UNIT-III **9L**

NumPy: Arrays, indexing, broadcasting, mathematical operations. Pandas: Series, DataFrame, data import/export, cleaning, grouping, and aggregation. Matplotlib: Basic plots – line, bar, scatter, histogram, boxplot. Seaborn: Statistical visualizations – pairplot, heatmap, distplot. Scikit-learn (Intro): Overview of preprocessing tools and utilities.

UNIT-IV **9L**

Introduction to EDA: Objectives, workflow, and best practices. Data Cleaning: Handling missing values and inconsistent data. Outlier Detection and Treatment. Data Visualization for EDA: Correlation plots, pairplots, distribution plots. Feature Engineering: Encoding categorical variables, normalization, and scaling. Feature Selection and Importance. Dimensionality Reduction (Introduction to PCA).

Textbooks

1. W. McKinney, *Python for Data Analysis,* O'Reilly Media, 2012.
2. J. Grus, *Data Science from Scratch: First Principles with Python*, Data Science from Scratch, O'Reilly Media, 2019.
3. J. VanderPlas, *A Whirlwind Tour of Python,* O'Reilly Media, 2016.
4. A. B. Downey, *Think Stats: Probability and Statistics for Programmers,* Green Tea Press, 2014.

Reference Books

1. A. Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media, **2022**.
2. G. James, D. Witten, T. Hastie, and R. Tibshirani, *An Introduction to Statistical Learning, with Applications in R,* Springer, **2021.**
3. R. D. Peng, *Exploratory Data Analysis with R,* Lulu.com, **2016.**

ECS-204	:	**Introduction to Distributed Ledger Technologies**
Course category	:	PE2
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials, and one minor test and one major examination.
Course Objectives	:	1. This course provides a strong foundational understanding of blockchain technology. 2. It introduces students to the **historical evolution, core architecture, cryptographic techniques,** and **consensus mechanisms** that make blockchains secure and decentralized. 3. The emphasis is on understanding how blockchain works internally from block structure to network consensus through both theoretical and practical learning.
Course Outcomes	:	After successful completion of this course, students will be able to:

CO1. Explain the evolution, principles, and architecture of distributed ledger and blockchain systems.
CO2. Describe the structure, components, and functioning of blockchain networks.
CO3. Apply cryptographic methods such as hashing and digital signatures in blockchain applications.
CO4. Analyse different consensus algorithms used in decentralized networks.
CO5. Evaluate security, regulatory, and ethical aspects of distributed ledger technologies.
CO6. Assess real-world applications and limitations of blockchain-based systems.

Topics Covered

UNIT-I **9L**

Introduction to Distributed Systems, Centralized, Decentralized, and Distributed Network Architectures, Evolution of Digital Cash Systems, Bitcoin Whitepaper (Overview of Nakamoto's Design), Fundamentals of Blockchain: Ledger, Block, Node, Transaction, and Mining, Timestamping and Proof of Work Concepts, Key Features of Blockchain: Immutability, Transparency, Security, and Decentralization, Overview of Blockchain Generations (Blockchain 1.0 to 3.0), Types of Blockchains.

UNIT-II **9L**

Blockchain System Framework: Layers and Components, Structure of a Block: Block Header and Block Body, Block Fields: Version, Previous Block Hash, Merkle Root, Timestamp, Nonce, Difficulty Target, Transactions Creation, Verified, and Broadcast, Blockchain Network Components: Nodes, Miners, and Validators, Process of Adding a New Block to the Chain, Block Propagation, Orphan Blocks, and Chain Synchronization, Chain Storage: Linking Blocks via Cryptographic Hashes.

UNIT-III **9L**

Role of Cryptography in Blockchain Security, Basics of Cryptographic Algorithms, Hash Functions, Merkle Trees: Structure, Construction, and Proof of Inclusion, Public Key Cryptography, Security Concepts**:** Immutability, Pseudonymity, Anonymity, and Non-repudiation, Common Attacks on Blockchain: Eclipse Attack, Replay Attack.

UNIT-IV **9L**

Need for Consensus in Distributed Networks, Byzantine Generals Problem and Fault Tolerance,

Characteristics of a Good Consensus Mechanism: Agreement, Termination, Validity, Overview of Consensus Types: Proof of Work (PoW), Proof of Stake (PoS), Delegated Proof of Stake (DPoS), Proof of Authority (PoA), Practical Byzantine Fault Tolerance (PBFT), Mining Process and Difficulty Adjustment, Energy Efficiency and Scalability Issues.

Textbooks

1. Arshdeep Bahga and Vijay Madisetti, Blockchain Applications: A Hands-On Approach, VPT, 2017.
2. Imran Bashir, Mastering Blockchain, 3rd Edition, Packt Publishing, 2020.
3. Melanie Swan, Blockchain: Blueprint for a New Economy, O'Reilly Media, 2015.

Reference Books

1. Andreas M. Antonopoulos, Mastering Bitcoin, O'Reilly Media, 2017.
2. Daniel Drescher, Blockchain Basics, Apress, 2017.
3. Roger Wattenhofer, The Science of the Blockchain, Inverted Forest Publishing, 2016.
4. Narayanan et al., Bitcoin and Cryptocurrency Technologies, Princeton University Press, 2016.

SKILL-BASED COURSES TO QUALIFY FOR UG DIPLOMA (ENGG.) IN COMPUTER SCIENCE & ENGINEERING

BCS-264	:	**DATA ANALYTICS USING PYTHON**
Course category	:	**Skill Enhancement**
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 2, Tutorial: 0 & Practical: 2
Number of Credits	:	3
Course Assessment Methods	:	Continuous assessment through assignments, quizzes, tutorials, examination, and lab-based project evaluations.
Course Objectives	:	1. To provide knowledge and expertise to perform data analytics using Python and its libraries. 2. To demonstrate an understanding of data analytics concepts, including data collection, processing, and visualization. 3. To produce Python code to analyze datasets and derive actionable insights.
Course Outcomes	:	After successful completion of this course, students will be able to:
CO1. Explain the data analytics pipeline and the role of Python in data analysis.		

CO2. Understand key concepts in data analytics, including real-world applications and tools used by data analysts.
CO3. Implement data processing and analysis scripts using Python libraries like Pandas and NumPy.
CO4. Create effective data visualizations to communicate insights using Matplotlib and Seaborn.
CO5. Evaluate and interpret analytical results to support data-driven decision-making.
CO6. Effectively present analytical findings through reports and visualizations.

Topics Covered

Unit-I: Introduction to Data Analytics and Python **6**

Overview of data analytics: Definition, importance, and applications; Python for data analytics: features, libraries (Pandas, NumPy, Matplotlib); data types and sources (CSV, JSON, databases); setting up Python environment (Jupyter Notebook, VS Code); ethical considerations: data privacy, bias, and security; case studies: real-world data analytics projects.

Unit-II: Data Collection and Preprocessing **6**

Data collection methods: APIs, web scraping, and databases; data cleaning: handling missing values, duplicates, and outliers; data transformation: normalization, encoding, and scaling; exploratory data analysis (EDA): summary statistics and correlations; Python libraries: Pandas for data manipulation, NumPy for numerical operations; exercise: preprocess a dataset using Pandas.

Unit-III: Data Analysis and Statistical Techniques **6**

Statistical foundations: mean, median, variance, and distributions; data analysis techniques: grouping, filtering, and aggregation; feature engineering: creating and selecting relevant features; introduction to machine learning: regression and classification basics; Python libraries: SciPy, Scikit-learn; exercise: analyze a dataset to identify trends and patterns.

Unit-IV: Data Visualization and Reporting **6**

Data visualization principles: design, clarity, and storytelling; visualization tools: Matplotlib, Seaborn, and Plotly; creating charts: bar, line, scatter, and heatmaps; reporting insights: dashboards and summary reports; sharing results: exporting visualizations and reports; project: develop a data analytics project with visualizations and insights (e.g., sales or social media analysis).

Text and Reference Books

1. *Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython*, Wes McKinney, O'Reilly Media (2017).
2. *Data Science for Beginners: 4 Books in 1*, Andrew Park, Independently Published (2020).
3. *Practical Data Science with Python*, Nathan George, Packt Publishing (2021).
4. *Python Data Science Handbook*, Jake VanderPlas, O'Reilly Media (2016).

List of Experiments

1. Set up a Python data analytics environment with Jupyter Notebook and install Pandas, NumPy, and Matplotlib.
2. Collect and preprocess a CSV dataset (e.g., sales data) by handling missing values and outliers using Pandas.
3. Perform exploratory data analysis (EDA) on a dataset to compute summary statistics and correlations.
4. Create visualizations (bar, line, and scatter plots) for a dataset using Matplotlib and Seaborn.
5. Build a simple linear regression model using Scikit-learn to predict trends in a dataset.
6. Develop a dashboard with multiple visualizations to summarize insights from a dataset (e.g., customer data).

7. Complete a mini-project: Analyze a public dataset (e.g., COVID-19 or e-commerce) and present findings with visualizations.

BCS-265	:	**MOBILE APPLICATION DEVELOPMENT**
Course category	:	**Skill Enhancement**
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 2, Tutorial: 0 & Practical: 2
Number of Credits	:	3
Course Assessment Methods	:	Continuous assessment through assignments, quizzes, tutorials, examination, and lab-based project evaluations.
Course Objectives	:	1. To provide knowledge and expertise to develop cross-platform mobile applications using Flutter and Dart. 2. To demonstrate an understanding of mobile app development concepts, including UI design, state management, and API integration. 3. To produce Flutter code to create functional and responsive mobile applications.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course:
CO1. Explain the architecture and components of mobile applications and the Flutter framework. CO2. Understand key concepts in mobile app development, including their real-world applications and tools used by developers. CO3. Implement UI designs and navigation using Flutter widgets and Dart programming. CO4. Integrate APIs and external data sources into mobile applications. CO5. Evaluate and debug mobile applications to ensure functionality and performance. CO6. Effectively deploy and present mobile apps for Android and iOS platforms.		
Topics Covered		
Unit-I: Introduction to Mobile Application Development **6**		
Overview of native vs. cross-platform frameworks; Flutter and Dart features, architecture, setup; Android/iOS ecosystem, app stores; IDE setup (VS Code/Android Studio), emulators, SDKs; ethical issues (privacy, permissions, security); case studies of Flutter apps.		
Unit-II: User Interface Design with Flutter **6**		
Flutter widgets (stateless, stateful, widget tree); responsive layouts (Flexbox, rows, columns, stacks); UI components (buttons, text fields, images, navigation); styling (themes, fonts, colors); accessibility best practices; exercise: design a simple app UI.		
Unit-III: State Management and App Functionality **6**		
State management (setState, Provider, Riverpod); navigation (routes, named routes); user input (forms, validation); local storage (SharedPreferences, SQLite); debugging/testing (unit, widget tests); exercise: build a to-do list app with state and storage.		
Unit-IV: API Integration and Deployment **6**		
REST APIs, HTTP requests, JSON parsing; external services (Firebase, third-party libraries); app		

optimization, error handling; deployment (APKs for Android, IPA for iOS); app store guidelines; project: develop and deploy a functional app (e.g., weather, e-commerce).

Text and Reference Books

1. Flutter for Beginners: An introductory guide to building cross-platform mobile applications, Alessandro Biessek, Packt Publishing (2020).
2. Beginning App Development with Flutter: Create Cross-Platform Mobile Apps, Rap Payne, Apress (2019).
3. Dart Apprentice, Jonathan Sande & Matt Galloway, Razeware LLC (2021).
4. Flutter in Action, Eric Windmill, Manning Publications (2020).
5. Google Flutter Mobile Development Quick Start Guide, Salvatore Giordano, Packt Publishing (2019).

List of Experiments

Set up a Flutter development environment and run a sample app on an emulator.

1. Create a responsive UI for a login screen using Flutter widgets.
2. Build a to-do list app with state management using Provider or Riverpod.
3. Develop a weather app that fetches data from a public API (e.g., OpenWeatherMap).
4. Implement local storage in an app using SQLite to save user preferences.
5. Debug a Flutter app using Dart DevTools to identify and fix performance issues.
6. Build and deploy a simple app (e.g., a note-taking app) to an Android emulator or device.

3rd Year 5th Semester Syllabus

BHS-301/351	:	ENGINEERING AND MANAGERIAL ECONOMICS
Course category	:	HSSE
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Three Minor tests and One Major Theory Examination
Course Objectives	:	4. To make fundamentally strong base for decision making skills by applying the concepts of economics. 5. Educate the students on how to systematically evaluate the various cost elements of a typical manufactured product or service, with a view to determining the price offer. 6. Prepare engineering students to analyze profit/revenue data and carry out make economic analysis in the decision-making process to justify or reject alternatives/projects. 7. Be equipped with the tools necessary in forecasting product

		demand. 8. Understand and analyze the macro environment affecting the business decision making. 9. To make students understand basic elements of Indian Economy
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

CO13. Students will acquire basic knowledge in Engineering & managerial economics, which allows students to gain theoretical and empirical skill of economics.
CO14. To make Engineering students prepared for economic empowerment so that they could manage their wealth, help them in starting their own business or during managerial period.
CO15. Students will develop Interdisciplinary skills which can help them to thrive in the life- long changing environment in various fields of Industry of Economics.
CO16. Students will acquire practical knowledge of economics, the kind of markets, cost theory, various issues of demand and other major economic concepts.
CO17. Able to explain succinctly the meaning and definition of managerial economics; elucidate on the characteristics and scope of managerial economics.
CO18. Able to describe the techniques of managerial economics.
CO19. Able to explain the applications of managerial economics in various aspects.
CO20. To learn about the management and economics of the industrial environment.

Topics Covered

UNIT-I **9L**

Introduction to the Managerial Economics- Economics and Managerial economics, Review of Economic Terms and Economic Rationality, Law of diminishing marginal utility, Theories of Profit, Decision making Process with reference to Managerial economics, Managerial Economics and its application in engineering perspective.

UNIT-II **9L**

Theory of Demand: Law of Demand, Demand Function, Types of Demand, Demand Schedule, Demand Curve, Shift in Demand Curve, Factors affecting Demand, Elasticity of Demand, Theory of consumer behavior.
Theory of Supply: Law of Supply, Supply Function, Supply Schedule, Supply Curve, Factors, affecting Supply.

UNIT-III **9L**

Demand Forecasting: Meaning, significance and methods of demand forecasting, production function, Laws of returns to scale & Law of Diminishing returns scale. An overview of Short and Long run cost curves – fixed cost, variable cost, average cost, marginal cost, Opportunity cost.

UNIT-IV **9L**

Market Structure: Perfect Competition, Imperfect competition – Monopolistic, Oligopoly, duopoly sorbent features of price determination and various market conditions.
National Income, Inflation and Business Cycles: Concept of N.I. and Measurement. Meaning of Inflation, Type causes & prevention methods, Phases of business cycle.

TEXT/REFERENCE BOOKS

1. Mote, Paul and Gupta, Managerial Economics, T M H, New Delhi.
2. H L Ahuja, Managerial Economics, S Chand & Co. New Delhi
3. P.L. Mehta, Managerial Economics, Analysis, Problems and Cases, Sultan Chand Sons, New Delhi.
4. Prof. D.N. Kakkar , Managerial Economics for Engineering, PHI publication, New Delhi
5. Varshney and Maheshwari, Managerial Economics, Sultan Chand and Sons, New Delhi

BCS-305	:	PRINCIPLES OF OPERATING SYSTEMS
Course category	:	PC
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Continuous Assessment through one minor test, Teacher Assessment (Quiz, Tutorial, Assignment, Attendance), Practical Work & Viva-voce, and One Major Theory & One Practical Examinations.
Course Objectives	:	This course helps the students in gaining the knowledge to basic principle of operating systems. This course helps to undertake future courses that assume as a background in management of system resources. 1. Understand the role and structure of operating systems in modern computing environments. 2. Apply scheduling, synchronization, and deadlock handling algorithms to real-world problems. 3. Learn process, memory, storage, and file management techniques used in operating systems. 4. Evaluate operating system design choices with respect to performance, security, and sustainability. 5. Be familiar with issues in the design of operating systems
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course
CO1. Explain OS concepts, services, and system calls using standard terminology. CO2. Implement synchronization and deadlock handling mechanisms. CO3. Understand the principles of concurrency and deadlocks CO4. Design and analyze CPU scheduling and memory management algorithms. CO5. Study I/O management and File systems CO6. Recognize file system interface, protection and security mechanisms		
Topics Covered		

UNIT-I **9L**

Operating Systems Overview- Components, Goals of Designer, System Structures, User Services, Interrupt Systems and Device Programming-Interrupt Sources and Priorities, Interrupt Service Routines, Hardware Support - Machine States, Context Switching, Privileged Instructions and registers.

UNIT-II **9L**

Process and Thread Management-Process/Thread Creation and Termination, Process/Thread States and Their Transitions CPU Scheduling Algorithms, Non-Preemptive Approaches, Preemptive Approach, Multi- Processor considerations.

Deadlock and Resource Conflict- Prevention, Avoidance, Detection, Recovery Concurrency Problems and Solutions- Critical Section Problem, Process Synchronization and Coordination, Semaphores, Special Instructions, Monitors, Inter-process Communication, Remote Procedure Calls, Special Problems of Transaction-Based Systems

UNIT-III **9L**

Memory Management-Major Issues: Fetch, Placement, Contiguity, Relocation Adjustment, Paging and Virtual Memory, Translate-Look-Aside Buffer (Associative Memory), Single and Multi-Level Page Tables, Paging with Segmentation, Problems of Large Address Spaces and How They Are addressed.

Virtual Storage Management- Storage Hierarchy, Cache Usage, Partial Residency, Page Replacement Strategies, Working sets.

UNIT-IV **9L**

Physical Storage Management- Disk Scheduling Algorithms, Disk Performance Features, Disk Reliability Concerns

File System Organization - The Boot Record - Where Things Start, Directory Organization, File Descriptors, Access Control Backup

System Security- Principle of Least Privilege, Threats and Vulnerabilities, Protection Mechanisms, Access and Capability Control, User (Subject) Authentication, Levels of Security in "Trusted" Systems, Confinement problem

LIST OF EXPERIMENTS-

1. Study of hardware and software requirements of different operating systems (UNIX, LINUX, various version of WINDOWS.
2. Execute various UNIX system calls for
a. Process management
b. File management
c. Input/output Systems calls
3. Implement CPU Scheduling Policies:
a. SJF Priority
b. FCFS
c. Multi-level Queue
4. Implement file storage allocation technique:
a. Contiguous (using array)
b. Linked –list (using linked-list)
c. Indirect allocation (indexing)

5. Implementation of contiguous allocation techniques:
a. Worst-Fit
b. Best- Fit
c. First- Fit
6. Calculation of external and internal fragmentation
a. Free space list of blocks from system
b. List process file from the system
7. Implementation of compaction for the continually changing memory layout and calculate total movement of data
8. Implementation of resource allocation graph RAG)
9. Implementation of Banker's algorithm
10. Conversion of resource allocation graph (RAG) to wait for graph (WFG) for each type of method used for storing graph.
11. Implement the solution for Bounded Buffer (producer-consumer) problem using inter process communication techniques-Semaphores
12. Implement the solutions for Readers-Writers problem using inter process communication technique -Semaphore.

TEXTBOOKS

1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, John Wiley & Sons (ASIA) Pvt. Ltd, Seventh Edition 2005
2. Pramod Chandra and P. Bhatt, "An Introduction to Operating Systems Concepts and Practice", Prentice Hall India,3rd edition 2010

REFERENCE BOOKS

1. Milenekovie, Operating System Concept, McGraw Hill
2. Harvey M. Deitel, Paul J. Deitel, and David R. Choffnes, Operating Systems, Prentice Hall, Third edition2003
3. Petersons, "Operating Systems", Addison Wesley
4. Andrew S. Tannenbaum & Albert S. Woodhull, "Operating System Design and Implementation", Prentice Hall, 3rd Edition, 2006
5. William Stallings, Operating Systems – internals and design principles, Prentice Hall, 7thEdition, 2011
6. Gary J. Nutt, "Operating Systems", Pearson/Addison Wesley, 3rd Edition 2004.
7. Andrew S. Tannenbaum, "Modern Operating Systems", Prentice Hall,3rd Edition 2007

BCS-306	:	PRINCIPLES OF COMPILER DESIGN
Course category	:	PC
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Continuous Assessment through one minor test, Teacher Assessment (Quiz, Tutorial, Assignment, Attendance), Practical Work & Viva-voce, and One Major Theory & One Practical Examinations.
Course Objectives	:	This course helps the students in gaining the knowledge of Computer

		Organization and Architecture. The principal objectives of this course are: 1. Provide an understanding of the fundamental principles in compiler design 2. Provide the skills needed for building compilers for various situations that one may encounter in a career in Computer Science. 3. Learn the process of translating a modern high-level language to executable code required for compiler construction.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

CO1. Understand fundamentals of compiler and identify the relationships among different phases of the compiler.
CO2. Understand the application of finite state machines, recursive descent, production rules, parsing, and language semantics.
CO3. Analyze & implement required module, which may include front-end, back-end, and a small set of middle-end optimizations.
CO4. Use modern tools and technologies for designing new compiler.
CO5. To understand how linker and loader create an executable program from an object module created by assembler and compiler.
CO6. Design the structures and support required for compiling advanced language features

Topics Covered

UNIT-I **9L**

Compiler Structure: Analysis-Synthesis Model of Compilation, Various Phases of a Compiler, Tool Based Approach to Compiler Construction Lexical Analysis: Interface with Input, Parser and Symbol Table, Token, Lexeme and Patterns, Difficulties in Lexical Analysis, Error Reporting, and Implementation. Regular Definition, Transition Diagrams, LEX.

UNIT-II **9L**

Syntax Analysis: Context Free Grammars, Ambiguity, Associativity, Precedence, Top Down Parsing, Recursive Descent Parsing, Transformation on the Grammars, Predictive Parsing, Bottom Up Parsing, Operator Precedence Grammars, LR Parsers (SLR, LALR, LR), YACC

UNIT-III **9L**

Syntax Directed Definitions: Inherited and Synthesized Attributes, Dependency Graph, Evaluation Order, Bottom Up and Top Down Evaluation Of Attributes, L- and S-Attributed Definitions. Type Checking: Type System, Type Expressions, Structural and Name Equivalence of Types, Type Conversion, Overloaded Functions and Operators, Polymorphic Functions. Intermediate Code Generation: Intermediate Representations, Translation of Declarations, Assignments Intermediate Code Generation For Control Flow, Boolean Expressions and Procedure Calls, Implementation Issues.

UNIT-IV **9L**

Symbol Table Management Runtime Environments, Source Language Issues, Storage Organization, Storage Allocation Strategies, Access to Non-Local Names, Parameter Passing. Code Optimization,

Peephole Optimization, Source of Optimizations, Optimization of Basic Blocks, Loops, Global Dataflow Analysis, Introduction to Code Generation.

LIST OF EXPERIMENTS-

1. Write a program using Lex to calculate the number of characters, number of words and the number of lines present in the given text file as input.
2. Write a program using Lex to implement the set of regular expression and indicates the acceptance of a given string for a particular regular expression.
3. Write a C program to implement the conversion of regular expression to non-deterministic finite automation
4. Write a program using Yacc to check whether a string belong to the given grammar or not.
5. Write a C program to compute FIRST and FOLLOW of the non-terminals of given grammar.
6. Write a C program to check the given grammar is Left recursive and remove Left recursion.
7. Write Syntax Directed Translation actions using Yacc to generate Parse Tree for the grammar for arithmetic expressions.
8. Write Syntax Directed Translation actions using Yacc to translate arithmetic expressions into Postfix form.
9. Write Syntax Directed Translation actions using Yacc to translate arithmetic expressions into three address code.

TEXTBOOKS

1. A.V. Aho, M.S. Lam, R. Sethi, and J.D. Ullman, Compilers: Principles, Techniques, and Tools, Pearson Education, 2007 (second ed.).
2. K.D. Cooper, and L. Torczon, Engineering a Compiler, Elsevier, 2004.

REFERENCE BOOKS

1. W Appel, J Palsberg, Modern Compiler Implementation in JAVA, Cambridge University Press, 2002 AW Appel, M Ginsburg, Modern Compiler Implementation in C, Cambridge

BCS-307	:	COMPUTER NETWORKS
Course category	:	PC
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials, course-based project, one minor test and one major examination.
Course Objectives	:	1. To provide students with a strong understanding of data communication concepts and computer networking fundamentals. 2. To familiarize students with OSI and TCP/IP reference models and layered network architectures. 3. To help students understand transmission media, multiplexing techniques, and switching methods used in networks. 4. To introduce medium access protocols, error control techniques, and data link layer operations. 5. To develop knowledge of routing, congestion control, transport

		protocols, and application layer services. 6. To provide hands-on experience in network design, simulation, protocol implementation, and traffic analysis.
Course Outcomes	:	After successful completion of this course, students will be able to:

CO1. Explain data communication concepts, network models, and layered architectures.
CO2. Analyze transmission media, network topologies, and switching techniques.
CO3. Apply medium access protocols and error detection and correction techniques in data transmission.
CO4. Implement routing algorithms and configure IP-based networks using simulation tools.
CO5. Develop client-server applications using TCP and UDP protocols.
CO6. Analyze network traffic and application layer protocols using packet capture and monitoring tools

Topics Covered

UNIT-I 9L

Data Communication Concepts, Introduction to Networks and Layered Architecture, Protocols and Standards, Reference models-OSI Reference Model and TCP/IP Reference Model. A Comparison of the OSI and TCP/IP Reference Models, Transmission Media and Networks Topology, Multiplexing-Frequency Division, Time Division and Wave Division, Circuit Switching and Packet Switching, Goals and Applications of Networks, LAN: Wired LAN, Wireless LANs, LAN Inter Connection Devices.

UNIT-II **9L**

Medium Access Sub Layer: Channel Allocations, LAN Protocols, ALOHA Protocols- Pure ALOHA, Slotted ALOHA, Carrier Sense Multiple Access Protocols, CSMA with Collision Detection, Collision Free Protocols, IEEE Standards, Ethernet, FDDI, Data Link Layer- Basic Design Issues, Error Correction & Detection Algorithms, Elementary Data Link Layer Protocols, Sliding Window Protocols, Error Handling, High Level Data Link Control

UNIT-III **9L**

Network Layer: Packet Switched Networks – IP – ARP – RARP –DHCP – ICMP – Queuing Discipline – Routing Algorithms, Congestion Control Algorithms, Internetworking, TCP/IP Protocol, IP Addresses, IPv4 and IPv6.

UNIT-IV **9L**

Transport Layer: Design Issues, Connection Management, Internet Transport Protocol (UDP), Transmission Control Protocol. (TCP) -Adaptive Retransmission Congestion Control, Congestion Avoidance – Quality of Service (QOS).
Application Layer: Domain Name System, Electronic Mail (Email), File Transfer Protocol, Hyper Text Transfer Protocol, Introduction to Cryptography and Network Security.

LIST OF EXPERIMENTS

1. Study and design of network topologies and transmission media using Cisco Packet Tracer.
2. Simulation of OSI and TCP/IP models and analysis of data flow across layers using Cisco Packet Tracer.
3. Performance comparison of circuit switching and packet switching techniques using simulation.

4. Simulation and performance analysis of CSMA/CD protocol using NS2 or Python.
5. Implementation of error detection techniques using Parity, CRC, and Checksum.
6. Implementation of error correction using Hamming Code.
7. Implementation and study of Stop-and-Wait ARQ protocol.
8. Implementation and study of Go-Back-N ARQ protocol.
9. Implementation and study of Selective Repeat ARQ protocol.
10. Study of ARP protocol and MAC address resolution using Wireshark.
11. Implementation of Distance Vector routing algorithm.
12. Simulation of static and dynamic routing protocols (RIP and OSPF).
13. Development of client-server chat application using TCP.
14. Development of connectionless client-server application using UDP.
15. Packet capture and analysis of TCP and UDP traffic using Wireshark.
16. Study and analysis of DNS, HTTP, FTP, and Email protocols using packet capture.
17. Network scanning and service discovery using Nmap.

TEXTBOOKS

1. Behrouz A. Forouzan, Data Communication and Networking, McGraw-Hill.
2. Andrew S. Tanenbaum, Computer Networks, Prentice Hall.
3. Keshav S. An Engineering Approach to Computer Networks, 2nd Edition, Pearson, Education.
4. Kurose J. Keith Ross Computer Networking-Top Down approach.

REFERENCE BOOKS

1. William Stallings, Data and Computer Communication, Prentice Hall of India.
2. Comer, Computer Networks & Internet with Internet Applications, Pearson Education
3. Comer, Internetworking with TCP/IP, 6th Edition, PHI.
4. W Stallings, Computer Networks with Internet Protocols, Pearson Education
5. W Stallings, Local and Metropolitan Area Networks, 6th edition, Pearson Education

ECS-303	:	COMPUTING USING PYTHON
Course category	:	PE3
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, practical work, record, viva voce and one minor test and one major examination.
Course Objectives	:	The course will enable students to: 1. Learn the syntax and semantics of Python Programming Language. 2. Write Python functions to facilitate code reuse and manipulate strings. 3. Illustrate the process of structuring the data using lists, tuples and dictionaries. 4. Demonstrate the use of built-in functions to navigate the file system. 5. Appraise the need for working on web scraping.

Course Outcomes	:	

CO1. Understand and apply basic Python syntax, data types, variables, and flow control structures.
CO2. Develop functions with parameters, return values, and manage variable scope and exceptions.
CO3. Perform operations on lists using built-in methods and augmented assignment operators.
CO4. Use dictionaries and strings to structure and manipulate textual and real-world data.
CO5. Implement pattern matching using regular expressions for text processing tasks.
CO6. Build Python programs integrating functions, data structures, and regular expression

Topics Covered

UNIT-I **9L**

Introduction, Python Basics: Entering Expressions into the Interactive Shell, The Integer, Floating-Point, and String Data Types, String Concatenation and Replication, Storing Values in Variables, Your First Program, Dissecting Your Program. Flow control: Boolean Values, Comparison Operators, Boolean Operators, Mixing Boolean and Comparison Operators, Elements of Flow Control, Program Execution, Flow Control Statements, Importing Modules, Ending a Program Early with sys.exit().

UNIT-II **9L**

Functions: def Statements with Parameters, Return Values and return Statements, The None Value, Keyword Arguments and print(), Local and Global Scope, The global Statement, Exception Handling. Lists: The List Data Type, Working with Lists, Augmented Assignment Operators, Methods

UNIT-III **9L**

Dictionaries and Structuring Data: The Dictionary Data Type, Pretty Printing, Using Data Structures to Model Real-World Things. Manipulating Strings - Working with Strings, Useful String Methods.

UNIT-IV **9L**

Pattern Matching with Regular Expressions: Finding Patterns of Text without Regular Expressions, Finding Patterns of Text with Regular Expressions, More Pattern Matching with Regular Expressions, Greedy and Nongreedy Matching, The find all() Method, Character Classes, Making Your Own Character Classes, The Caret and Dollar Sign Characters, The Wildcard Character, Review of Regex Symbols, Case-Insensitive Matching, Substituting Strings with the sub() Method, Managing Complex Regexes, Combining re. IGNORECASE, re .DOTALL, and re .VERBOSE.

LIST OF EXPERIMENTS

1. Write a Python program to demonstrate basic data types, expressions, variable assignments, and string operations (concatenation, replication).
2. Develop a Python program using flow control statements (if-else, while, for) and Boolean logic to solve a real-life problem.
3. Create functions with parameters and return values, demonstrate local and global scope, and implement basic exception handling.
4. Write a Python program to perform list operations such as indexing, slicing, appending, inserting, deleting, and using list methods.
5. Implement a program using dictionaries to store and retrieve data, and use string methods for data

formatting and manipulation.
6. Develop a Python script that uses regular expressions to find, match, and replace patterns in a given text input

TEXTBOOKS

1. Al Sweigart, “Automate the Boring Stuff with Python”, William Pollock, 2015,
ISBN: 978-1593275990

REFERENCE BOOKS

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist”, 2nd Edition,Green Tea Press, 2015, ISBN: 978-9352134755.
2. Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt Ltd. ISBN-13: 978-8126556014.
3. Wesley J Chun, “Core Python Applications Programming”, 3rd Edition, Pearson EducationIndia, 2015. ISBN-13: 978-9332555365.
4. Roberto Tamassia, Michael H Goldwasser, Michael T Goodrich, “Data Structures and Algorithms in Python”, 1st Edition, Wiley India Pvt Ltd, 2016. ISBN-13: 978-8126562176.
5. ReemaThareja, “Python Programming using problem solving approach”, Oxford University press, 2017. ISBN-13: 978-0199480173
6. Charles R. Severance, “Python for Everybody: Exploring Data Using Python 3”, 1st Edition, Shroff Publishers, 2017. ISBN: 978-9352136278.

ECS-304	:	INTRODUCTION TO MACHINE LEARNING
Course category	:	PE3
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods		
	:	Continuous assessment through assignments, quizzes, tutorials,

One minor test, one major examination, and lab-based project evaluations.

Course Objectives:

1. To introduce the fundamental concepts, types, and applications of machine learning.
2. To develop mathematical and computational foundations required for machine learning, including linear algebra and optimization techniques.
3. To enable students to understand and implement basic supervised learning algorithms such as linear and logistic regression.
4. To familiarize students with unsupervised learning techniques including clustering and dimensionality reduction.
5. To provide hands-on experience in data preprocessing, model evaluation, and practical implementation of machine learning algorithms using Python tools.
6. Analyze ethical issues, limitations, and practical challenges in deploying machine learning solutions in real-world applications.

Course Outcomes : Upon successful completion of this course, students will be able to:
CO1. Explain basic machine learning concepts and types of learning (supervised, unsupervised, reinforcement).
CO2. Apply linear algebra concepts like vectors and matrices in machine learning algorithms.
CO3. Use simple optimization techniques like gradient descent for model training.
CO4. Implement supervised learning algorithms such as linear regression and logistic regression.
CO5. Apply unsupervised learning techniques like clustering for data analysis.
CO6. Evaluate machine learning models using metrics like accuracy, precision, and recall
Topics Covered
UNIT-I **9L**
Overview of machine learning: Definition, history, and applications.Types of machine learning: Supervised, unsupervised, and reinforcement learning.Basic concepts: Features, labels, training and test datasets.Linear algebra for machine learning: Vectors, matrices, and their operations.Introduction to Python for machine learning: NumPy, pandas, scikit-learn
UNIT-II **9L**
Linear regression: Model, cost function, and gradient descent. Logistic regression: Binary classification and probability estimation. Overfitting and underfitting: Bias-variance tradeoff Evaluation metrics: Accuracy, precision, recall, F1-score.Data preprocessing: Normalization, encoding categorical variables
UNIT-III **9L**
Introduction to unsupervised learning: Goals and applications. K-means clustering: Algorithm and implementation. Hierarchical clustering: Concepts and dendrograms. Principal Component Analysis (PCA): Dimensionality reduction. Applications: Customer segmentation, anomaly detection.
UNIT-IV **9L**
Decision trees and random forests: Concepts and implementation. Support Vector Machines: Linear and kernel-based approaches. Model evaluation techniques: Cross-validation, confusion matrix. Regularization: L1 (Lasso) and L2 (Ridge) regularization. Introduction to neural networks: Perceptron and basic architecture.
LIST OF EXPERIMENTS
1. Perform vector and matrix operations using NumPy for machine learning applications.
2. Load and explore a dataset using pandas; identify features, labels, and handle missing values.
3. Split data into training and testing sets and perform basic visualizations using matplotlib/seaborn.
4. Implement Linear Regression using scikit-learn and visualize the regression line.
5. Implement Logistic Regression for binary classification and evaluate the model.
6. Demonstrate overfitting and underfitting using polynomial regression and analyze the bias-variance tradeoff.
7. Apply data preprocessing techniques: normalization, encoding categorical variables, and feature scaling.
8. Implement K-means clustering and visualize clusters for unsupervised learning.
9. Perform Principal Component Analysis (PCA) for dimensionality reduction and visualize the output.
10. Build and evaluate a Decision Tree classifier using cross-validation and a confusion matrix
TEXTBOOKS

1. Machine Learning for Absolute Beginners – Oliver Theobald
2. "Machine Learning Yearning" by Andrew Ng — deeplearning.ai, 2018.
REFERENCE BOOKS
1. "Mathematics for Machine Learning" by Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong — Cambridge University Press, 2020.
2. "Pattern Recognition and Machine Learning" by Christopher M. Bishop — Springer, 2006

ECS-305	:	PRACTICAL CYBER SECURITY FOR CYBER SECURITY PRACTITIONERS
Course category	:	PE3
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, practical work, record, viva voce and one minor test and one major examination.
Course Objectives	:	1. To develop understanding of cybersecurity posture assessment, maturity models, and continuous improvement strategies using frameworks such as MITRE ATT&CK. 2. To familiarize students with cyber kill chain models, defensive frameworks (MITRE DEF3ND), and secure configuration practices including STIG benchmarking. 3. To introduce threat intelligence sharing mechanisms such as STIX and TAXII, along with cybersecurity risk management and resilience assessment techniques. 4. To enable students to design cybersecurity policies, cyber crisis management plans, and incident management strategies for organizational environments.
Course Outcomes	:	After successful completion of the course, the learners would be able to:
CO1. Understand cyber security posture, maturity models. CO2. Analyze attacker behaviour and continuous improvement strategies. CO3. Explain Cyber Kill Chains including Lockheed Martin. CO4. Implement defence strategies using the MITRE DEF3ND framework. CO5. Secure system configurations using STIG benchmarks. CO6. Develop cyber security policies, risk management plans.		
Topics Covered		

UNIT-I **9L**

Cyber Security Posture, Maturity, and Continuous Improvement Strategies, Knowing your attacker: MITRE ATT&CK Framework

UNIT-II **9L**

Cyber Kill Chains: Lockheed Martin Cyber Kill Chain and Unified Kill Chain, Defending Yourself: MITRE DEF3ND Framework, Securing your Configurations: STIG Benchmarking

UNIT-III **9L**

Sharing Threat Intelligence: STIX and TAXII 2.0, Cyber Security Risk Management, Cyber Resilience Assessment.

UNIT-IV **9L**

Cyber Security Policy Formulation, Cyber Crisis Management Plan and Cyber Incident Management Plan.

LIST OF EXPERIMENTS

1. Explore and map attacker techniques using the MITRE ATT&CK framework.
2. Analyze case studies based on the Lockheed Martin Cyber Kill Chain stages.
3. Perform STIG benchmarking on sample system configurations.
4. Conduct a cybersecurity risk assessment on a simulated environment.
5. Develop a cybersecurity policy document tailored for a hypothetical organization.
6. Prepare a Cyber Crisis Management Plan and simulate incident handling.
7. Create a Cyber Incident Management Plan including communication workflows.
8. Conduct a tabletop exercise simulating a cybersecurity incident response.

TEXTBOOKS

1. Jason Andress, The Basics of Cyber Security: Understanding the Fundamentals of InfoSec in Theory and Practice, Syngress, Latest Edition.

2. Eric Cole, Cybersecurity Blue Team Toolkit, Wiley, Latest Edition.
3. Joseph Muniz and Gary McIntyre, Security Operations Center: Building, Operating, and Maintaining Your SOC, Cisco Press, Latest Edition.

REFERENCE BOOKS

1. “Cybersecurity and Cyberwar: What Everyone Needs to Know” by P.W. Singer and Allan Friedman — Oxford University Press, 2014.
2. “The Cybersecurity Playbook: How Every Leader and Employee Can Contribute to a Culture of Security” by Allison Cerra — McGraw-Hill Education, 2020.
3. “Cybersecurity Operations Handbook” by John R. Vacca — Academic Press, 2014.

ECS-306	:	COMPUTER GRAPHICS AND GAME PROGRAMMING
Course category	:	PE3
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, practical work, record, viva voce and one minor test and one major examination.
Course Objectives	:	
Course Outcomes	:	After successful completion of the course, students will be able to:

CO1. Explain the core architecture of game engines, including game loops, timing systems, input handling, and basic physics mechanisms.

CO2. Implement collision detection, collision resolution, and animation techniques such as sprite-based and skeletal animation in game development.

CO3. Design and manage game scenes, object hierarchies, level structures, and audio systems for interactive game environments.

CO4. Apply scripting techniques to define object behaviors and develop event-driven game logic using modern game development frameworks.

CO5. Develop interactive game interfaces and integrate basic artificial intelligence techniques such as FSMs and pathfinding into games.

CO6. Implement game state management features including save/load systems and apply performance optimization techniques in game projects.

Topics Covered

UNIT-I **9L**

Game Loop and Timing Central structure of a game (initialization, update, render) Delta time, frame rate control Fixed vs variable timestep logic Keyboard, mouse, touch, controller inputs Input mapping and event handling Input buffering and polling, Collision detection (AABB, Circle, Pixel-based) Collision resolution (impulse, overlap correction) Basic physics (velocity, acceleration, gravity, jump mechanics) Sprite sheets and frame-based animation Skeletal animation basics Blend trees (for 3D character animation in engines)

UNIT-II **9L**

Scene and Object Management Game world representation Object hierarchies and parent-child relationships Level design, tilemaps, and layers Audio Systems Playing sound effects and background music 2D/3D positional audio Audio mixing and resource management Scripting and Behavior Programming Scripting languages (C#, GDScript, Blueprints) Attaching behavior to game objects Event-driven game logic

UNIT-III **9L**

UI/UX Design in Games HUD (Health bars, score) Menu systems and transitions Feedback elements: popups, visual effects, sound cues Artificial Intelligence in Games Finite State Machines (FSM) Pathfinding (A*, Dijkstra) Decision trees, Behavior Trees (introductory level).

UNIT-IV **9L**

Save Systems & Game States Serialization of game data (JSON/XML/binary) Save/load mechanics Checkpoints, progress tracking Game Engine Internals components, Scenes, Prefabs Resource loading and management Optimization techniques (culling, LOD, batching) Multiplayer and Networking (Optional/Advanced) Local multiplayer (split-screen or shared screen) Client-server model basics Synchronization and lag compensation (intro level).

LIST OF EXPERIMENTS

1. Develop a basic 2D game loop with update, render, and timing control.
2. Implement player input handling using keyboard/mouse/touch and integrate movement physics.
3. Design a tile-based level with layered scene management and integrate object hierarchy.
4. Show sound effects and background music using positional audio and test audio mixing.
5. Create a game UI with health bar and implement simple AI using a finite state machine.
6. Implement a save/load system using JSON or XML

Textbooks

1. Gregory, J. (2018). *Game engine architecture* (3rd ed.). CRC Press.
2. Nystrom, R. (2014). *Game programming patterns*. Genever Benning.

Reference Books

1. Millington, I. (2019). *Artificial intelligence for games* (3rd ed.). CRC Press.
2. Rabin, S. (Ed.). (2019). *Game AI Pro 360: Guide to architecture*. CRC Press.
3. Rogers, S. (2014). *Level up! The guide to great video game design* (2nd ed.). Wiley.
4. Shelly, G. B., & Rosenblatt, H. J. (2012). *Systems analysis and design*. Cengage Learning.

ECS-307	:	PRIVATE AND CONSORTIUM BLOCKCHAIN FOR ENTERPRISE
Course category	:	PE3
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.
Course Objectives	:	1. Develop a strong foundation in enterprise blockchain concepts, including private and consortium blockchain models, virtual machines, consensus mechanisms, and Ethereum architecture. 2. Design, develop, test, and deploy secure smart contracts using industry tools, debugging techniques, and standard design

		patterns. 3. Evaluate smart contract security, quality assurance practices, Blockchain-as-a-Service (BaaS), and enterprise deployment considerations. 4. Apply formal verification methods and cross-chain interoperability technologies to build scalable, secure, and enterprise-ready blockchain solutions.
Course Outcomes	:	After successful completion of the course, students will be able to:

CO1. Understand the architecture of Ethereum Virtual Machine.
CO2. Apply state replication and consensus concepts.
CO3. Perform unit testing, debugging, and gas estimation.
CO4. Analyze security vulnerabilities in smart contracts.
CO5. Evaluate smart contract quality assurance practices.
CO6. Explore Blockchain-as-a-Service (BaaS) platforms beyond Ethereum

Topics Covered

UNIT-I **9L**

History of Virtual Machines- State replication, consensus and the Ethereum Architecture - Introduction to the Ethereum Virtual Machine and EVM Byte Code interpretation Incentivisation structures, rewards schemes, and gas pricing

UNIT-II **9L**

The Ethereum Name Services (ENS) Unit Testing and Debugging Contracts Estimating Gas Costs Basics of using Truffle for testing Troubleshooting and Debugging Common design patterns Smart Contract security – overview of attacks on Ethereum smart contracts Deployment Considerations and Other Smart Contract Platforms

UNIT-III **9L**

Smart Contacts Quality Assurance Beyond Ethereum Blockchain-as-a-Service (BaaS) and the Dark Market- Secure smart contracts with OpenZeppelin Experimenting.

UNIT-IV **9L**

Introduction to formal methods for verifying correctness and security.Cross-chain Communication: Concepts of interoperability and tools for cross-chain smart contracts (e.g., Polkadot, Cosmos, LayerZero)

TEXTBOOKS

1. Solorio, K., Kanna, R., & Hoover, D. H., Hands-On Smart Contract Development with Solidity and Ethereum, O'Reilly Media, 2019.
2. Lee, W.-M., Beginning Ethereum Smart Contracts Programming, Apress, 2019.
3. Infante, R., Building Ethereum DApps: Decentralized Applications on Ethereum, Manning Publications, 2019
4. Drescher, D., Blockchain Basics: A Non-Technical Introduction in 25 Steps, Apress, 2017.

REFERENCE BOOKS

1. "Mastering Ethereum: Building Smart Contracts and DApps" By Andreas M. Antonopoulos and Gavin Wood
2. "Introducing Ethereum and Solidity: Foundations of Cryptocurrency and Blockchain Programming for Beginners"By Chris Dannen.

ECS-308	:	DATA STRUCTURES AND ALGORITHMS USING C
Course category	:	PE3
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, practical work, record, viva voce and one minor test and one major examination.
Course Objectives	:	This course helps the students in gaining the knowledge of basic principles of Data Structures. The principal objectives of this course are: 1. To provide the knowledge of basic data structures and their implementations. 2. To understand importance of data structures in context of writing efficient programs. 3. To develop skills to apply appropriate data structures in problem solving
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

CO1. Learn the basic types for data structure, implementation, and application.
CO2. Know the strength and weakness of different data structures.
CO3. Use the appropriate data structure in context of solution of given problem.
CO4. Develop programming skills which require to solve given problem.
CO5. Apply Algorithm for solving problems like sorting, searching, insertion and deletion of data
CO6. Solve problem involving graphs, trees and heaps

Topics Covered

UNIT-I **9L**

Introduction: Basic Terminology, Elementary Data Organization, Structure Operations, Complexity and Time-Space Trade-off. Arrays: Definition, Representation and Analysis, Single and Multi-Dimension Array, Address Calculation, Application of Arrays, Character, String in C, Character String

Operation, Arrays Parameters, Ordered List, Sparse Matrices and Vectors.Stacks: Array Representation and Implementation of Stack, Operations on Stacks: Push &Pop, Array Representation of Stack, Linked Representation of Stack, Operations Associated with Stacks, Application of Stack, Conversion of Infix to Prefix and Postfix Expressions,

UNIT-II **9L**

Queues: Array and Linked Representation and Implementation of Queues, Operations on Queue: Create, Add, Delete, Full and Empty, Circular Queues, D-Queues and Priority Queues. Linked List: Representation and Implementation of Singly Linked Lists, Two-Way Header List, Traversing and Searching of Linked List, Overflow and Underflow, Insertion and Deletion to / from Linked Lists, Insertion and Deletion Algorithms, Doubly Linked List, Linked List in Array, Polynomial Representation and Addition, Generalized Linked List, Garbage Collection and Compaction

UNIT-III **9L**

Trees: Basic Terminology, Binary Trees, Binary Tree Representation, Algebraic Expressions, Complete Binary Tree, Extended Binary Trees, Array and Linked Representation of Binary Trees, Traversing Binary Trees, Threaded Binary Trees, Traversing Threaded Binary Trees, Huffman Algorithm. Binary Search Trees: Binary Search Tree (BST), Insertion and Deletion in BST, Complexity of Search Algorithm, Path Length, AVL Trees, B-Trees

UNIT-IV **9L**

Searching and Hashing: Sequential Search, Binary Search, Comparison and Analysis, Hash Table, Hash Functions, Collision Resolution Strategies, Hash Table Implementation. Sorting: Insertion Sort, Bubble Sorting, Quick Sort, Two Way Merge Sort, Heap Sort, Sorting on Different Keys, Practical Consideration for Internal Sorting. Graphs: Terminology &Representations, Graphs &Multi-Graphs, Directed Graphs, Sequential Representations of Graphs, Adjacency Matrices, Traversal, Connected Component and Spanning Trees, Minimum Cost Spanning Trees

LIST OF EXPERIMENTS

1. Implement a program to create, traverse, and perform basic operations on single and multi-dimensional arrays.
2. Write a program to implement stack operations (push, pop) using arrays and test infix to postfix expression conversion.
3. Implement stack using linked list and perform stack operations.
4. Write a program to implement queue operations using arrays (including circular queue).
5. Implement a singly linked list with insert, delete, and search functionalities.
6. Implement a doubly linked list and perform insertion and deletion at various positions.
7. Create a program to represent and traverse binary trees (inorder, preorder, postorder) using linked representation.
8. Implement Binary Search Tree (BST) with insertion, deletion, and searching operations.
9. Write a program to implement AVL tree insertion and rotations to maintain balance.
10. Implement sequential search and binary search on arrays.
11. Write programs to implement different sorting algorithms: bubble sort, quick sort, and heap sort.
12. Implement hash table with collision resolution (e.g., chaining or linear probing).

13.Write a program to represent a graph using adjacency matrix and perform Depth-First Search (DFS) and Breadth-First Search (BFS).

TEXTBOOKS

1. Horowitz and Sahani, Fundamentals of Data Structures, Galgotia Publication, New Delhi.
2. R. Kruse et al, Data Structure and Pragram Design in C, Pearson Education Asia Delhi
3. A. M. Tenenbaum, Data Structures using C & C++, PHI, India
4. K Loudon, Mastering Algorithms with C, Shroff Publication and Distributor Pvt. Ltd.
5. Bruno R Preiss, Data Structure and Algorithms with Object Oriented Design Pattern in C++, John Wiley & Sons
6. Adam Drozdek, "Data Structures and Algorithms in C++", Thomson Asia Pvt. Ltd. Singapore

REFERENCE BOOKS

1. Lewis, H.R., Denenberg, L., Data Structures and their Algorithms. Published by AddisonWesley, UK, 1991
2. Oluwadare, S.A., Agbonifo, O.C., Fundamentals of Data structures and Algorithms. Lecture Notes, 2013.

ECS-309	:	PRINCIPLE OF REMOTE SENSING
Course category	:	PE3
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.
Course Objectives	:	1. To understand the fundamentals of remote sensing systems including electromagnetic radiation, spectral characteristics, energy interactions with atmosphere and earth features, and the principles of active and passive remote sensing. 2. To familiarize students with airborne and satellite platforms and sensor systems, their working principles, characteristics, and applications, with emphasis on major satellite missions such as LANDSAT, SPOT, and IRS. 3. To develop knowledge of digital image processing techniques including image representation, enhancement, radiometric and geometric corrections, and image transformation methods such as NDVI and PCA. 4. To enable students to apply image classification and analysis techniques using ground truth data, supervised and unsupervised classification methods, accuracy assessment, and to understand

		practical applications of remote sensing in various fields.
Course Outcomes	:	After successful completion of the course, students will be able to:

CO1. Explain the principles of remote sensing, electromagnetic spectrum, and interaction of EM energy with atmospheric and surface features.
CO2. Identify and differentiate between various remote sensing platforms and sensors, along with their specifications and applications.
CO3. Understand and perform basic digital image processing techniques including enhancement, correction, and transformation of satellite imagery.
CO4. Apply thematic classification techniques and assess the accuracy of classified images using standard algorithms.
CO5.Apply image interpretation techniques to identify land use and land cover features from satellite data.
CO6. Demonstrate the ability to utilize remote sensing data for practical applications in environmental and resource studies

Topics Covered

UNIT-I **9L**

Remote sensing system and its components, Electromagnetic spectrum, definition of emissivity, reflectance, absorbance and transmittance. Spectral signature, atmospheric window, active and passive remote sensing systems, Interaction of electromagnetic energy with atmosphere and earth features, factors affecting the reflectance, Thermal and Microwave Remote Sensing.

UNIT-II **9L**

Airborne and space platforms, Advantages and disadvantages of each, principle and functioning of multi-spectral, thermal & line scanners, Multi concept of remote sensing, Different satellite and sensor combinations: LANDSAT, SPOT, IRS series of satellites and sensors. Their important characteristics: such as flight altitude, IFOV, spatial resolution, swath, spectral bands, and receptivity

UNIT-III **9L**

Introduction to Digital Image Processing, digital image representation, and characterization, Concept of color, Color composites, histograms and scatter plot, image enhancement, contrast stretching, radiometric processing including correction of atmospheric corrections; geometric corrections, Image Transformations such as subtraction, ratioing, NDVI and PCA

UNIT-IV **9L**

Ground truth: Geographic and Radiometric, Thematic classification and clustering to include unsupervised and supervised classification based on parallelepiped, minimum distance and maximum likelihood classification, accuracy assessment of classification. Applications of remote sensing, Image transformations

TEXTBOOKS

1. Thomas Lillesand, Ralph W. Kiefer, Jonathan Chipman., Remote Sensing and Image Interpretation. Wiley
2. Reddy, M. Anji, Remote sensing and Geographic Information System BS Publications
3. B. Bhatta, Remote Sensing and GIS, Oxford University Press

REFERENCE BOOKS

1. John A. Richards, Remote Sensing Digital Image Analysis, 6th Edition, Springer Nature, 2022.
2. Dr. William G. Rees, Physical Principles of Remote Sensing, (3rd Edition),the Scott Polar Research Institute at the University of Cambridge, 2023.
3. S.C. Bhatia, Fundamentals of Remote Sensing, Atlantic Publishers & Distributors (P) Ltd, 2023.

ECS-401	:	DIGITAL FORENSICS
Course category	:	PE4
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials, course-based project, one minor test and one major examination
Course Objectives	:	1. To introduce fundamental concepts, scope, and importance of digital and computer forensics in cybercrime investigations. 2. To provide in-depth understanding of digital evidence types, forensic investigation processes, and crime scene handling procedures. 3. To familiarize students with forensic data acquisition techniques and evidence integrity preservation mechanisms. 4. To develop competency in using forensic tools for data processing, analysis, and interpretation of digital evidence. 5. To introduce mobile forensics concepts, mobile device architectures, and mobile evidence acquisition using open-source tools. 6. To emphasize legal, ethical, and procedural compliance in digital and mobile forensic investigations
Course Outcomes	:	After successful completion of this course, students will be able to:
CO1. Understand the fundamental principles, processes, and legal considerations of digital and computer forensics investigations. CO2. Identify, classify, and preserve digital evidence from computer systems and crime scenes while maintaining chain of custody. CO3. Apply forensic data acquisition techniques (logical, physical, and file system) and validate evidence using cryptographic hashing methods. CO4. Analyze digital evidence using appropriate forensic tools to recover, interpret, and correlate data from file systems, multimedia, networks, and emails. CO5. Perform mobile forensic investigations by acquiring and analyzing mobile artefacts using open-		

source forensic tools for Android and iOS devices.
CO6. .Prepare legally admissible and ethically compliant forensic investigation reports in accordance with cyber laws and digital forensic standards.

Topics Covered

UNIT-I **9L**

Introduction to Digital and Computer Forensics: Introduction to Digital and Computer Forensics, Scope and Importance of Digital Forensics, Types of Digital Evidence and Characteristics, Forensic Investigation Process and Methodology, Preparing for Digital Investigations, Systematic Approach to Forensic Analysis, Corporate and High-Tech Crime Investigations, Digital Forensics Laboratory Overview, Basic Forensic Workstation Requirements, Legal and Ethical Considerations in Digital Forensics.

UNIT-II **9L**

Evidence Acquisition and Crime Scene Handling: Digital Evidence Identification and Classification, Processing Computer Crime and Incident Scenes, Search and Seizure Procedures, Evidence Collection in Private-Sector and Law Enforcement Investigations, Securing Digital Crime Scenes, Data Acquisition Techniques (Logical, Physical, and File System), Live and Dead Acquisition, Validation and Verification of Acquired Data, Hashing Techniques, Chain of Custody Documentation, Storage and Transportation of Digital Evidence

UNIT-III **9L**

Forensic Tools and Evidence Analysis: Overview of Computer Forensic Tools (Software and Hardware), Criteria for Selecting Forensic Tools, Validation and Testing of Forensic Tools, Forensic Data Processing and Analysis, File System and Storage Analysis, Graphics and Multimedia File Recovery, Network Forensics Fundamentals (Log Analysis, Packet Capture), Email Forensics (Header Analysis and Tracing), Addressing Data-Hiding and Anti-Forensics Techniques.

UNIT-IV **9L**

Mobile Forensics and Advanced Digital Investigations: Introduction to Mobile Forensics, Mobile Device Architecture (Android and iOS), Mobile Evidence Types and Challenges, Mobile Device Seizure and Preservation, Mobile Data Acquisition Methods, Mobile Artefact Analysis (Call Logs, Messages, Contacts, App Data, Media Files), SIM and IMEI Analysis, Open-Source Mobile Forensic Tools, Validation of Mobile Forensic Results, Legal and Ethical Issues in Mobile Forensics.

LIST OF EXPERIMENTS

1. Introduction to digital forensics tools and the investigation environment using open-source tools such as Autopsy and Sleuth Kit.
2. Generation and verification of cryptographic hash values to ensure the integrity of digital evidence using md5sum, sha1sum, and Autopsy.
3. Creation and analysis of disk images for extracting file system artefacts using Autopsy and Sleuth Kit.
4. Performance of file system analysis and recovery of deleted files, along with examination of file metadata using Autopsy and Sleuth Kit.
5. Analysis of email headers for tracing sender and routing information using open-source email header

analysis tools and Autopsy.
6. Examination of network traffic and logs to identify suspicious activities using Wireshark and Network Miner.
7. Understanding of Android architecture and identification of mobile evidence types using Android Debug Bridge (ADB).
8. Logical data acquisition from Android devices, including contacts, messages, and call logs, using ADB and AFLogical.
9. Extraction and analysis of Android file system artefacts using ADB in combination with Autopsy and Sleuth Kit.
10. Analysis of mobile application artefacts such as WhatsApp data, browser history, and media files using Autopsy and Andriller Community Edition.
11. Extraction of SIM card information and IMEI details from mobile devices using ADB and Andriller Community Edition.
12. Acquisition and analysis of iOS backup data using libimobiledevice and Autopsy.
13. Analysis of multimedia evidence by extracting metadata from image, audio, and video files using ExifTool and Autopsy.
14. Identification of deleted, hidden, and obfuscated mobile artefacts to detect anti-forensics techniques using Autopsy and Sleuth Kit.
15. Preparation of a legally admissible mobile forensic investigation report using the reporting module of Autopsy

TEXTBOOKS

1. Nelson, Phillips, Enfinger, and Steuart, Computer Forensics and Investigations, Cengage Learning.

REFERENCE BOOKS

1. John R. Vacca, "Computer Forensics: Computer Crime Scene Investigation", Cengage Learning, 2nd Edition, 2005
2. Marjie T Britz, "Computer Forensics and Cyber Crime: An Introduction", Pearson Education, 2nd Edition, 2008. (CHAPTERS 3 – 13).
3. Real Digital Forensics by Keith j. Jones, Richard Bejitlich, Curtis W. Rose, Addison Wesley Pearson Education
4. Forensic Compiling, A Tractitioneris Guide by Tony Sammes and Brain Jenkinson, Springer International edition.
5. Computer Evidence Collection &Presentation by Chrostopher L.T. Brown, Firewall Media.

ECS-402	:	INTRODUCTION TO DEEP LEARNING
Course category	:	PE4
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials, laboratory exercises, course-based mini project, one minor test and one major examination.
Course Objectives	:	1. To provide fundamental understanding of deep learning concepts, architectures, and learning paradigms.

		2. To familiarize learners with neural networks, optimization techniques, and backpropagation. 3. To introduce convolutional, recurrent, and transformer-based deep learning models. 4. To develop practical skills for designing, training, evaluating, and deploying deep learning models for real-world applications
Course Outcomes	:	After successful completion of this course, students will be able to:

CO1. Understand core concepts of deep learning including neural networks, activation functions, loss functions, and optimization techniques.
CO2. Design and implement feedforward and deep neural networks using modern deep learning frameworks.
CO3. Analyze and apply Convolutional Neural Networks (CNNs) for image and vision-based tasks.
CO4. Apply Recurrent Neural Networks (RNNs), LSTM, and GRU architectures for sequential and time-series data.
CO5. Evaluate deep learning models using appropriate performance metrics and regularization techniques.
CO6. Develop and implement deep learning solutions for practical applications such as image classification, object detection, and natural language processing

Topics Covered

UNIT-I **9L**

Introduction to Deep Learning: Overview of Machine Learning vs Deep Learning, Biological Neuron vs Artificial Neuron, Artificial Neural Network Architecture, Perceptron Model, Activation Functions-Sigmoid, Tanh, ReLU, Softmax, Loss Functions-MSE, Cross Entropy, Gradient Descent, Backpropagation Algorithm, Challenges in Training Deep Networks-Vanishing & Exploding Gradients, Bias-Variance Tradeoff.

UNIT-II **9L**

Deep Neural Networks: Multi-layer Perceptron (MLP), Weight Initialization Techniques, Optimization Algorithms-SGD, Momentum, RMSProp, Adam, Learning Rate Scheduling, Regularization Techniques-L1, L2, Dropout, Batch Normalization, Model Evaluation Metrics-Accuracy, Precision, Recall, F1-Score, Confusion Matrix, Overfitting and Underfitting

UNIT-III **9L**

Convolutional Neural Networks: Introduction to CNNs, Convolution Operation, Filters and Feature Maps, Padding and Stride, Pooling-Max & Average Pooling, CNN Architectures-LeNet, AlexNet, VGG, ResNet (Overview), Transfer Learning, Fine-tuning Pretrained Models, Applications in Image Classification and Object Detection.

UNIT-IV **9L**

Sequence Models & Advanced Topics: Recurrent Neural Networks (RNN), Backpropagation Through Time (BPTT), LSTM and GRU Architectures, Introduction to Attention Mechanism, Transformers (Overview), Autoencoders and Variational Autoencoders, Introduction to GANs, Ethical Issues in Deep Learning, Model Deployment Overview.

LIST OF EXPERIMENTS

1. Write a Python program to implement an artificial neuron and demonstrate common activation functions such as Sigmoid, Tanh, ReLU, and Softmax with graphical visualization.
2. Develop a Python program to implement a single-layer Perceptron model for binary classification and analyze the effect of learning rate on convergence.
3. Create a feedforward neural network (Multi-Layer Perceptron) using a deep learning framework to perform classification on a standard dataset and evaluate model performance.
4. Write a Python program to implement backpropagation and compare different optimization algorithms such as SGD, Momentum, RMSProp, and Adam.
5. Develop a deep learning model to study the impact of regularization techniques including L1, L2, Dropout, and Batch Normalization on overfitting.
6. Implement a Convolutional Neural Network (CNN) for image classification using datasets such as MNIST or CIFAR-10 and analyze feature maps.
7. Write a Python program to apply transfer learning using a pre-trained CNN model (VGG/ResNet/MobileNet) and fine-tune it for a custom image dataset.
8. Develop a Recurrent Neural Network (RNN) model for sequence or time-series data and compare its performance with LSTM and GRU architectures.
9. Implement an autoencoder or variational autoencoder for dimensionality reduction or data reconstruction and analyze reconstruction loss.
10. Design and deploy a basic deep learning application (image classification or text classification) and evaluate the model using accuracy, precision, recall, and F1-score.

TEXTBOOKS

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press.
2. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer.
3. Francois Chollet, Deep Learning with Python, Manning Publications.
4. Simon Haykin, Neural Networks and Learning Machines, Pearson.
5. Bishop, C. M., Pattern Recognition and Machine Learning, Springer.

REFERENCE BOOKS

1. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow, O'Reilly.
2. Nikhil Buduma & Nicholas Locascio, Fundamentals of Deep Learning, O'Reilly.
3. Andrew Glassner, Deep Learning: From Basics to Practice, No Starch Press.
4. Christopher M. Bishop, Neural Networks for Pattern Recognition, Oxford University Press.
5. Research Papers and Tutorials from arXiv, IEEE, and NeurIPS Proceedings.

ECS-403	:	DATA ENGINEERING AND BIG DATA ANALYTICS
Course category	:	PE4
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through assignments, quizzes, tutorials, and one minor test and one major examination.
Course Objectives	:	1. Introduce data types, sources, and characteristics in real-world

		environments. 2. Develop skills in data cleaning, preprocessing, and transformation. 3. Familiarize students with big data ecosystem components and processing frameworks. 4. Enable students to apply predictive analytics and evaluate societal impact.
Course Outcomes	:	

CO1. Identify and classify different data types, sources, and characteristics in real applications.
CO2. Understand different types of data (structured, semi-structured, unstructured), data sources, characteristics (5Vs), and the complete data lifecycle in real-world applications.
CO3. Perform data cleaning and preprocessing tasks including handling missing values, outliers, duplicates, encoding, scaling, and normalization using tools like Python, SQL, and OpenRefine.
CO4. Apply data cleaning, preprocessing, and transformation techniques to prepare datasets for analysis
CO5. Demonstrate understanding of Big Data ecosystem and perform distributed processing using modern tools.
CO6. Build predictive models and evaluate their societal and ethical impact.

Topics Covered

UNIT-I **9L**

Data Generation and Understanding: Types of Data: Structured, Semi-structured, Unstructured Sources: Sensors, IoT devices, Social media, Transactions, Logs, Open data; Data characteristics: 5Vs (Volume, Velocity, Variety, Veracity, Value); Data lifecycle: Acquisition, Storage, Processing, Analysis, Visualization; Case studies: Healthcare, Smart cities, E-commerce.

UNIT-II **9L**

Data Cleaning and Preparation Data quality: Missing values, Outliers, Duplicates; Data preprocessing: Encoding, Scaling, Normalization; Data integration and reduction; Tools: Python (Pandas, NumPy), SQL, OpenRefine

UNIT-III **9 L**

Big Data Ecosystem and Processing Frameworks: Introduction to Big Data and challenges, Big Data Ecosystem: HDFS, YARN, MapReduce, Apache Spark: Architecture, RDDs, DataFrames, PySpark, NoSQL Databases: MongoDB, Cassandra, HBase Ingestion Tools: Kafka, Flume (overview).

UNIT-IV **9L**

Predictive Analytics and Societal Impact : Types of Analytics: Descriptive, Diagnostic, Predictive, Prescriptive, Predictive modeling basics: Regression, Classification, Decision Trees, Model Evaluation: Accuracy, Precision, Recall, F1-score Ethical considerations, privacy, and societal implications, Case studies: Public policy, Agriculture, Urban sustainability

TEXTBOOKS

1. Raj, P. & Deka, G.C., Big Data Analytics.

2. Leskovec, Rajaraman & Ullman, Mining of Massive Datasets.
3. Joel Grus, Data Science from Scratch.
4. Tom White, Hadoop: The Definitive Guide.

REFERENCE BOOKS

1. Mayer-Schönberger & Cukier, Big Data: A Revolution…
2. Buyya et al., Big Data: Principles and Paradigms.
3. Wes McKinney, Python for Data Analysis

ECS-404	:	ETHEREUM SMART CONTRACTS AND DISTRIBUTED SYSTEMS
Course category	:	PE4
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.
Course Objectives	:	The objective of this course is to provide an in-depth understanding of blockchain-based smart contracts and distributed application (DApp) development. It aims to build conceptual and technical proficiency in creating, deploying, and managing decentralized systems using modern blockchain platforms. The key objectives of the course are: 1. To understand the principles and architecture of blockchain-based smart contracts and DApps. 2. To design, implement, and deploy smart contracts using blockchain frameworks such as Ethereum, Hyperledger, and Solana. 3. To apply decentralized logic for real-world automation, transparency, and trust management. 4. To explore integration of DApps with Web3 technologies, wallets, and oracles. 5. To evaluate performance, scalability, and security issues in smart contract and DApp ecosystems.
Course **Outcomes**	:	

CO1. Explain the fundamentals of smart contracts, DApps, and blockchain ecosystems.
CO2. Develop and deploy smart contracts using Solidity or similar languages.
CO3. Design DApps integrating blockchain, front-end interfaces, and decentralized storage systems.
CO4. Analyze the security, privacy, and gas optimization aspects of smart contracts.
CO5. Evaluate and test blockchain-based distributed applications for efficiency and scalability.
CO6. Demonstrate the ability to deploy, test, and document a complete decentralized application (DApp) using industry-standard blockchain development tools.

Topics Covered

UNIT-I **9L**

Introduction to Blockchain-based Applications, Smart Contract Fundamentals: concepts, structure, lifecycle, and execution model. Ethereum Virtual Machine (EVM), Solidity programming basics, and token standards (ERC-20, ERC-721). Comparison of blockchain platforms for DApp deployment (Ethereum, Binance Smart Chain, Polygon).

UNIT-II **9L**

Smart Contract Design and Development: data types, functions, modifiers, and events. Contract-to-contract interaction, inheritance, libraries, and error handling. Deployment using Remix IDE, Truffle, and Hardhat frameworks. Integration with blockchain explorers and testnets.

UNIT-III **9L**

Distributed Application Architecture: components, Web3.js, and ethers.js libraries, wallet and metamask interaction. Frontend integration using React, Node.js, and APIs. Decentralized storage using IPFS and Filecoin, Off-chain computation and oracle integration for real-world data access.

UNIT-IV **9L**

Security and Performance in Smart Contracts: reentrancy, overflow/underflow, and access control vulnerabilities. Smart contract auditing tools (MythX, Slither, Oyente), Scalability solutions – sidechains, Layer 2, sharding. Interoperability and multi-chain DApps, governance models, and regulatory implications.

TEXTBOOKS

1. Bashir, Imran. "Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications", 4th ed. Packt Publishing, 2023.

2. Dannen, C. "Introducing Ethereum and Solidity: Foundations of Cryptocurrency and Blockchain Programming for Beginners", Apress, 2017.

3. Dhillon, V., Metcalf, D., Hooper, M. "Blockchain-Enabled Applications: Understand the Blockchain Ecosystem and How to Make it Work for You", Apress, 2021.

4. Antonopoulos, A.M., and Wood, G. "Mastering Ethereum: Building Smart Contracts and DApps", O'Reilly Media, 2023

REFERENCE BOOKS

1. W.-M. Lee, Beginning Ethereum Smart Contracts Programming: With Examples in Python, Solidity, and JavaScript, 2nd ed., Berkeley, CA: Apress, 2023.
2. M. Mukhopadhyay, Ethereum Smart Contract Development, Birmingham, UK: Packt Publishing, 2018.
3. G. Zheng, L. Gao, L. Huang and J. Guan, Ethereum Smart Contract Development in Solidity, Singapore: Springer, 2021.
4. W. Zhang and T. Anand, Blockchain and Ethereum Smart Contract Solution Development,

Berkeley, CA: Apress, 2022.

3rd Year 6th Semester Syllabus

BMS-301	PRINCIPLES OF INDUSTRIAL MANAGEMENT	
Course category	:	BMS
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and one Minor Test and one Major Theory Examination.
Course Objectives		To enable students to develop the operational skills and analyzing different situations in the industrial scenario having limited resources and obtain the optimal solution with and without constraints.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Students should be able to become efficient and acquire acumen for more profitable business practices.
2. Students should be able to understand the importance of better customer service and product quality.
3. Students should be able to make work safer, faster, easier, and more rewarding.
4. Students should be able to help the industry in the production of more products that possess all utility factors
5. Students should be able to reduce costs associated with new technologies.
6. Students should be able to understand different principle of Industrial Management.

Topics Covered

UNIT-I

Introduction of Industrial Management: Definition, Nature and Scope of Management, Process of management, Elements of management, Definition of industrial management, Scope and Application of industrial management.

Plant Location and Layout: Factors affecting Plant Location, Objectives and Principles of Plant Layout, Types of Plant-Layout

UNIT-II

Work Analysis and Measurement: Design of work study, steps involved in work-study process, Definition and Concept of Method study, Procedure involved in Method study, Objectives and techniques of Work Measurement, work sampling and its application, Selection of Personnel and wage payment plans.

UNIT-III

Material Management: Meaning of Inventory management, Economic Order Quantity Model, ABC analysis, Just-in-time, Minimum Safety Stock Industrial Safety: Occupational safety, safety programs; Safety aspects in work system design
UNIT-IV
Project Management: Meaning, Features, Project management life cycle, Project cost control System, Project planning and control, Project scheduling and techniques.
Text & Reference books:
1. Joseph Russell Smith, "The Elements of Industrial Management", Hard Press 2. Gavriel Salvendy, "Handbook of Industrial Engineering: Technology and Operations Management", John Wiley & Sons, Inc. 3. S. N. Chary, "Production and Operations Management", Tata McGraw Hill 4. R. Paneerselvam, "Production and Operations Management", PHI 5. E. S. Buffa and R. K. Sarin, Modern Production/ Operations Management, Wiley.

BCS-355		Software Engineering
Course category	:	Program Core Course (PC)
Pre-requisite Subject:	:	NIL
Contact hours/week:	:	Lecture: 3, Tutorial: 0, Practical: 2
Course Objective:	:	It contains a basic introduction to familiarize students with the basics of software Engineering. Here are the key objectives covered in this course
		1. The aim of the course is to provide an understanding of the working knowledge of the techniques for estimation, design, testing and quality management of large software development projects.
		2. Topics include process models, software requirements, software design, software testing, software process/product metrics, risk management, quality management and UML diagrams.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.
		CO1. List and describe the fundamental phases of the Software Development Life cycle (SDLC)
		CO2. Define and describe fundamental software engineering terminology and coding practices
		CO3. Explore/explain relationships between software engineering and other engineering
		disciplines (Systems Engineering, Electrical and Computer Engineering, Industrial Engineering)
		CO4. Modify/build a software program that introduces students to software development tools environments.
		CO5. Troubleshoot and debug changes made to an existing software program

		CO6. Build a foundation for academic success in the Software Engineering degree program
UNIT-I		9L
Software Process – Introduction, S/W Engineering Paradigm, Life Cycle Models (Waterfall, Incremental, Spiral, Evolutionary, Prototyping), Software Requirements –Functional And Non-Functional – Software Document – Requirement Engineering Process – Feasibility Studies – Software Prototyping – Prototyping in Software, Process – Data – Functional and Behavioral Models – Structured Analysis And Data Dictionary.		
UNIT-II		9L
Basic Concept of Software Design, Architectural Design, Low Level Design: Modularization, Design Structure Charts, Pseudo Codes, Flow Charts, Coupling and Cohesion Measures, Design Strategies: Function Oriented Design, Object Oriented Design, Top-Down and Bottom-Up Design. Software Measurement and Metrics: Various Size Oriented Measures: Halestead's Software Science, Function Point (FP) Based Measures, Cyclomatic Complexity Measures: Control Flow Graph.		
UNIT-III		9L
Software Testing – Taxonomy of S/W Testing Levels - Black Box Testing – Testing Boundary Conditions – Structural Testing — Regression Testing– S/W Testing Strategies, Unit Testing, Integration Testing, Validation Testing, System Testing and Debugging.		
UNIT-IV		9L
Measures and Measurements – Zipf's Law, Software Cost Estimation – Function Point Models, COCOMO Model. Delphi Method – Scheduling – Earned Value Analysis – Error Tracking – Software Configuration Management – Program Evolution Dynamics – Software Maintenance – Project Planning – Project Scheduling– Risk Management – Case Tools		
List of Experiments	:	
		1. To perform the system analysis: Requirement analysis, SRS. (Both Functional and Non- functional requirements).
		2. To perform the function oriented diagram: DFD and Structured chart.
		3. To perform the user's view analysis: Use case diagram.
		4. To draw the structural view diagram: Class diagram, object diagram.
		5. To draw the behavioral view diagram: Sequence diagram, Collaboration diagram.
		6. To draw the behavioral view diagram: State-chart diagram, Activity diagram.
		7. To draw the implementation view diagram: Component diagram.
		8. To draw the environmental view diagram: Deployment diagram.
		9. To perform various testing using the testing tool unit testing, integration testing
		10. Define security and quality aspects of the identified module
Textbooks	:	

		1. R. S. Pressman, "Software Engineering - A practitioners approach", 3rd Edition, McGraw Hill International editions, 1992.
		2. IAN Sommerville, Software Engineering, Pearson Education Asia, VI Edition, 2000
		3. Pankaj Jalote,"An Integrated Approach to software Engineering", Springer Verlag, 1997.
Reference Books:		
		1. Software Engineering: A Primer By: Waman S. Jawadekar Publication details: New Delhi TMH 2010.
		2. Software Engineering 1: Abstraction and Modelling Paperback, by Dines Bjorner, 2010.

BCS-361	:	IMAGE AND VIDEO PROCESSING
Course category	:	PC
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Course Assessment methods: Continuous assessment through assignments, quizzes, a course-based project, one minor test, and one major examination.
Course Objectives	:	1. Provide a clear understanding of digital image formation, representation, and visualization techniques. 2. Explain the relationship between spatial and frequency domains for image and video analysis at a conceptual level. 3. Enable students to map signal processing techniques to digital images and videos for enhancement and analysis. 4. Introduce multimedia data such as images and videos, along with basic processing operations. 5. Provide exposure to image and video compression standards and their practical significance.
Course Outcomes	:	After successful completion of this course, students will be able to:
CO1. Apply image and video processing techniques to solve real-world problems. CO2. Implement basic enhancement, filtering, segmentation, and compression techniques using programming tools. CO3. Analyze images and videos using spatial and limited frequency-domain concepts. CO4. Develop simple and effective image and video processing solutions for practical applications. CO5. Perform image segmentation and basic feature extraction using thresholding methods, watershed algorithm, and gray-level segmentation approaches. CO6. Understand image and video compression techniques and standards such as JPEG, JPEG2000, MPEG, and explain basic concepts of video processing and streaming applications.		
Topics Covered		

UNIT-I **9L**

Digital image fundamentals: simple image model, digital image formation, sampling, quantization, resolution, and image representation. Relationship among pixels and types of digital images. Color image processing: color representation, chromaticity diagram, color spaces, types of digital imaging, and application areas. Image enhancement using point processing: contrast stretching, power-law and gamma transformation. Histogram processing: histogram equalization and histogram matching

UNIT-II **9L**

Image degradation and noise models. Spatial domain filtering: correlation and convolution. Smoothing filters: linear and nonlinear filters, mean and median filters, adaptive filtering. Sharpening filters: derivative operators, Laplacian, unsharp masking, and high-boost filtering. Introduction to frequency-domain filtering: low-pass and high-pass filtering (ideal, Butterworth, Gaussian – conceptual emphasis). Image restoration techniques: inverse filtering and Wiener filtering (conceptual and application-oriented).

UNIT-III **9L**

Edges, lines, and boundary detection: first and second order edge operators, multi-scale edge detection, Canny edge detection algorithm. Hough transform for line and edge detection. Morphological operations and applications: boundary extraction, skeletonization, convex hull, thinning, and pruning. Image segmentation and feature extraction: optimal and multilevel thresholding, gray-level image segmentation, watershed algorithm. Introduction to feature extraction concepts for image analysis.

UNIT-IV **9L**

Compression techniques: lossy and lossless compression. Image compression standards: JPEG, JPEG2000, and variants. Introduction to video processing concepts. Video compression standards and formats: MPEG and H.XXX family. Basics of video streaming and applications.

LIST OF EXPERIMENTS

1. Digital Image Fundamentals: Study of image types (binary, grayscale, RGB), pixel representation, image resolution, and basic image display operations.
2. Image Sampling and Quantization Perform sampling and quantization on grayscale images and observe the effect on image quality.
3. Image Enhancement Using Point Processing Techniques Implementation of contrast stretching and power-law (gamma) transformation.
4. Histogram Processing of Images. Plotting of image histogram and application of histogram equalization for contrast enhancement.
5. Image Smoothing Using Linear Filters Implementation of mean and weighted mean filters for noise reduction.
6. Noise Addition and Removal Using Nonlinear Filtering Addition of salt-and-pepper noise and its removal using a median filter.
7. Image Sharpening Techniques Implementation of Laplacian and unsharp masking for edge enhancement.
8. Edge Detection Techniques Implementation of Sobel and Canny edge detection algorithms.
9. Morphological Image Processing Implementation of erosion, dilation, opening, and

closing operations.

10. Image Segmentation Using Thresholding Implementation of global and multilevel thresholding techniques.
11. Basic Image Compression Techniques: Study and implementation of lossy and lossless image compression with emphasis on JPEG compression.
12. Basic Video Processing Operations:

Reading a video file, extracting frames, and displaying basic video properties such as frame count and resolution.

TEXTBOOKS.

1. William K. Pratt, Digital Image Processing (3rd Edition), John Wiley & Sons.
2. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Pearson.

REFERENCE BOOKS.

1. Milan Sonka, Vaclav Hlavac, and Roger Boyle, Image Processing, Analysis, and Machine Vision, Cengage Learning.
2. William K. Pratt, Digital Image Processing, John Wiley & Sons.
3. S. Jayaraman, S. Esakkirajan, and T. Veerakumar, Digital Image Processing, Tata McGraw-Hill.
4. Al Bovik (Ed.), Handbook of Image and Video Processing, Academic Press.

BCS-356	:	Parallel & Distributed Programming
Course category	:	PC
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Continuous Assessment through one minor test, Teacher Assessment (Quiz, Tutorial, Assignment, Attendance), Practical Work & Viva-voce, and One Major Theory & One Practical Examinations.
Course Objectives	:	This course helps the students in gaining the knowledge to basic principle of parallel and distributed systems. This course helps to undertake future courses that assume as a background in management of system resources. 1. Discuss basic theory and practice of Parallel and Distributed algorithms 2. Design and implement new Parallel and Distributed algorithms
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.
CO1 Understand and account for models, limitations, and fundamental concepts in message passing and shared memory concurrency, and apply this understanding to example systems and algorithms		

CO2. Adapt, and design algorithms for execution in parallel and distributed settings, and analyze the algorithms for correctness, reliability, security, and performance
CO3. Develop and apply knowledge of parallel and distributed computing techniques and methodologies
CO4. Apply design, development, and performance analysis of parallel and distributed applications
CO5. Use the application of fundamental Computer Science methods and algorithms in the development of parallel applications.
CO6. Explain the design, testing, and performance analysis of a software system, and to be able to communicate that design to others.

Topics Covered

UNIT-I **9L**

Parallel Computing, Parallel Computer Model, Parallel Architectural Classification Schemes, Multiprocessor System and Interconnection Networks. Theoretical Foundation for Distributed System: Limitation of Distributed System, Absence of Global Clock, Shared Memory, LogicalClocks, Lamport's & Vectors Logical Clocks, Causal Ordering of Messages, Global State, Termination Detection.

UNIT-II **9L**

Distributed Mutual Exclusion: Classification of Distributed Mutual Exclusion, Requirement of Mutual Exclusion Theorem, Token Based and Non-Token Based Algorithms, Performance Metric for Distributed Mutual Exclusion Algorithms

UNIT-III **9L**

Distributed Deadlock Detection: System Model, Resource vs Communication Deadlocks, Deadlock Prevention, Avoidance, Detection & Resolution, Centralized Dead Lock Detection, Distributed Dead Lock Detection, Path Pushing Algorithms, Edge Chasing Algorithms. Agreement Protocols: Introduction, System Models, Classification of Agreement Problem, Byzantine Agreement Problem, Consensus Problem, Interactive Consistency Problem, Solution to Byzantine Agreement Problem, Application of Agreement Problem

UNIT-IV **9L**

Distributed File Systems: File Service Architecture, Sun Network File System, The Andrew File System, Recent Advances.
Distributed Algorithms: Introduction to Communication Protocols, Balanced Sliding Window Protocol, Routing Algorithms, Destination Based Routing, APP Problem, Deadlock Free Packet Switching, Introduction to Wave & Traversal Algorithms, Election Algorithm, CORBA Case Study: CORBA RMI, CORBA Services

LIST OF EXPERIMENTS

1. Write a C/C++ program to simulate the functioning of Lamport's Logical Clock for event ordering in a distributed system.
2. Write a C program to simulate Vector Clocks and demonstrate causal ordering of events in distributed processes.
3. Write a C program to implement a token-based distributed mutual exclusion algorithm and

analyze its performance.
4. Write a C program to simulate a non-token-based distributed mutual exclusion algorithm (e.g., Ricart–Agrawala).
5. Write a C program to implement a distributed leader election algorithm (Bully or Ring algorithm).
6. Write a C program to simulate distributed deadlock detection using edge-chasing or path-pushing algorithms.
7.Write a C program to implement the Sliding Window Protocol for reliable data communication.
8. Write a C program to implement a distributed chat server using TCP socket programming.
9. Implement an RPC mechanism in C for file transfer across a network.
10. Write a JAVA code to implement JAVA RMI mechanism for accessing methods of remote systems.
12. Write a C program to increment a shared counter using shared memory and synchronization mechanisms.
13. Implement COBRA mechanism by using C++ program at one end and JAVA program at the other.

TEXTBOOKS

1 Singhal Mukesh & Shivaratri N. G., Advanced Concepts in Operating Systems, TMH

REFERENCE BOOKS

1. D. Culler, J. P. Singh, A. Gupta, Parallel Computer Architecture, Elsevier
2. Andrew S. Tanenbaum and Maarten Van Steen, Distributed Systems Principles and Paradigms, PHI
3. Tanenbaum, A. S. Distributed Operating Systems, Prentice Hall
4. Tanenbaum, A. S., Modern Operating Systems, 2nd Edition, Prentice Hall, 2001
5. Bacon, J., Concurrent Systems, 2nd Edition, Addison Wesley 1998
6. Coulouris, G. et al, Distributed Systems: Concepts and Design, 3rd Edition, Addison Wesley
7. Galli, D.L., Distributed Operating Systems: Concepts and Practice, Prentice-Hall

ECS-503	:	Data Visualization
Course category	:	PE5
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.
Course Objectives	:	1. To introduce the fundamental concepts and importance of data visualization in data analysis and decision-making. 2. To develop understanding of data abstraction, task abstraction, and visual encoding techniques using marks and channels. 3. To train students in creating static, interactive, and dynamic

		visualizations using tools such as Matplotlib, Seaborn, Plotly, and Altair. 4. To apply principles of visual perception and design in developing effective and meaningful visual representations. 5. To evaluate and validate visualization effectiveness using established validation methods and design guidelines.
Course Outcomes	:	Upon successful completion of this course, students will be able to:

CO1. Identify and interpret basic plots using Matplotlib, Seaborn, and Plotly.
CO2. Analyze dataset types and apply suitable visualization techniques.
CO3. Create dynamic and animated visualizations using modern tools.
CO4. Evaluate visualization effectiveness using validation techniques and design rules.
CO5. Design spatial and network visualizations using visual encoding principles.
CO6. Develop data-driven reports and presentations that communicate analytical findings ethically and effectively to technical and non-technical audiences.

Topics Covered

UNIT-I **9L**

Line plot - Bar plot - Pie Chart - Scatter Plot - Histogram - Stacked Bar Charts - Sub Plots - Matplotlib, Searborn, Plotly - Seaborn Styles, What is Visualization and Why do it: External representation – Interactivity – Difficulty in Validation. Data Abstraction: Dataset types – Attribute types – Semantics. Task Abstraction – Analyze, Produce

UNIT-II **9L**

Box plot - Density Plot - Area Chart - Heat map - Tree map - Graph Networks, Value of Visualization –, Search, Query. Four levels of validation – Validation approaches – Validation examples. Marks and Channels

UNIT-III **9L**

Dynamic charts - Dynamic maps - Animation types - 2D, 3D, Motion Animation - Animation Principles - Altair Package - Statistical Visualizations Rules of thumb – Arrange tables: Categorical regions – Spatial axis orientation – Spatial layout density. Arrange spatial data: Geometry – Scalar fields – Vector fields – Tensor fields. Arrange networks and trees: Connections, Matrix views – Containment. Map color: Color theory, Color maps and other channels.

UNIT-IV **9L**

Visual Perception and Cognition - Gestalt's Principles - Tufte's Principles - Applications of Principles of Information Visualization - Dashboard Design, Manipulate view: Change view over time – Select elements – Changing viewpoint – Reducing attributes. Facet into multiple views: Juxtapose and Coordinate views – Partition into views – Static and Dynamic layers – Reduce items and attributes: Filter – Aggregate. Focus and context: Elide – Superimpose – Distort – Case studies

TEXTBOOKS

1. "Fundamentals of Data Visualization" by Claus O. Wilke

REFERENCE BOOKS

Interactive Data Visualization for the Web Scott Murray, O'Reilly Media.
"Information Visualization: Perception for Design" by Colin Ware

ECS-504	:	Artificial Intelligence: Knowledge Representation and Reasoning
Course category	:	PE5
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.
Course Objectives	:	1. To develop a strong foundation in symbolic reasoning and formal logic for knowledge representation in Artificial Intelligence. 2. To enable students to understand and apply propositional and first-order logic for modeling intelligent systems. 3. To introduce inference mechanisms such as unification, resolution, forward chaining, and backward chaining. 4. To provide knowledge of logic programming and rule-based systems using Prolog. 5. To familiarize students with advanced knowledge representation techniques including frames, description logics, and non-monotonic reasoning.
Course Outcomes	:	After successful completion of the course, the learners would be able to:

CO1. Apply propositional logic, truth tables, and proof techniques (direct proof and tableau method) to solve logical problems.

CO2. Analyze and represent knowledge using first-order logic and implement unification, forward chaining, and backward chaining mechanisms.

CO3. Apply the resolution refutation method and Horn clauses for automated theorem proving and logical inference.

CO4. Develop basic logic programs using Prolog and explain the working of rule-based systems, OPS5, and the Rete algorithm.

CO5 Evaluate and apply advanced knowledge representation techniques such as frames, description logics, taxonomies, inheritance, and non-monotonic reasoning methods.

CO6. Evaluate the performance and limitations of various knowledge representation schemes

and reasoning approaches in AI systems.

Topics Covered

UNIT-I **9L**

Symbolic Reasoning. Truth, Logic and Provability. Propositional Logic. Direct Proofs. The Tableau Method.

UNIT-II **9L**

First Order Logic. Universal Instantiation. The Unification Algorithm. Forward and Backward Chaining. The Resolution Refutation Method

UNIT-III **9L**

Horn Clauses and Logic Programming. Prolog. Rule Based Systems. The OPS5 Language. The Rete Algorithm

UNIT-IV **9L**

Representation in First Order Logic. Conceptual Dependency. Frames. Description Logics and the Web Ontology Language, Taxonomies and Inheritance. Default Reasoning. Circumscription. Auto-epistemic Reasoning. Event Calculus Epistemic Logic. Knowledge and Belief

Textbooks

1. Russell, S., & Norvig, P. (2021). *Artificial Intelligence: A Modern Approach* (4th ed.). Pearson Education.
2. Rich, E., Knight, K., & Nair, S. B. (2009). *Artificial Intelligence* (3rd ed.). McGraw-Hill Education.
3. Bratko, I. (2012). *Prolog Programming for Artificial Intelligence* (4th ed.). Pearson Education.

Reference Books

1. Brachman, R. J., & Levesque, H. J. (2004). *Knowledge Representation and Reasoning*. Morgan Kaufmann.
2. Genesereth, M. R., & Nilsson, N. J. (1987). *Logical Foundations of Artificial Intelligence*. Morgan Kaufmann.
3. Ginsberg, M. L. (1987). *Readings in Nonmonotonic Reasoning*. Morgan Kaufmann.
4. Baader, F., Calvanese, D., McGuinness, D., Nardi, D., & Patel-Schneider, P. (Eds.). (2003). *The Description Logic Handbook.* Cambridge University Press

ECS-505	:	CYBER SECURITY & PRIVACY
Course category	:	PE5
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.
Course Objectives	:	1. To understand the fundamental concepts of Cyber Security, including Confidentiality, Integrity, Availability (CIA), core principles, and real-world data breach cases. 2. To develop knowledge of security management and governance, including GRC frameworks, security standards, control strategies, and cyber security policies (ESSP, ISSP, SYSSP). 3. To analyze cyber risk management processes, including risk identification, assessment, mitigation, and control mechanisms. 4. To explore cyber security technologies and industry practices, including defense technologies, attack mechanisms, exploits, access control, encryption, and standards. 5. To understand the foundations of privacy, including information privacy theories, privacy measurement, anonymity, and regulatory frameworks. 6. To examine global and Indian privacy regulations, including GDPR, DPDP Act, Aadhaar-related concerns, and the economic value and strategic importance of privacy.
Course Outcomes	:	After successful completion of the course, the learners would be able to:

CO1. Understand the core principles of cybersecurity including.
CO2. Explain confidentiality, integrity, and availability (CIA).
CO3. Explain governance, risk management, compliance frameworks
CO4. Analyze cyber security policies and their role in organizational security.
CO5. Describe industry defense technologies, attack methods, and cybersecurity standards.
CO6. Understand foundations of information privacy, measurement theories, and privacy regulations.

Topics Covered
UNIT-I **9L** Introduction to cyber security, Confidentiality, integrity, and availability. Foundations - Fundamental concepts, CIA, CIA triangle, data breach at target.
UNIT-II **9L** Security management, Governance, risk, and compliance (GRC)- GRC framework, security standards Control strategies and protection mechanisms, Cryptography for security. Cyber security policy - ESSP, ISSP, SYSSP. Risk Management - Cyber Risk Identification, Assessment, and Control.
UNIT-III **9L** Cyber security: Industry perspective - Defense Technologies, Attack, Exploits. Cyber security technologies - Access control, Encryption, Standards. Foundations of privacy - Information privacy, Measurement, Theories. Privacy regulation - Privacy, Anonymity, Regulation, Data Breach.
UNIT-IV **9L** Privacy regulation in Europe, Privacy: The Indian Way - Data Protection, GDPR, DPDP, Aadhar. Information privacy: Economics and strategy, Economic value of privacy, privacy valuation
TEXTBOOKS 1. "Principles of Information Security" by Michael E. Whitman and Herbert J. Mattord – Cengage Learning, 6th Edition, 2017. **REFERENCE BOOKS** 1. "Cybersecurity for Beginners" by RaefMeeuwisse – Cyber Simplicity Ltd., 2021. 2. "Information Privacy: Statutes and Regulations" by Richard M. Smith – Aspen Publishing, Latest Edition.

ECS-506	:	CONCEPT OF VIRTUAL AND AUGMENTED REALITY
Course category	:	PE5
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination
Course Objectives	:	This course is designed to give historical and modern overviews and perspectives on virtual reality. It describes the fundamentals of sensation, perception, technical and engineering aspects of virtual reality systems.
Course Outcomes	:	After successful completion of the course, the learners would be able to:

Topics Covered

UNIT-I **9L**

Virtual reality and virtual environments: the historical development of VR, scientific landmarks computer graphics, real-time computer graphics, virtual environments, requirements for VR, benefits of virtual reality. Hardware technologies for 3D user interfaces: visual displays, auditory displays, haptic displays, choosing output devices for 3D user interfaces.

UNIT-II **9L**

3D user interface input hardware: input device characteristics, desktop input devices, tracking devices, 3d mice, special purpose input devices, direct human input, home - brewed input devices, choosing input devices for 3D interfaces. Software technologies: database - world space, world coordinate, world environment, objects - geometry, position / orientation, hierarchy, bounding volume, scripts and other attributes, VR environment - VR database, tessellated data, LODs, Cullers and Occluders, lights and cameras, scripts, interaction - simple, feedback, graphical user interface, control panel, 2D controls, hardware controls, room / stage / area descriptions, world authoring and playback, VR toolkits, available software in the market.

UNIT-III **9L**

3D interaction techniques: 3D manipulation tasks, manipulation techniques and input devices, interaction techniques for 3D manipulation, design guidelines – 3D travel tasks, travel techniques, design guidelines - theoretical foundations of wayfinding, user centered wayfinding support, environment centered wayfinding support, evaluating wayfinding aids, design guidelines - system control, classification, graphical menus, voice commands, Gestrual commands, tools, mutimodal system control techniques, design guidelines, case study: mixing system control methods, symbolic input tasks, symbolic input techniques, design guidelines, beyond text and number entry.

UNIT-IV **9L**

Designing and developing 3D user interfaces: strategies for designing and developing guidelines and evaluation. Advances in 3D user interfaces: 3D user interfaces for the real world, AR interfaces as 3D data browsers, 3D augmented reality interfaces, augmented surfaces and tangible interfaces, agents in AR, transitional AR-VR interfaces - the future of 3D user interfaces, questions of 3D UI technology, 3d interaction techniques, 3d UI design and development, 3D UI evaluation and other issues.

Textbooks/References:

1. Paul Mealy, Virtual & Augmented Reality for Dummies, John Wiley & Sons.
2. Alan B Craig, William R Sherman and Jeffrey D Will, “Developing Virtual Reality Applications: Foundations of Effective Design”, Morgan Kaufmann.
3. Jan Erik Solem, Programming Computer Vision with Python, Shroff Publisher/O’Reilly Publisher
4. Gerard Jounghyun Kim, “Designing Virtual Systems: The Structured Approach”.
5. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, “3D User Interfaces, Theory and Practice”, Addison Wesley, USA

ECS-507	:	Smart Contracts and Decentralized Applications
Course category	:	PE5
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination
Course Objectives	:	1.Understand the fundamentals and historical evolution of blockchain technology and smart contracts, including the life-cycle of a smart contract and Ethereum ecosystem components. 2. Compare Ethereum and Bitcoin in terms of architecture, scripting capability, consensus, and application scope. 3. Develop, compile, and deploy smart contracts using Solidity and tools such as Remix IDE, Web3.js/Web3J, and Ganache. 4. Analyze Ethereum components including EVM, Gas mechanism, reward scheme, Swarm, Whisper, and ABI for decentralized application development. 5. Design and implement decentralized applications (DApps) by integrating smart contracts with frontend applications. 6. Identify common smart contract vulnerabilities and apply security best practices, testing, and debugging techniques.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

CO1. Understand the ecosystem of smart contracts within Ethereum networks.
CO2. Develop smart contracts using Solidity.
CO3. Compare the technical foundations of Ethereum and Bitcoin.
CO4. Analyze Ethereum's and its roles in contract execution.
CO5. Implement and deploy smart contracts.

CO6. Identify common smart contract vulnerabilities and apply best practices for secure development.

Topics Covered

UNIT-I **9L**

An overview to the history of smart contracts o An intro to the life-cycle of a smart contract Ethereum's smart contract languages- Interfacing with Ethereum Networks (overview of Ethereum Networks, Clients, Wallets, Transactions etc.)

UNIT-II **9L**

The Solidity Programming Language o Development Environments Blockchain technology

Supporting Turing-Complete Languages- A comparison of Ethereum and Bitcoin- Overview of Ethereum's tech stack, architecture.

UNIT-III **9L**

The Ethereum reward scheme, Mist, EVM, Swarm, Whisper, Eth, Gas- A simple Solidity Contract (Contract Walk-through)- The Solidity compiler o Ethereum Contract ABI- Deployment with the Web3.js or Web3J library Virtual Machines and Beyond

UNIT-IV **9L**

Security in Smart Contracts: Common vulnerabilities and best practices. Testing and Debugging: Tools like Ganache, Remix IDE for unit testing and debugging smart contracts.

TEXTBOOKS

1. *Hands-On Smart Contract Development with Solidity and Ethereum* by Kevin Solorio, Randall Kanna & David H. Hoover
2. *Building Ethereum Dapps* by Roberto Infante
3. *Ethereum Smart Contract Development in Solidity* by Gavin Zheng, Longxiang Gao, Liqun Huang and Jian Guan

REFERENCE BOOKS

1. "Mastering Ethereum: Building Smart Contracts and DApps" By Andreas M. Antonopoulos and Gavin Wood
2. "Introducing Ethereum and Solidity: Foundations of Cryptocurrency and Blockchain Programming for Beginners"By Chris Dannen

ECS-508	:	INTRODUCTION TO SOFTWARE ENGINEERING
Course category	:	PE5
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.
Course Objectives	:	
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course
CO1. Explain various software characteristics and analyse different software Development Models CO2. Demonstrate the contents of a SRS and apply basic software quality assurance practices to ensure that design, development meet or exceed applicable standards CO3. Compare and contrast various methods for software design		

CO4. Formulate testing strategy for software systems, employ techniques such as unit testing, Test driven development and functional testing
CO5. Manage software development process independently as well as in teams and make use of Various software management tools for development, maintenance, and analysis.
CO6. Understand software project management concepts such as estimation, scheduling, risk management, teamwork, and professional ethics in software engineering.

Topics Covered

UNIT-I **9L**

Software Requirement Specification: Requirements Elicitation Techniques, Requirements analysis, Models for Requirements analysis, requirements specification, requirements validationDesign Principles: Problem partitioning, abstraction. Top down and bottom up – design, structured approach. Functional versus 6object oriented approach of design, design specification, Cohesiveness and Coupling. Overview of SA/SD Methodology, structured analysis, data flow diagrams, extending DFD to structure chart.

UNIT-II **9L**

Testing: Verification and validation, code inspection, test plan, test case specification. Level of testing: Unit, Integration Testing, Top down and bottom-up integration testing, Alpha and Beta testing, System testing and debugging. functional testing, structural testing, Software testing strategies.

UNIT-III **9L**

Testing: Verification and validation, code inspection, test plan, test case specification. Level of testing: Unit, Integration Testing, Top down and bottom-up integration testing, Alpha and Beta testing, System testing and debugging. functional testing, structural testing, Software testing strategies.

UNIT-IV **9L**

Software Maintenance: Structured Vs 5 unstructured maintenance, Maintenance Models,Configuration Management, Reverse Engineering, Software Re-engineering

TEXTBOOKS.

1 Pressman, “Software Engineering – A practitioner’s approach”, 3rd ed.,McGraw Hill Int. Ed..
2 K.K. Aggarwal & Yogesh Singh, “Software Engineering”, 2ndEd., New Age International.
3 SomR. S.merville, “Software Engineering”, Addison Wesley.

REFERENCE BOOKS

ECS-509	:	SPATIAL INFORMATION TECHNOLOGY
Course category	:	PE5
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4

Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.
Course Objectives	:	
Course Outcomes	:	After successful completion of this course, students will be able to:

CO1. Define and explain the core concepts of Spatial Information Technology and distinguish between spatial and attribute data in various spatial models.
CO2. Understand and apply different representations of spatial information including regular and irregular tessellations, vector formats, and topological relationships.
CO3. Perform spatial data input and transformation techniques such as digitization, raster-vector conversion, and analytical transformations including rubber-sheeting.
CO4. Analyze and evaluate the accuracy and precision of spatial data, including positional, attribute, temporal accuracy, and data completeness.
CO5. Design and manage spatial databases using different DBMS models and retrieve data using spatial and attribute queries.
CO6. Conduct spatial analyses such as overlays, buffering, and network analysis, and apply spatial analysis tools in real-world planning and engineering applications like environmental management, transportation, and water resources.

Topics Covered

UNIT-I **9L**

Definition of Spatial Information Technology, Cartography and Spatial Information, Spatial database: spatial and attribute data; Spatial models: Semantics, spatial information, temporal information, conceptual models of spatial information, Computer representation of geographic information: Regular tessellations, irregular tessellations, Vector representations, Topology and Spatial relationships, Scale and Resolution, Representation of Geographic fields, Representation of spatial objects.

UNIT-II **9L**

Raster and vector data input, raster to vector data conversion, map projection, analytical transformation, rubber sheet transformation, manual digitizing and semi-automatic line following digitizer; Remote sensing data as an input to Spatial data, Direct and indirect spatial data capture Accuracy and Precision, Positional accuracy, Attribute accuracy, temporal accuracy, Lineage, Completeness, Logical consistency.

UNIT-III **9L**

Spatial database Concepts and management systems, Types of Database management Systems, hierarchical, network, relational models, Object oriented DBMS, Spatial data functionality; data storage and data retrieval through query, generalization, classification, containment search within a spatial region.

UNIT-IV **9L**

Overlay: arithmetical, logical and conditional overlay, buffers, inter visibility, aggregation; Network

analysis; Applications of Spatial Information Technology in planning and management of utility lines and in the field of Urban Planning, Disaster Management, Smart City Projects, transportation planning and water body restoration & Climate Change.

LIST OF EXPERIMENTS

1. Familiarize with GIS software environment and basic functions on tools: QGIS/ArcGIS
2. Understand and implement raster vs. vector models and Link spatial data with tabular attribute data and visualize.
3. Digitize point, line, and polygon features from scanned maps.
4. Establish topological relationships and perform basic topology checks.
5. Apply different projections to spatial data and study distortion.
6. Digitizing and apply rubber sheet transformations to correct spatial distortions.
7. Perform sub-setting and mosaicking of adjacent location images.
8. Performing classification for land-use and land-cover on satellite imagery. Supervised Classification (Max. Likelihood, Min. Distance). Unsupervised Classification (K-means, ISODATA).
9. Compare classified image with ground truth using confusion matrix. Overall accuracy, Kappa coefficient.
10. Understand multispectral concepts using LANDSAT/IRS data. Band-wise image comparison and band combination outputs.

TEXTBOOKS

1. Stan Arnoff Geographic Information Systems: A Management Perspective, WDL Publications.
2. C.P. Lo and Albert K. W. Yeung, Concepts and Techniques of Geographical Information Systems, Prentice- Hall India
3. Reddy, M. Anji, Remote sensing and Geographic Information System BS Publications Hyderabad
4. B. Bhatta, Remote Sensing and GIS, Oxford University Press

REFERENCE BOOKS

Robert Laurini and Derek Thompson Fundamentals of Spatial Information Systems, Academic Press.
Tor Bernhardsen Geographic Information Systems: An Introduction, Wiley
Burrough P.A. and Rachel A. McDonell, Principles of Geographical Information Systems, Oxford Publication
Michael N. DeMers, Fundamentals of Geographic Information Systems, Wiley5. Computer Evidence Collection &Presentation by Chrostopher L.T. Brown, Firewall Media.

ECS-601	:	Intrusion Detection and Prevention Systems
Course category	:	PE6
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials, course-based project, one minor test and one major examination.

Course Objectives	:	1. To introduce the fundamental concepts and need for intrusion detection and prevention systems. 2. To familiarize students with different types of intrusions, threats, and vulnerabilities in computer networks and hosts. 3.To provide in-depth knowledge of IDS and IPS architectures, detection mechanisms, and deployment strategies. 4. To enable students to analyze network traffic and system logs for intrusion detection. 5. To provide hands-on exposure to open-source IDS/IPS tools used in real-world environments. 6. To introduce anomaly detection and machine learning techniques for modern intrusion detection systems.
Course Outcomes	:	After successful completion of this course, students will be able to:

CO1. Explain the concepts, objectives, and requirements of intrusion detection and prevention systems.
CO2. Identify and analyze different types of network and host-based intrusions and attacks.
CO3. Describe the architecture and working of NIDS, HIDS, and IPS.
CO4. Configure and use open-source IDS/IPS tools for intrusion detection and prevention.
CO5. Apply anomaly detection and basic machine learning techniques for intrusion detection.
CO6. Evaluate the effectiveness and performance of IDS/IPS solutions in practical scenarios.

Topics Covered

UNIT I: **9L**

Introduction to Intrusion Detection and Prevention Systems
Overview of Intrusion Detection and Prevention Systems, need for IDS and IPS, types of intrusions, goals and requirements of intrusion detection and prevention systems, IDS architecture and components, classification of IDS, deployment strategies, challenges in intrusion detection, and differences between IDS and IPS.

UNIT II: **9L**

Network and Host-Based Intrusion Detection Systems
Network security fundamentals, network security basics, OSI reference model, TCP/IP protocol suite, common network security threats, Network-Based IDS (NIDS), NIDS architecture and detection techniques, Snort as an open-source NIDS, Snort rules and alert generation, Host-Based IDS (HIDS), HIDS architecture and detection techniques, OSSEC as an open-source HIDS, OSSEC rules, anomaly detection concepts, anomaly detection and classification, and introduction to machine learning techniques for anomaly detection

UNIT III: **9L**

Intrusion Prevention Systems
Introduction to intrusion prevention systems, IPS architecture and mechanisms, inline and passive

IPS, signature-based IPS, behavior-based IPS, protocol analysis, deployment strategies, performance issues, limitations, and real-world IPS use cases.

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UNIT IV: **9L**

Anomaly Detection and Machine Learning Techniques
Anomaly detection concepts, statistical anomaly detection methods, supervised and unsupervised machine learning techniques for intrusion detection, feature selection and data preprocessing, intrusion detection datasets (KDD, NSL-KDD), performance evaluation metrics, and emerging trends in intrusion detection and prevention systems.

LIST OF EXPERIMENTS

1. Study the concepts, components, architecture, and deployment models of IDS and IPS using simulation and case studies.
2. Capture live network traffic and analyze packets to identify normal and suspicious behavior using Wireshark.
3. Install and configure Snort as a Network-Based Intrusion Detection System (NIDS) on a Linux platform.
4. Write custom Snort rules and generate alerts for common network attacks such as port scanning and DoS attacks.
5. Perform detection of attacks such as TCP SYN flood, ICMP flood, and port scanning using Snort and analyze alert logs.
6. Install and configure OSSEC as a Host-Based Intrusion Detection System (HIDS) and study its architecture.
7. Analyze system and application logs to detect suspicious activities using OSSEC rule sets.
8. Perform a comparative study of NIDS and HIDS in terms of detection capability, performance, and deployment.
9. Study IPS concepts and configure basic IPS features using Snort in inline mode or Suricata.
10. Analyze TCP, UDP, and ICMP protocols to identify malicious patterns using Wireshark.
11. Implement statistical techniques such as mean, variance, and threshold-based detection for anomaly identification.
12. Implement supervised learning algorithms (Decision Tree, SVM, Naïve Bayes) using Python and Scikit-learn on IDS datasets.
13. Apply unsupervised learning techniques such as K-Means and Isolation Forest for anomaly detection.
14. Perform data cleaning, normalization, and feature selection on KDD / NSL-KDD datasets using Python.
15. Evaluate IDS/IPS performance using metrics such as accuracy, precision, recall, F1-score, and ROC curves.

TEXTBOOKS

1. Ali A. Ghorbani and Wei Lu, Network Intrusion Detection and Prevention: Concepts and Techniques, Springer, 2010.
2. Carl Endorf, Eugene Schultz, and Jim Mellander, Intrusion Detection and Prevention, McGraw-Hill, 2004.

REFERENCE BOOKS

1. Paul E. Proctor, The Practical Intrusion Detection Handbook, Prentice Hall, 2001.
2. Ankit Fadia and Manu Zacharia, Intrusion Alert, Vikas Publishing House Pvt. Ltd., 2007.
3. Earl Carter and Jonathan Hogue, Intrusion Prevention Fundamentals, Pearson Education, 2006.
4. Rafeeq Ur Rehman, Intrusion Detection Systems with Snort, Prentice Hall Professional, 2003.

ECS-602	:	GENERATIVE AI
Course category	:	PE6
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through assignments, quizzes, tutorials, and one minor test and one major examination.
Course Objectives	:	1. To provide foundational understanding of generative artificial intelligence concepts and models. 2. To familiarize learners with probabilistic, neural, and deep generative modeling techniques. 3. To introduce modern generative architectures such as GANs, VAEs, diffusion models, and large language models. 4. To develop practical skills for designing, training, evaluating, and ethically deploying generative AI systems.
Course Outcomes	:	After successful completion of this course, students will be able to:

CO1. Understand the fundamental concepts of generative AI including probabilistic modeling, latent variable models, and representation learning.
CO2. Apply generative models such as Autoencoders, Variational Autoencoders, and Generative Adversarial Networks for data generation tasks.
CO3. Analyze text, image, and multimodal generation techniques using transformer-based architectures and large language models.
CO4. Evaluate generative models using qualitative and quantitative metrics such as likelihood, FID, BLEU, and ROUGE scores.
CO5. Create generative AI applications for text generation, image synthesis, data augmentation, and content creation.
CO6. Design responsible, ethical, and legally compliant generative AI systems addressing bias, privacy, copyright, and societal impact.

Topics Covered

UNIT-I **9L**

Introduction to Generative AI: Overview of Generative vs Discriminative Models, Probability Theory Basics, Random Variables and Distributions, Maximum Likelihood Estimation, Latent Variable Models, Introduction to Representation Learning, Autoencoders-Architecture, Encoder-

Decoder Framework, Reconstruction Loss, Applications of Generative Models.

UNIT-II **9L**

Variational Autoencoders & GANs: Variational Autoencoders (VAE)-Evidence Lower Bound (ELBO), Reparameterization Trick, Conditional VAE, Introduction to Generative Adversarial Networks (GANs), Generator and Discriminator, Minimax Game, Training Challenges-Mode Collapse, Vanishing Gradients, GAN Variants-DCGAN, Conditional GAN, WGAN, Applications in Image and Data Synthesis.

UNIT-III **9L**

Transformers & Large Language Models: Attention Mechanism, Self-Attention and Multi-Head Attention, Transformer Architecture, Positional Encoding, Pre-training and Fine-tuning Paradigms, Large Language Models (LLMs)-GPT, BERT (Overview), Prompt Engineering Basics, Text Generation, Summarization, Question Answering, Multimodal Generative Models (Overview).

UNIT-IV **9L**

Diffusion Models & Responsible AI: Introduction to Diffusion and Score-Based Models, Denoising Diffusion Probabilistic Models (DDPM), Image and Audio Generation using Diffusion Models, Evaluation Metrics for Generative Models, Ethical and Societal Implications of Generative AI-Bias, Hallucinations, Deepfakes, Copyright Issues, AI Governance, Responsible and Trustworthy Generative AI.

List of Experiments:

1. Write a Python program to explore basic concepts of generative AI using simple data generation and visualization techniques.
2. Develop a Python program to implement a basic autoencoder for data reconstruction using a small dataset.
3. Create and train a simple Variational Autoencoder (VAE) and visualize the latent space using 2-D plots.
4. Write a Python program to generate images using a basic Generative Adversarial Network (GAN) on a standard dataset such as MNIST.
5. Develop a program to experiment with Conditional GAN for generating class-specific images.
6. Implement a simple transformer-based text generation model using a pre-trained library and generate short text samples.
7. Write a Python program to perform text generation and summarization using a pre-trained Large Language Model through prompt-based interaction.
8. Develop a Python program to generate images using a pre-trained diffusion model and observe the generation steps.
9. Implement basic evaluation of generative models using simple metrics such as loss curves, sample quality comparison, and basic text similarity scores.
10. Design a small generative AI application (text or image generation) and discuss ethical considerations such as bias, misuse, and content safety.

TEXTBOOKS

1 Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press.
2 David Foster, Generative Deep Learning, O'Reilly Media.

3 Charu C. Aggarwal, Neural Networks and Deep Learning, Springer.
4 Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer.
Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, Foundations of Machine Learning, MIT Press.

REFERENCE BOOKS

1. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow, O'Reilly.
2. Nikhil Buduma & Nicholas Locascio, Fundamentals of Deep Learning, O'Reilly.
3. Lilian Weng, Generative Modeling Tutorials, OpenAI Research Blog (Selected Readings).
4. Stanford CS25 & CS236 Lecture Notes – Generative Models.
5. Research Papers from arXiv, NeurIPS, ICML, and CVPR on Generative AI.

ECS-603	:	Data Science for Predictive Maintenance
Course category	:	PE6
Pre-requisite Subject	:	Data Science Tools and Techniques
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.
Course Objectives	:	1. To introduce core machine learning concepts and algorithms. 2. To train students in supervised and unsupervised learning techniques. 3. To apply Python-based ML libraries for model development and evaluation.
Course Outcomes	:	After successful completion of this course, students will be able to:

CO1. Understand the mathematical foundations of machine learning.
CO2. Apply supervised and unsupervised algorithms to real-world problems.
CO3. Evaluate model performance using appropriate metrics.
CO4. Use Scikit-learn for model implementation and tuning.
CO5. Evaluate and validate predictive maintenance models using performance metrics and model optimization techniques.
CO6. Develop data-driven maintenance strategies and communicate insights effectively for decision-making in industrial and engineering environments.

Topics Covered

UNIT-I **9L**

Introduction to Machine Learning

Machine Learning Paradigms: Supervised, Unsupervised, Reinforcement Learning. ML Process: Data → Features → Model → Evaluation. Key Concepts: Training, testing, overfitting, underfitting, bias-variance tradeoff. Overview of ML libraries: Scikit-learn, TensorFlow (intro), Keras.

UNIT-II **9L**

Supervised Learning

Regression Techniques: Linear, Polynomial, Ridge, Lasso. Classification Algorithms: Logistic Regression, KNN, Decision Tree, Random Forest, SVM. Evaluation Metrics: Accuracy, Precision, Recall, F1-Score, ROC Curve.

UNIT-III **9L**

Unsupervised Learning

Clustering: K-Means, Hierarchical Clustering, DBSCAN. Dimensionality Reduction: PCA, t-SNE. Association Rule Learning: Apriori, FP-Growth (overview).

UNIT-IV **9L**

Model Tuning and Applications

Model Optimization: Cross-validation, Grid Search, Random Search. Ensemble Methods: Bagging, Boosting, Stacking. Real-world Applications: Text classification, image categorization, and predictive analytics.

TEXT BOOKS

1. Joel Grus, *Data Science from Scratch*.
2. Tom White, *Hadoop: The Definitive Guide*.
3. Wes McKinney, *Python for Data Analysis*.

REFERENCE BOOKS:

1. Pattern Recognition and Machine Learning Christopher M. Bishop, Springer. *(Comprehensive mathematical foundation of machine learning concepts.)*
2. The Elements of Statistical Learning Trevor Hastie, Robert Tibshirani, Jerome Friedman, Springer. *(Advanced treatment of regression, classification, and ensemble methods.)*
3. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow Aurélien Géron, O'Reilly Media. *(Practical implementation of ML models using Python libraries.)*

ECS-604	:	Security, Privacy, and Legal Aspects in Blockchain
Course category	:	PE6
Pre-requisite Subject	:	Data Science Tools and Techniques
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.
Course Objectives	:	1. To understand blockchain architecture and its security foundations 2. To analyze vulnerabilities, threats, and attack vectors in blockchain systems. 3. To study cryptographic techniques ensuring privacy and data integrity.

		4. To explore privacy-preserving mechanisms and regulatory compliance. 5. To study ethical and legal aspect of the Blockchain.
Course Outcomes	:	After successful completion of this course, students will be able to:

CO1. Explain the security model and consensus mechanisms of blockchain.
CO2. Identify and evaluate various blockchain attack types and defences.
CO3. Apply cryptographic and privacy-preserving techniques in blockchain applications.
CO4. Analyse real-world blockchain security incidents.
CO5. Analyse legal and ethical issues in Blockchain and able to assess the future of the Blockchain.
CO6. Evaluate emerging security threats and future trends in blockchain systems and propose mitigation strategies aligned with legal and ethical frameworks.

Topics Covered

UNIT I **9L**

Introduction to Blockchain Security: Basics of blockchain technology and architecture. Public, private, and consortium blockchains. Security goals: confidentiality, integrity, availability, and immutability. Trust model and decentralization. Blockchain vs. traditional databases in terms of security.

UNIT **9L**

Cryptography in Blockchain: Hash functions, Merkle trees, and digital signatures. Public key infrastructure (PKI) in blockchain. Elliptic Curve Cryptography (ECC) and ECDSA. Key management and wallet security. Smart contract authentication and access control

UNIT III **9L**

Consensus and Security: Consensus algorithms: PoW, PoS, PBFT, and DPoS, Security analysis of consensus protocols, Double-spending attacks and Sybil attacks, Forks, selfish minig, and chain reorganization. Mitigation and detection mechanisms, Privacy Issues and Solutions: Privacy challenges in public blockchains, Pseudonymity vs. anonymity. Privacy-enhancing techniques: Zero-Knowledge Proofs (ZKP), Ring signatures, Homomorphic encryption, Mixers and tumblers (e.g., Tornado Cash), Privacy-focused blockchains: Monero, Zcash, and MimbleWimble

UNIT IV **9L**

Legal, Ethical, and Future Security Trends: Blockchain governance and compliance challenges. Data privacy laws (GDPR, Indian DPDP Act) and immutable ledgers, Ethical concerns: anonymity misuse, illicit transactions, Blockchain interoperability and cross-chain security, Post-quantum cryptography and confidential computing in blockchain, Security frameworks and best practices for blockchain applications.

Textbooks

1. Antonopoulos, A. M., & Wood, G. (2018). *Mastering Ethereum: Building smart contracts*

and DApps. O'Reilly Media.
2. Antonopoulos, A. M. (2017). *Mastering Bitcoin: Programming the open blockchain* (2nd ed.). O'Reilly Media.
3. Drescher, D. (2017). *Blockchain basics: A non-technical introduction in 25 steps*. Apress.
4. Narayanan, A., Bonneau, J., Felten, E., Miller, A., & Goldfeder, S. (2016). *Bitcoin and cryptocurrency technologies: A comprehensive introduction*. Princeton University Press.

References books

1. Bonneau, J., Miller, A., Clark, J., Narayanan, A., Kroll, J. A., & Felten, E. W. (2015). SoK: Research perspectives and challenges for Bitcoin and cryptocurrencies. *IEEE Symposium on Security and Privacy*, 104–121. https://doi.org/10.1109/SP.2015.14
2. Crosby, M., Nachiappan, Pattanayak, P., Verma, S., & Kalyanaraman, V. (2016). Blockchain technology: Beyond Bitcoin. *Applied Innovation Review, 2*, 6–19.
3. Bashir, I. (2023). *Mastering blockchain* (4th ed.). Packt Publishing.
4. Tapscott, D., & Tapscott, A. (2016). *Blockchain revolution: How the technology behind Bitcoin is changing money, business, and the world*. Portfolio.
5. Zohar, A. (2015). Bitcoin: Under the hood. *Communications of the ACM, 58*(9), 104–113. https://doi.org/10.1145/2701411
6. European Union. (2016). *General Data Protection Regulation (GDPR)* (Regulation (EU) 2016/679). Official Journal of the European Union.
7. Government of India. (2023). *Digital Personal Data Protection Act, 2023*. Ministry of Law and Justice, Government of India.

SKILL-BASED COURSES TO QUALIFY FOR B. Voc. (Engg.).

BCS-310		**Artificial Intelligence in Modern Healthcare Systems**
Course category	:	PE
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 2, Tutorial:0, Practical: 2
Number of Credits	:	3
Course Assessment methods	:	Continuous assessment through assignments, quizzes, case studies, lab work, one minor tests, and one major theory examination.
Course Objectives	:	This course introduces Artificial Intelligence techniques and their applications in modern healthcare systems. It emphasizes medical data analytics, diagnostic AI models, clinical decision support, predictive healthcare, telemedicine, and ethical AI practices while maintaining industry and research relevance.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.
1. Explain the role of Artificial Intelligence and Machine Learning in modern healthcare systems.		

2. Analyze healthcare datasets including physiological signals, medical imaging, and electronic health records.
3. Apply AI/ML algorithms for disease prediction, diagnosis, and clinical decision support.
4. Design AI-driven solutions for telemedicine, remote patient monitoring, and smart healthcare systems.
5. Evaluate data security, privacy, ethical, and regulatory challenges in AI-based healthcare systems.
6. Assess emerging AI technologies such as deep learning, explainable AI, and federated learning in healthcare applications.

Topics Covered

UNIT-I	9
Introduction to Artificial Intelligence in healthcare, digital health ecosystem, and smart healthcare architecture. Types of healthcare data including Electronic Health Records (EHR), medical imaging, physiological signals, and genomics data. Overview of Machine Learning approaches such as supervised, unsupervised, and reinforcement learning. Data preprocessing, feature engineering, model evaluation techniques, and challenges in healthcare datasets including imbalance, bias, and regulatory considerations.	

UNIT-II	9
AI techniques for disease prediction and medical diagnosis. Machine Learning models for chronic disease prediction. Deep learning and Convolutional Neural Networks (CNNs) for medical image analysis. Natural Language Processing (NLP) for clinical text analytics. Clinical Decision Support Systems (CDSS) and predictive healthcare analytics. Introduction to Explainable AI (XAI) in medical applications.	
UNIT-III	9
IoT-enabled healthcare systems and wearable devices for vital sign monitoring. Remote Patient Monitoring (RPM) and telemedicine platforms. AI-based analysis of physiological signals such as ECG and EEG. Emergency healthcare analytics and real-time monitoring. Federated learning and edge AI applications in distributed healthcare systems.	
UNIT-IV	9
Healthcare data privacy and cybersecurity concepts including regulatory frameworks. Ethical challenges in AI such as bias, fairness, and accountability. Security in medical information systems. Emerging trends including AI in robotic surgery, precision medicine, drug discovery, digital twins, and generative AI applications in healthcare**.**	

Experiments

1. Preprocessing and visualization of healthcare datasets.
2. Disease prediction using classification algorithms (Logistic Regression, SVM, Random Forest).
3. Implementation of CNN for medical image classification.
4. Analysis of physiological signal datasets (ECG/EEG).
5. NLP-based analysis of clinical text data.
6. Design of a simple Clinical Decision Support System.
7. Implementation of anomaly detection in healthcare data.
8. Study of explainable AI techniques (SHAP/LIME concept).
9. Development of a basic remote patient monitoring dashboard.
10. Case study analysis of AI in real-world healthcare systems.

Books & References
1. Intorne, A. C., et al. *Intelligent Healthcare Systems*. Ed. Vania Vieira Estrela. Boca Raton, FL, USA: CRC Press, 2023. 2. Topol, Eric, Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again, Basic Books, 2019. 3. Reddy, C.K., Aggarwal, C.C. Healthcare Data Analytics, CRC Press. 4. Holzinger, A., et al., Explainable AI: Interpreting, Explaining and Visualizing Deep Learning, Springer, 2019.

BCS-311		**Secure DevOps**
Course category	:	PE
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 2, Tutorial:0, Practical: 2
Number of Credits	:	3
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, one minor tests, and one major theory exam.
Course Objectives	:	This course introduces Secure DevOps (DevSecOps) methodologies with emphasis on secure software development, CI/CD automation, infrastructure as code, container security, cloud security, and continuous monitoring. The course focuses on integrating security practices throughout the software development lifecycle to build scalable, resilient, and secure systems.
Course Outcomes	:	After completing this course, students will be able to:
1. Explain Secure DevOps principles, lifecycle, and workflow integration. 2. Describe Secure Software Development Lifecycle (SSDLC) and common software vulnerabilities. 3. Apply security practices and automation techniques within CI/CD pipelines. 4. Analyze security challenges associated with containerization, infrastructure as code, and cloud environments. 5. Design secure DevOps workflows incorporating monitoring, compliance, and governance. 6. Evaluate DevSecOps implementations with respect to security effectiveness, scalability, and operational efficiency.		
Topics Covered		
UNIT-I		9
Introduction to Secure DevOps Practices: Evolution and principles of DevOps culture. DevOps lifecycle, workflows, and Agile integration. Introduction to DevSecOps and the concept of shift-left security. Continuous Integration (CI), Continuous Delivery (CD), and Continuous Deployment concepts. Overview of CI/CD tools and automation platforms. DevOps metrics and performance indicators. Industrial use cases and practical workflow examples.		
UNIT-II		9
Concept and phases of Secure Software Development Lifecycle (SSDLC). Security integration in		

requirements, design, coding, testing, deployment, and maintenance. Threat modeling and risk assessment basics. Secure coding practices and common vulnerabilities (e.g., injection, XSS, misconfiguration). Static Application Security Testing (SAST) and Dynamic Application Security Testing (DAST). Case studies of real-world software breaches.	
UNIT-III	9
Introduction to containerization and virtualization. Basic concepts of Docker and container lifecycle. Overview of container orchestration and Kubernetes concepts. Security challenges in containerized applications. Introduction to Infrastructure as Code (IaC): concepts and benefits. Basic understanding of configuration management tools. Cloud computing fundamentals and shared responsibility model.	
UNIT-IV	9
Role of automation in DevSecOps. Overview of automated security testing in CI/CD pipelines. Basics of dependency and vulnerability scanning. Continuous monitoring and logging concepts. Security incident detection and response fundamentals. DevSecOps practices for microservices-based systems. Introduction to compliance, auditing, and security governance. Emerging trends in secure DevOps practices. Case studies highlighting DevSecOps implementation in industry.	

EXPERIMENTS:

1. Setup of DevOps and DevSecOps tools environment.
2. Version control management using Git.
3. CI pipeline configuration for a sample application.
4. Automated build and testing execution.
5. Static code analysis using security scanning tools.
6. Vulnerability scanning of web applications.
7. Containerization using Docker.
8. Secure container configuration and deployment.
9. Infrastructure provisioning using basic IaC scripts.
10. Cloud security configuration and IAM setup.
11. Application logging and monitoring setup.
12. Security incident simulation and analysis. Integrating security checks in CI/CD pipeline.
13. Mini project: Secure DevOps workflow for a small application.

Textbooks & Reference Books

1. Eugene K. Smith, DevOps and Continuous Delivery: Concepts and Practices, Wiley
2. John Willis, The DevOps Handbook, IT Revolution Press
3. Practical DevSecOps: Deliver Secure Software Faster, Packt Publishing
4. Gene Kim, Jez Humble, Patrick Debois, John Willis, The Phoenix Project, IT Revolution Press
5. Official documentation of Docker, Kubernetes, Terraform, Jenkins, GitHub Actions, OWASP ZAP

4th Year 7th Semester Syllabus

BCS-441	:	Minor Project – II
Course Category	:	Minor Project – I (BCS-371)
Pre-requisites	:	NIL
Contact Hours / Week	:	Lecture: 0, Tutorial: 0, Practical: 12
Number of Credits	:	6
Course Assessment Methods	:	Continuous assessment through one viva voce / presentation, final project report, evaluation of development of hardware-based or software-based simulation module, and contribution made to the literary world through one viva voce / presentation at the Institute.
Course Outcome	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course CO1. Ability to learn, design & analysis of computer engineering modules. CO2. Development of software-based simulation module. CO3. Innovative tool-based research work in computer engineering. CO4. Communicate with engineers and the community at large in written an oral form. CO5. Design engineering solutions to complex problems utilising a AI approach. CO6. Exhibit professional ethics, innovation, and effective communication skills while presenting project outcomes to technical and non-technical audiences.

ECS-703	:	Statistical Learning for Reliability Analysis
Course category	:	PE7
Pre-requisites	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through assignments, quizzes, tutorials, one minor test and one major examination.

Course Objectives	:	1. To introduce the fundamental concepts of reliability engineering and statistical learning, and their role in reliability estimation and prediction. 2. To develop an understanding of probability distributions and sampling distribution techniques for modeling and analysing reliability data. 3. To enable students to apply parametric statistical inference methods, including hypothesis testing and confidence interval estimation, in reliability analysis. 4. To provide knowledge of supervised and unsupervised machine learning algorithms for reliability prediction and data-driven analysis. 5. To equip students with the ability to perform feature selection, dimensionality reduction, and model evaluation techniques for reliability-based decision-making
Course Outcomes	:	CO1. Understand the fundamentals of reliability analysis and apply probability distributions in reliability estimation. CO2. Apply sampling distribution techniques for reliability prediction and perform parametric statistical inference. CO3. Use hypothesis testing and confidence intervals for reliability analysis using parametric methods. CO4. Analyse the underlying relationships within and across Machine Learning algorithms and the paradigms of supervised and un-supervised learning. CO5. Plan and execute successful machine learning and big data projects, including selecting an adequate process for the specific task and avoiding the machine learning pit falls. CO6. Evaluate the issues raised by current research in the field of machine learning

TOPIC COVERED	:	**UNIT-I** 9L Introduction to reliability, reliability estimation, concept of statistical learning, advanced techniques to reliability analysis. Probability distribution techniques: discrete and continuous probability distributions and their applications to reliability estimation modeling. **UNIT-II** 9L Sampling distribution techniques and their different applications for reliability prediction., Statistical inference technique-I (Parametric-based approaches: Hypothesis testing, Confidence interval estimation). Case studies for reliability analysis with parametric-based approaches. **UNIT-III** 9L What is Machine Learning, Introduction to ML's three approaches: Supervised, Unsupervised and Reinforcement Learning.Linear Regression, Logistic Regression, Decision Trees, Random Forest, Support Vector Machine, K-Nearest Neighbours, CN2 Algorithm, Naive Bayes **UNIT-IV** 9L K-means, Silhoutte Scores, Hierarchical Clustering, Fuzzy c-means, DBScan, Low Variance Filter, High Correlation Filter, Backward Feature Elimination,Forward Feature Selection, Principal Component Analysis, Projection Methods.
Books and References	:	1. An Introduction to Statistical Learning: with Applications in R, G James, D. Witten, T Hastie, and R. Tibshirani, (Springer) 2. Software for Data Analysis: Programming with R (Statistics and Computing), John M. Chambers (Springer) 3. Advances in Complex Data Modeling and Computational Methods in Statistics, Anna Maria Paganoni and Piercesare Secchi, (Springer) 4. Machine Learning For Dummies, John Paul Mueller and Luca Massaron 5. A Course in Machine Learning, Hal Daumé III. 6. Programming Collective Intelligence: Building Smart Web 2.0 Applications, Toby Segaran

ECS-704	:	Natural Language Processing
Course category	:	PE7
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through assignments, quizzes, tutorials, one minor test and one major examination.
Course Objectives	:	By the end of this course, students will: 1. Understand fundamental concepts and techniques in Natural Language Processing. 2. Develop the ability to analyze and model linguistic data computationally and experience using NLP tools and libraries (e.g., NLTK, spaCy). 3. Apply NLP methods to solve real-world text processing problems.
Course Outcomes	:	CO1. Understand fundamental concepts and techniques in Natural Language Processing. CO2. Apply parsing techniques and sequential tagging models. CO3. Implement text classification and sequence labeling models. CO4. Use word embeddings and lexical semantics for meaning representation. CO5. Develop systems for machine translation and question answering. CO6. Apply NLP techniques while addressing ethical considerations.
TOPIC COVERED	:	
Unit-I: Introduction and Core Concepts		**9L**
Overview of NLP and its applications, Text Pre-processing: Tokenization, Stemming, Lemmatization, Stop-word Removal, Regular Expressions: Basic syntax and semantics, Spelling Correction, Language Modeling: Basics and advanced smoothing techniques, Part-of-Speech (POS) Tagging		
Unit-II: Syntax and Parsing		**9L**
Context-Free Grammar (CFG), Constituency Parsing and Dependency Parsing, Syntax-Driven Translation, Sequential Tagging Models, Text Classification		
Unit-III: Semantics and Word Representations		**9L**
Word Sense Disambiguation, Word Embeddings: Word2Vec, GloVe, fastText, Language Modeling: N-grams, Perplexity, Distributional and Lexical Semantics, Topic Modeling		
Unit-IV: Advanced Applications and Ethics		**9L**
Named Entity Recognition (NER), Machine Translation: Seq2Seq Overview, Question Answering, Text Summarization, Sentiment Analysis and Opinion Mining, Information Extraction, Ethical Considerations in NLP		
Textbooks	:	1. Jurafsky, D., & Martin, J. (2009). Speech and Language Processing (2nd ed.). Prentice Hall. 2. Manning, C., & Schütze, H. (1999). Foundations of Statistical Natural Language Processing. MIT Press.

Reference Books	:	1. Natural Language Processing with Python, Steven Bird, Ewan Klein & Edward Loper, O'Reilly Media. 2. Speech and Language Processing, Daniel Jurafsky & James H. Martin.
List of practical	:	1. Implement tokenization, stemming, lemmatization, and stop-word removal on a text dataset (e.g., news articles) using Python, NLTK, and spaCy. Output cleaned tokens, stems, and lemmas. 2. Use Python's re module to extract patterns like emails, phone numbers, and URLs from a text corpus. Test on a sample dataset. 3. Build a POS tagger using NLTK or spaCy to label words in sentences from a dataset (e.g., Brown Corpus). Compare results with ground truth tags. 4. Train a classifier for sentiment analysis (positive/negative) on a dataset (e.g., IMDB reviews) using scikit-learn or PyTorch/Keras. 5. Generate word embeddings using Word2Vec (Gensim) on a text corpus and visualize similarities with t-SNE or PCA. 6. Implement NER using spaCy or Hugging Face Transformers to identify entities (e.g., person, organization) in a news dataset. 7. Build an extractive or abstractive summarization model using Hugging Face Transformers (e.g., BERT) on a dataset like CNN/Daily Mail. 8. Fine-tune a pretrained transformer (e.g., BERT) for sentiment analysis on a dataset like Twitter sentiments using PyTorch/Keras or TensorFlow.

ECS-705	:	Introduction to Security of Cyber-Physical Systems
Course category	:	PE7
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through assignments, quizzes, tutorials, one minor test and one major examination.

Course Objectives	:	1. Provide foundational knowledge of security and privacy principles in information systems, including applied cryptography, intrusion detection, authentication, and integrity mechanisms. 2. Develop understanding of security challenges in emerging technologies such as Internet of Things (IoT), Software-Defined Networks (SDN), and Cyber-Physical Systems (CPS). 3. Familiarize students with cryptographic techniques including hash functions, encryption algorithms, digital signatures (Diffie–Hellman, RSA), and their practical applications. 4. Analyze security and privacy issues in real-world IoT environments such as smart homes, smart grids, vehicles, wearable systems, and mobile healthcare. 5. Equip learners with the ability to evaluate and design secure architectures for CPS, considering deployment challenges, privacy risks, and intelligent system integration.
Course Outcomes	:	CO1. To apply basics of security and issues related to it. CO2. To use biometric techniques available and how they are used in today's world. CO3. To investigate Security issues in web and how to tackle them. CO4. To Learn mechanisms for transport and network security CO5. Understand abstraction in system designs CO6. Express pre- and post-conditions and invariants for CPS models
TOPIC COVERED	:	
UNIT-I		**9L**
Overview of Security and Privacy in Information System, Applied Cryptography & Intrusion Detection, Architecture of Applied Cryptography, One Way Hash Function and Integrity, Encryption Algorithms and Confidentiality, Digital Signature and Authentication (DH, RSA, 2 class), Intrusion Detection and Information Theory.		
UNIT-II		**9L**
Internet of Things Security, Security and Privacy for IoT Case Study: Smart Home, Smart Grid Network, Modern Vehicle, Wearable Computing & BYOD, Mobile HealthCare.		
UNIT-III		**9L**
Software-Defined Networks, Introduction of Software-Defined Networks, Security for Software-Defined Networks, Privacy Leakages for Software-Defined Networks, Case Studies: How to Attack Software-Defined Networks.		
UNIT-IV		**9L**
Cyber-Physical Systems (CPS), CPS - Platform components, CPS implementation issues, Intelligent CPS, Secure Deployment of CPS.		
TEXTBOOKS	:	1. Cyber Security, Nina Godbole, John Wiley & Sons. 2. Li Da Xu, Shancang Li, "Securing the Internet of Things", Syngress. 3. Alasdair Gilchrist, "IoT Security Issues", De Gruyter

REFERENCE BOOKS	:	1. Sean Smith, "The Internet of Risky Things", Sean Smith, Shroff Publisher/O'Reilly Publisher

ECS-706	:	Scientific and Engineering Data Visualization
Course category	:	PE7
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through assignments, quizzes, tutorials, one minor test and one major examination.
Course Outcomes	:	After completion of course, students would be able: CO1. Explain the fundamental concepts of scientific and engineering visualization and the complete visualization pipeline. CO2. Identify and classify different types of data used in visualization, including scalar, vector, tensor, and volumetric data. CO3. Apply visualization techniques to represent scalar fields in one-, two-, and three-dimensional domains. CO4. Apply advanced visualization methods for vector, flow, and tensor data using techniques such as streamlines, particle tracing, and tensor glyphs. CO5. Design and evaluate visualization systems for analyzing large-scale and complex engineering datasets. CO6. Use modern engineering visualization tools and technologies, including pre-processors, solvers, post-processors, and volume rendering systems.
TOPIC COVERED	:	

UNIT-I **9L**

Visualization - Scientific and engineering perspective - Impact of Visualization in product design, an overview of computer graphics for visualization –Types of data for visualization, Introduction to tensors. role of pre-processor, solver and post processor in solving engineering problems. Overview of massive data visualization: Simplification methods, Multi-resolution methods, External memory methods, Visual scalability. Scalar visualization techniques:

UNIT-II **9L**

Visualization Goals, Representation of mesh and results data, mapping analysis results to Visualizations, one dimensional, two dimensional and 3D Scalar fields - Element face color coding - contour display -Isosurface techniques - Marching Cubes algorithm - Particle sampling.Visualization of flow data: Visualization mappings of flow data.

UNIT-III **9L**

Vector mapping - elementary icons - particle traces – streaklines, streamlines – streamribbons and streamtubes - global icons - Tensor mappings - elementary icons - global icons. Continuum volume display: Volume rendering Terminology, Surface and Volume rendering techniques, Optimization.		
UNIT-IV		**9L**
Applications of engineering visualization: Case studies created in the laboratory. FUTURE TRENDS: Trends in Computing Hardware, Animation, Video and multi-media, software trends in Visualization.		
Textbook	:	1. Schroeder, W., Martin, K., & Lorensen, B. (n.d.). The visualization toolkit: An object-oriented approach to 3D graphics. Kitware Inc.
Reference Books	:	1. Hansen, C. D., & Johnson, C. R. (Eds.). (n.d.). The visualization handbook. Elsevier Academic Press. 2. Post, F. H., Vrolijk, B., Hauser, H., Laramee, R. S., & Doleisch, H. (n.d.). The state of the art in flow visualization. Springer. 3. Engel, K., Hadwiger, M., Kniss, J., Rezk-Salama, C., & Weiskopf, D. (n.d.). Real-time volume graphics. A K Peters/CRC Press. 4. Ware, C. (n.d.). Information visualization: Perception for design. Morgan Kaufmann. 5. McCormick, B., DeFanti, T., & Brown, M. (n.d.). Visualization in scientific computing. ACM SIGGRAPH.

ECS-707	:	Introduction to Solidity Language
Course category	:	PE7
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through assignments, quizzes, practical work, record, viva voce, one minor test and one major examination.

Course Objectives	:	1. Understand the fundamentals of blockchain programming and Solidity, including compiler versions, pragmas, data types, variables, mappings, arrays, and built-in cryptographic functions for developing secure smart contracts. 2. Develop the ability to design and implement smart contract logic using user-defined functions, control structures, valid expressions, exception handling mechanisms, and event logging. 3. Apply object-oriented programming principles in Solidity such as constructors, modifiers, fallback functions, inheritance, multiple inheritance, abstract contracts, and interfaces to build modular and reusable smart contracts 4. Implement advanced smart contract features including interface implementation and function overloading, and integrate smart contracts with front-end web technologies and decentralized storage systems like IPFS. 5. Design and deploy decentralized applications (DApps) by combining smart contracts, Web3 libraries, and decentralized data storage solutions.
Course Outcome	:	CO1. Understand compiler versions, pragmas, and fundamental in Solidity. CO2. Develop user-defined functions with control structures. CO3. Use exception handling, and event logging. CO4. Apply object-oriented principles in Solidity. CO5. Implement abstract contracts, interfaces, and function overloading. CO6. Integrate smart contracts with front-end libraries.
TOPIC COVERED	:	
UNIT-I		**9L**
Understanding the different compiler versions and pragmas Authoring smart contracts o Contraindications- Basic data types- Local and State Variables Global Variables and Functions Predefined Global Variables Struts and Enums o Mapping and Arrays Build-in Functions (e.g., addmod, keccak256)		
UNIT-II		**9L**
User Functions Expressions and Control Structures Valid expressions of the language Exception Handling (e.g., assert, require, revert, throw) Events and Logging Conditional logic Implementation of loops		
UNIT-III		**9L**
Object Oriented Constructs Contract constructor and self-destruct Function Modifiers and Fallback functions Calling other contracts o Inheritance and Multiple Inheritance Declaring Abstract Classes and Interfaces		
UNIT-IV		**9L**
Implementation of Abstract interfaces Function Overloading Experimenting with Front-end Libraries Intro to front-end web interfaces Decentralized Data Storage		
Textbook	:	1. "Solidity Programming Essentials: A Beginner's Guide to Build Smart Contracts for Ethereum and Blockchain" By: Ritesh Modi

Reference Book	:	1. Beginning Solidity: Learn to program smart contracts with solidity: By ALEXANDROS DOLGOV, Wiley publications.
List of Experiments	:	1. Write and deploy a simple smart contract with basic data types. 2. Create a contract that uses structs and enums to store and manage user data. 3. Implement functions with control structures (if-else, loops). 4. Implement handle exceptions using require, assert, and revert. 5. Develop a smart contract with events and observe event logs in Remix or Ganache. 6. Build a contract demonstrating object-oriented concepts. 7. Create and deploy an abstract contract and an interface. 8. Overload functions in a smart contract and test calling different versions based on parameters.

ECS-708	:	Software Product Management
Course category	:	PE7
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through assignments, quizzes, tutorials, one minor test and one major examination.
COURSE OUTCOMES	:	After successful completion of the course, students will be able to: CO1. Explain the fundamentals of Software Product Management (SPM), its role in organizations, and the structure of product management frameworks. CO2. Analyze product strategy elements including positioning, product definition, business models, and value propositions to achieve product–market fit. CO3. Evaluate financial aspects of software products including costing, pricing, performance measurement, and risk management. CO4. Apply product release planning and product roadmapping techniques to manage software product evolution. CO5. Understand legal, ecosystem, and stakeholder considerations involved in managing software products. CO6. Analyze product life cycle management and relate development methodologies and strategic management practices to software product success.
TOPIC COVERED	:	

UNIT-I 9L		
Introduction and Foundations, and Software Product Management (SPM) Essentials: Introduction to the course, Software as a Business, SPM Role in organization structure and objectives Software Product Management Framework: Overview, Product Management Definitions, Product Family, Product Line, Product Platform, Structure of the SPM Framework and Startup SPM Framework		
UNIT-II 9L		
Product Strategy, and Product Strategy Essentials: Role and Elements of Product Strategy and Their Interdependencies, Positioning and Product Definition, Delivery Model, Service Strategy and Sourcing Business Models: Business Models and Business Case, Business Model Canvas, Business Archetypes Customer Segments and Value Propositions : Product Market Fit, Whole Product, Market Development Model		
UNIT-III 9L		
Financial Management Software Products: Costing and Pricing Performance and Risk Management AND Ecosystem Management: Performance and Risk Management, Role and Elements of Software Business Ecosystem Legal Aspects : Awareness of relevant legal frameworks, data privacy norms, Product Release Planning and Product Roadmapping: Release Planning Process and its conflicts, Structure of Release Plan Product Roadmap and its elements, Sources of input, Usage of Roadmaps		
UNIT-IV 9L		
Product Life Cycle Management: Phases of the Life Cycle, Performance Management Impact From Development Methodologies: Agile, Iterative, and Waterfall Development Methodologies Strategic Management: Strategic Management Essentials, Corporate Strategy and Portfolio Management, Innovation and Resource Management, Market and Product Analysis		
Textbooks	:	1. "Software Product Management" by HB Kittlaus and SA Fricker, ISBN: 978-3-642-55140-6
Reference Book	:	1. Ebert, C. (2009). Software product management: A practitioner's handbook. McGraw-Hill. 2. Pichler, R. (2010). Agile product management with Scrum: Creating products that customers love. Addison-Wesley. 3. Osterwalder, A., & Pigneur, Y. (2010). Business model generation. Wiley. 4. Blank, S., & Dorf, B. (2012). The startup owner's manual: The step-by-step guide for building a great company. K&S Ranch. 5. Moore, G. A. (2014). Crossing the chasm: Marketing and selling disruptive products to mainstream customers (3rd ed.). Harper Business. 6. Wheelwright, S. C., & Clark, K. B. (1992). Revolutionizing product development: Quantum leaps in speed, efficiency, and quality. Free Press.

ECS-709	:	Web Technology for Spatial Information Mapping
Course category	:	PE7
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through assignments, quizzes, tutorials, one minor test and one major examination.
Course Objectives	:	1. Introduce the fundamental concepts, evolution, and significance of web mapping and Internet GIS in comparison with traditional desktop GIS systems. 2. Provide understanding of web mapping architecture including client–server models, data formats, protocols, APIs, and Internet technologies. 3. Familiarize students with major Internet GIS software platforms such as ArcGIS Server, GeoServer, MapServer, and QGIS Server. 4. Develop skills to design and implement basic web-based GIS applications using web technologies (HTML, XML, Java) and database integration. 5. Enable application of web-based spatial tools for visualization and analysis of real-world spatio-temporal data in commercial and public utility domains.
Course Outcomes (COs)	:	CO1. Explain the evolution and significance of web mapping in comparison to traditional desktop GIS systems. CO2. Understand the architecture of web mapping applications including data formats, protocols, APIs, and the client-server model. CO3. Identify and compare different Internet GIS software platforms such as ArcGIS Server, GeoServer, MapServer, and QGIS Server. CO4. Design and develop basic web applications using HTML, XML, Java, and integrate spatial data with databases. CO5. Apply knowledge of web-based spatial tools to visualize and interpret spatio-temporal data effectively. CO6. Evaluate performance, usability, and security aspects of web-based spatial applications and deploy them for real-world mapping solutions.
Topics Covered	:	
Unit I		**9L**
Basics of Web Mapping and Computer networks: Evolution from desktop spatial information to web spatial information, applications and importance, web mapping architecture (client-server model), key concepts: data formats, protocols, and APIs, Principles of computer networks, hardware/software, client/server computing, protocols, topologies.		
Unit II		**9L**
History and concepts of Internet: Overview of Internet concepts & features: Internet protocol, Domain Name System, Internet services, World Wide Web, Web servers, Web clients, Internet spatial		

information: Application of Internet services to GIS, Internet GIS software, interoperability issues & OpenGIS. Geo-server: ArcGIS Server, GeoServer, MapServer, and QGIS server.		
Unit III		**9L**
Web application development: Web page design principles, HTML, XML, data formats, helper applications, Java, databases and the Web.		
Unit IV		**9L**
Application of Spatial Mapping in Real-world: Commercial utility apps such as public transports (Ola, Uber, Rapido, Chaloapp), Home delivery and (Zomato, Swiggy, Depto, Blinkit, bigBasket), public utility &spatio-temporal data visualization like WHO website, worldo-meter.		
Textbooks	:	1. Getting to Know WEB GIS by Pindefu, Fifth Edition, 2022, Esri press. 2. GeoServer Beginner's Guide,by Stefano Iacovella, Brian Youngblood, Shroff Publishers & Distributors Pvt Ltd. 3. Beginning MapServer: Open Source GIS Development, by by Bill Kropla, Apress.
Reference Books	:	1. An Introduction to R for Spatial Analysis and Mapping, by Chris Brunsdon, Lex Comber 2. Web Technologies: HTML, JAVASCRIPT, PHP, JAVA, JSP, ASP.NET, XML and Ajax, Black Book: HTML, Javascript, PHP, Java, Jsp, XML and Ajax, Black Book, by Kogent Learning Solutions Inc. 3. Advances in Web-based GIS Mapping Services and Applications, by Songnian Li, Suzana Dragicevic, Bert Veenendaal, CRC Press.

List of Experiments	:	1. Analyze a simple client-server web mapping setup.Use tools like Postman to send/receive map data requests (WMS, WFS) and map tile fetching & rendering on a web client. 2. Load and convert between various spatial data formats (GeoJSON, KML, Shapefile). 3. Experiment with OGC protocols like WMS, WFS using available public servers. 4. Access and analyze publicly available Internet GIS services (Google Maps API, OpenStreetMap).Test interoperability by integrating different services. 5. Install and configure one of these servers.Publish a spatial dataset as WMS/WFS.Access the published map services using a web client or QGIS desktop. 6. Design a basic HTML page to display a map.Use XML for storing and retrieving spatial data (e.g., GML format). 7. Use Leaflet.js or Google Maps API to create an interactive web map.Add markers, popups, and layers dynamically. 8. Set up a spatial database (PostGIS or SQLite with spatial extensions).Create a web app to query spatial data and display results on a map. Use helper applications like GeoJSONviewers. 9. Create a simple Java applet or servlet that processes spatial data (optional as Java applets are deprecated).

ECS-801	:	Advanced Cyber Operations and Forensics Analytics
Course category	:	PE8
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through assignments, quizzes, tutorials, course-based project, one minor test and one major examination.
Course Objectives	:	1. Introduce advanced concepts of cyber operations, cyber warfare, and digital forensics analytics. 2. Develop understanding of cyber-attack lifecycle, threat actors, and advanced persistent threats (APTs). 3. Provide in-depth knowledge of digital, network, memory, and malware forensics. 4. Enable students to perform cyber operations analysis using forensic and intelligence techniques. 5. Expose students to open-source cyber forensics, threat hunting, and analytics tools. 6. Apply data analytics and machine learning techniques for cyber threat detection and investigation.
Course Outcomes (COs)	:	After successful completion of the course, students will be able to: CO1. Explain advanced cyber operations concepts, cyber kill chain, and threat intelligence models. CO2. Analyze cyber-attacks and incidents using digital forensic methodologies. CO3. Perform network, memory, and malware forensic analysis using open-source tools. CO4. Apply cyber forensics analytics for threat hunting and incident response. CO5. Implement data analytics and machine learning techniques for cyber threat detection. CO6. Prepare legally admissible forensic reports for cyber operations investigations.
TOPIC COVERED	:	
UNIT I		**9L**
Advanced Cyber Operations and Threat Landscape: Cyber operations overview, cyber warfare and cybercrime, cyber kill chain model, MITRE ATT&CK framework, threat actors and motivations, advanced persistent threats (APTs), cyber threat intelligence lifecycle, indicators of compromise (IoCs), tactics, techniques, and procedures (TTPs).		
Unit II		**9L**
Digital and Network Forensics for Cyber Operations: Digital forensics process and standards, evidence handling and chain of custody, disk and file system forensics, network forensics concepts, packet capture and traffic analysis, log analysis, email and web forensics, timeline analysis, and correlation of digital evidence.		

Unit III		**9L**
Memory, Malware, and Advanced Forensics Techniques: Memory forensics concepts, volatile data acquisition, malware types and behaviors, static and dynamic malware analysis, rootkits and fileless malware, reverse engineering basics, sandboxing techniques, anti-forensics methods, and detection strategies.		
Unit IV		**9L**
Cyber Forensics Analytics and Machine Learning: Cyber forensics analytics concepts, big data in cyber security, threat hunting techniques, anomaly detection, supervised and unsupervised machine learning for cyber security, feature extraction, cyber datasets, performance evaluation metrics, and future trends in cyber operations analytics.		
List of Experiments	:	1. Study of cyber operations lifecycle and MITRE ATT&CK framework. 2. Disk and file system forensic analysis using Autopsy and Sleuth Kit. 3. Network traffic capture and cyber-attack analysis using Wireshark. 4. Log analysis and event correlation using ELK Stack (Elastic, Logstash, Kibana). 5. Email and web forensic investigation using Autopsy and open-source email tools. 6. Memory forensic analysis using Volatility Framework. 7. Static and dynamic malware analysis using Ghidra, Cuckoo Sandbox, and YARA. 8. Threat hunting and anomaly detection using Zeek and Suricata. 9. Machine learning–based cyber threat detection using Python (Scikit-learn, Pandas). 10. Cyber incident investigation and forensic report preparation using Autopsy.
Textbooks	:	1. Eoghan Casey, Digital Evidence and Computer Crime, Academic Press, 2011. 2. Mark Russinovich, David Solomon, Windows Internals, Microsoft Press.
Reference Books	:	1. Richard Bejtlich, The Practice of Network Security Monitoring, No Starch Press, 2013. 2. Michael Sikorski and Andrew Honig, Practical Malware Analysis, No Starch Press, 2012. 3. Jason Luttgens, Matthew Pepe, Kevin Mandia, Incident Response & Computer Forensics, McGraw-Hill, 2014. 4. Harlan Carvey, Windows Forensic Analysis Toolkit, Syngress.

ECS-802	:	Multi-modal AI
Course category	:	PE8
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	:	4

Course Assessment Methods	:	Continuous assessment through assignments, quizzes, laboratory exercises, course-based project, one minor test and one major examination.
Course Objective	:	1. To provide foundational understanding of multi-modal artificial intelligence and its significance in real-world applications. 2. To familiarize learners with representation, fusion, and alignment techniques for multiple data modalities. 3. To introduce deep learning architectures for joint learning from text, image, audio, and video data. 4. To develop analytical and practical skills for designing, training, and evaluating multi-modal AI systems.
Course Outcomes	:	After successful completion of this course, students will be able to: CO1. Understand the fundamental concepts of multi-modal AI including modality representation, fusion strategies, and cross-modal learning. CO2. Apply deep learning techniques for processing and integrating text, image, audio, and video modalities. CO3. Analyze multi-modal architectures such as CNN-RNN hybrids, attention-based models, and transformer-based systems. CO4. Evaluate multi-modal models using appropriate performance metrics for vision, language, and audio tasks. CO5. Create practical multi-modal AI applications such as visual question answering, image captioning, and speech-driven systems. CO6. Design ethical and responsible multi-modal AI solutions addressing bias, fairness, privacy, and societal impact.
TOPIC COVERED	:	

UNIT-I	**9L**
Introduction to Multi-modal AI: Overview of Multi-modal Learning, Types of Modalities-Text, Image, Audio, Video, Challenges in Multi-modal Data-Heterogeneity, Alignment, Missing Modalities, Feature Representation for Different Modalities, Early Fusion, Late Fusion, and Hybrid Fusion Techniques, Applications of Multi-modal AI.	
UNIT-II	**9L**
Multi-modal Deep Learning Architectures: CNNs for Visual Data, RNNs and Transformers for Text and Sequence Data, Audio Feature Extraction-MFCC, Spectrograms, Multi-modal Embedding Spaces, Cross-modal Retrieval, Attention Mechanisms for Multi-modal Learning, Multi-modal Transformers (Overview).	
UNIT-III	**9L**
Vision-Language and Audio-Visual Models: Image Captioning Models, Visual Question Answering (VQA), Text-to-Image and Image-to-Text Learning, Audio-Visual Speech Recognition, Video Understanding and Event Detection, Pre-trained Multi-modal Models-CLIP, BLIP, Flamingo (Overview).	
UNIT-IV	**9L**

Advanced Topics & Case Studies: Multi-modal Generative Models, Multi-modal Large Language Models (MLLMs), Human-AI Interaction using Multi-modal Systems, Evaluation Metrics for Multi-modal Tasks, Ethical, Legal, and Social Issues in Multi-modal AI-Bias, Privacy, Deepfakes, Responsible AI Practices, Future Trends in Multi-modal Intelligence.		
Textbooks	:	1. David Liu, Multimodal Machine Learning, Morgan & Claypool. 2. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press. 3. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer. 4. Fei-Fei Li, Ranjay Krishna, Danfei Xu, Deep Learning for Vision Systems, O'Reilly. 5. Jurafsky & Martin, Speech and Language Processing, Pearson.
Reference Books	:	1. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow, O'Reilly. 2. Stanford CS231n, CS224n, CS25 Lecture Notes – Vision, Language, and Multi-modal Learning. 3. Li Deng & Dong Yu, Deep Learning: Methods and Applications, Now Publishers. 4. Research Papers from arXiv, NeurIPS, ICML, CVPR, and ACL on Multi-modal AI. 5. OpenAI, Google DeepMind, and Meta AI Technical Reports on Multi-modal Models.

List of Experiments	:	1. Write a Python program to load and visualize different data modalities such as text, images, audio, and video using standard libraries. 2. Develop a program to extract basic features from text (tokenization), images (pixel values), and audio (spectrogram or MFCC) for multi-modal analysis. 3. Create a simple multi-modal dataset by combining text and image data and perform basic preprocessing and normalization. 4. Write a Python program to implement early fusion and late fusion techniques for combining features from two modalities. 5. Develop a basic CNN-RNN based model for image and text classification tasks using a small dataset. 6. Implement an attention-based multi-modal model to combine image and text features and analyze attention weights. 7. Write a Python program to perform image captioning using a pre-trained vision-language model. 8. Develop a program to perform visual question answering (VQA) using a pre-trained multi-modal model. 9. Implement cross-modal retrieval by matching text queries with related images using a shared embedding space. 10. Design a simple multi-modal AI application (image-text or audio-text) and analyze ethical issues such as bias, privacy, and responsible AI use.

ECS-803	:	Advanced Machine Learning and Predictive Modeling
Course Category	:	PE8
Pre-requisite	:	Machine Learning for Data Science
Contact Hours / Week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through assignments, quizzes, tutorials, one minor test, and one major examination.
Course Objectives	:	1. To explore advanced ML algorithms and model optimization techniques. 2. To introduce predictive modeling, ensemble learning, and deep learning concepts. 3. To develop practical skills in implementing ML pipelines for real-world applications.

Course Outcomes (COs)	:	CO1. Understand and implement advanced ML algorithms. CO2. Design predictive models using ensemble and deep learning methods. CO3. Perform data preprocessing, feature engineering, and model selection to improve predictive performance on large and complex datasets. CO4. Evaluate, interpret, and improve model performance. CO5. Build and deploy predictive analytics solutions using Python frameworks. CO6. Interpret model results, assess ethical considerations, and communicate predictive insights effectively for data-driven decision-making.
TOPIC COVERED	:	
UNIT I:		**9L**
Advanced Supervised and Ensemble Learning: Ensemble Methods: Random Forest, AdaBoost, Gradient Boosting, XGBoost, LightGBM. Model Stacking and Blending. Hyperparameter Tuning and Optimization (Bayesian Optimization, Optuna – overview).		
UNIT II		**9L**
Advanced Unsupervised and Semi-Supervised Learning: Advanced Clustering: Gaussian Mixture Models, Spectral Clustering. Anomaly Detection Techniques. Semi-Supervised Learning Approaches.		
UNIT III		**9L**
Neural Networks and Deep Learning: Basics of Neural Networks: Perceptron, Backpropagation, Activation Functions. Deep Learning Frameworks: TensorFlow, Keras. CNNs and RNNs (Overview and applications). Transfer Learning and Pretrained Models.		
UNIT IV		**9L**
Predictive Modeling and Deployment: Predictive Modeling Pipeline: Data → Model → Evaluation → Deployment. Model Explainability: SHAP, LIME. Model Deployment Tools: Flask, Streamlit, FastAPI. Case Study: Predictive analytics in healthcare / finance / IoT.		
Recommended **Textbooks/ Reference books**	:	1. Aurélien Géron – Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow. 2. Trevor Hastie et al. – The Elements of Statistical Learning. 3. Andrew Ng – Machine Learning Yearning. 4. Wes McKinney – Python for Data Analysis. 5. Ian Goodfellow – Deep Learning.

ECS-804	:	Case Studies of Industrial Applications in Blockchain
Course Category	:	PE8
Pre-requisites	:	NIL
Contact Hours / Week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials, and one minor test and one major examination.
Course Objectives	:	1. This course provides an applied understanding of how blockchain technology is transforming various industries. Through detailed case studies, students will analyze real-world blockchain implementations to understand their technical foundations, business value, and societal implications. After completing this course, students will be able to: 1. Identify major industrial sectors adopting blockchain. 2. Analyze real-world blockchain case studies and their outcomes. 3. Evaluate the benefits, limitations, and scalability issues of blockchain solutions. 4. Design conceptual frameworks for blockchain implementation in new industrial contexts.
Course Outcome	:	CO1. Explain the fundamental architecture and components of blockchain and assess its relevance in industrial applications. CO2. Analyze and compare blockchain implementations in finance, supply chain, and logistics sectors. CO3. Evaluate the effectiveness of blockchain in healthcare, energy, and public sector case studies. CO4. Design conceptual blockchain-based solutions for emerging sectors such as education, real estate, and creative industries. CO5. Critically assess the scalability, interoperability, and regulatory challenges of blockchain systems. CO6. Formulate and justify blockchain adoption strategies for real-world industrial problems based on technical feasibility, economic impact, and regulatory considerations.
TOPIC COVERED	:	
UNIT I		**9L**
Overview of industry leaders adopting blockchain (IBM, Oracle, Hyperledger, Ethereum, Blockchain adoption analysis across finance, supply chain, and healthcare, Hyperledger Fabric Pilot with Coca-Cola & U.S. State Department, Ensure fair labour practices in global bottling operations, Consortium of suppliers and regulators shared labour contracts securely on blockchain, Manufacturing / Labor Supply Chain.		
UNIT II		**9L**
Decentralized Finance (DeFi), CBDCs, and digital assets, Blockchain for KYC/AML compliance and settlement systems, Smart contract automation in financial transactions Provenance tracking and		

transparency, Integration with IoT and RFID for real-time monitoring, Blockchain for anti-counterfeiting and quality assurance, Case Studies: RippleNet & Santander (cross-border payments), JPMorgan Onyx / Quorum Platform (enterprise blockchain), IBM Food Trust (Walmart, Nestlé), Maersk TradeLens (global shipping), Everledger (diamond and luxury goods traceability).		
UNIT III		**9L**
Healthcare: Secure patient record management and data sharing, Drug traceability, clinical trials, and consent management, Energy and Sustainability: Renewable energy trading and carbon credit tracking, P2P energy trading and smart grids, Government & Public Sector: Digital identity management, Land records, voting systems, and public service transparency, Case Studies: MediLedger Project (pharmaceutical supply chain) Guardtime (Estonia's eHealth data integrity), Power Ledger (Australia – energy trading), Brooklyn Microgrid (P2P energy exchange), Estonia e-Residency and India's land registry projects.		
UNIT IV		**9L**
Emerging Sectors: Blockchain in education, real estate, and creative industries, NFTs, digital identity, and tokenized assets, Blockchain in IoT and Industry 4.0 , Challenges & Future Outlook: Scalability, interoperability, and security challenges, Regulatory, ethical, and environmental considerations, Web3, DAOs, and Metaverse integration with blockchain, Case Studies: Learning Machine & MIT Digital Diploma Project, Propy (blockchain in real estate), NBA Top Shot and Audius (media & entertainment), Bosch and IOTA (IoT integration).		
Textbook	:	1. IBM, "Walmart's food safety solution using IBM Food Trust built on the IBM Blockchain Platform," IBM Media Center, 2018. 2. Walmart Global Tech, "Blockchain in the food supply chain — What does the future look like?" Walmart Tech blog. 3. Maersk, "A game changer for global trade," Maersk news, Sept. 20, 2019. 4. M. Jovanovic et al., "Managing a blockchain-based platform ecosystem for global trade: the case of TradeLens," Technological Forecasting & Social Change, 2022. (analysis of TradeLens platform). 5. De Beers Group, "Tracr — Blockchain technology and diamond traceability," De Beers case studies.
Reference Book	:	1. I. Bashir, Mastering Blockchain: A Deep Dive into Distributed Ledgers, Consensus Protocols, Smart Contracts, DApps, Cryptocurrencies, Ethereum, and More, 3rd ed. Birmingham, UK: Packt Publishing, 2020. 2. D. Drescher, Blockchain Basics: A Non-Technical Introduction in 25 Steps. Berkeley, CA, USA: Apress, 2017. 3. N. Kshetri, Blockchain and Supply Chain Management. Amsterdam, Netherlands: Elsevier, 2021.

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4th Year 8th Semester Syllabus

ICS-400	:	INDUSTRIAL PRACTICE
Course category	:	IP
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 0, Tutorial: 0, Practical: 20
Number of Credits	:	10
Course Assessment methods	:	The industrial training of the students will be evaluated in three stages: (i) Evaluation by Industry (ii) Evaluation by faculty supervisor (iii) Evaluation through seminar presentation/vivavoce at the Institute.
Course Objectives	:	1. Participate in the projects in industries during his or her industrial training. 2. Interact with industrial personnel and follow engineering practices and discipline prescribed in industry.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

CO1. Learn to apply the technical knowledge in real industrial situations.
CO2. Promote academic, professional and/or personal development
CO3. Expose students to the engineer's responsibilities and ethics.
CO4. Familiarize with various materials, processes, products, and their applications along with relevant aspects of quality control. Gain experience in writing technical reports/projects
CO5. Expose the students to future employers.
CO6. Understand the social, economic, and administrative considerations that influence the working environment of industrial organizations.
Text Books:

1. Raman, Meenakshi & Sharma, Sangeeta, *"Technical Communication: Principles and Practice"*, Oxford University Press. (For report writing and presentation skills).
2. Martin, Mike W. & Schinzinger, Roland, *"Ethics in Engineering"*, McGraw Hill Education. (For understanding engineering ethics and responsibilities).

Reference Books:

1. Mitra, Barun K., *"Personality Development and Soft Skills"*, Oxford University Press. (For interpersonal skills and corporate readiness).
2. Lencioni, Patrick, *"The Five Dysfunctions of a Team: A Leadership Fable"*, Jossey-Bass. (For understanding team dynamics in industry).

ICS-481	:	MAJOR PROJECT
Course category	:	MP
Pre-requisite Subject	:	NIL

Contact hours/week	:	Lecture: 0, Tutorial: 0, Practical: 20
Number of Credits	:	10
Course Assessment methods	:	Continuous assessment through one viva voce/presentation, project report Submission, Evaluation of Development of hardware based or software-based simulation module by faculty supervisor through seminar.
Course Objectives	:	1. Provide opportunity to identify, formulate, and solve a complex real-world engineering problem using systematic and scientific approaches. 2. Enable students to design, develop, and implement hardware-based systems or software-based simulation modules using appropriate tools and technologies. 3. Promote independent learning and research skills through literature survey, problem analysis, system modeling, and validation. 4. Develop competence in applying modern engineering tools, techniques, and methodologies for system development and performance evaluation. 5. Enhance project management skills including planning, documentation, testing, debugging, and result analysis. 6. Strengthen professional communication skills through technical report writing, presentations, and viva voce examinations.
Course Outcomes	:	The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.
CO1. Ability to learn, design & analysis of computer engineering system modules. CO2. Acquire knowledge by developing of software-based engineering module. CO3. Acquire knowledge by developing of software-based simulation module. CO4. Obtain the knowledge about the recent tool-based research work in engineering. CO5. Communicate with engineers and the community at large in written an oral form. CO6. Design engineering solutions to complex problems utilizing a computer systems approach		

ECS-903	:	REINFORCEMENT LEARNING
Course category	:	PE9
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, practical work, record, viva voce and one minor test and one major examination.
Course Objectives	:	

1. To introduce the fundamental principles, terminology, and theoretical foundations of Reinforcement Learning.
2. To develop the probabilistic background necessary for understanding stochastic decision processes in RL.
3. To enable students to understand and analyze Markov Reward Processes (MRP) and Markov Decision Processes (MDP) using Bellman equations.
4. To provide practical knowledge of model-free reinforcement learning methods such as Monte Carlo techniques.
5. To equip students with the ability to implement and analyze policy gradient and actor-critic algorithms for solving sequential decision-making problems.

Course Outcomes	:	

CO1. Describe the history, scope, and interdisciplinary connections of Reinforcement Learning.
CO2. Apply foundational probability concepts relevant to Reinforcement Learning models.
CO3. Explain key RL concepts including Markov property, MRP, and MDP.
CO4. Derive and analyze Bellman equations for reward and decision processes.
CO5. Implement Monte Carlo methods for model-free reinforcement learning tasks.
CO6. Apply policy gradient and actor-critic methods to optimize RL policies

Topics Covered

UNIT-I **9L**

Course logistics and overview. Origin and history of Reinforcement Learning research. Its connections with other related fields and with different branches of machine learning.

UNIT-II **9L**

Brush up of Probability concepts - Axioms of probability, concepts of random variables, PMF, PDFs, CDFs, Expectation. Concepts of joint and multiple random variables, joint, conditional and marginal distributions. Correlation and independence.

UNIT-III **9L**

Introduction to RL terminology, Markov property, Markov chains, Markov reward process (MRP).

Introduction to and proof of Bellman equations for MRPs along with proof of existence of solution to Bellman equations in MRP. Introduction to Markov decision process (MDP), state and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations.

UNIT-IV **9L**

Overiew of Monte Carlo methods for model free RL, First visit and every visit Monte Carlo, Monte Carlo control, On policy and off policy learning, Importance sampling. Getting started with policy gradient methods, Log-derivative trick, Naive REINFORCE algorithm, bias and variance in Reinforcement Learning, Reducing variance in policy gradient estimates, baselines, advantage function, actor-critic methods.

LIST OF EXPERIMENTS

1. Study and present the history and evolution of reinforcement learning and its connections with supervised and unsupervised learning using a case-based presentation or report.
2. Implement a simulation to demonstrate probability concepts (e.g., generating PMFs, PDFs, CDFs) using Python and visualize the relationship between joint, marginal, and conditional distributions.
3. Create a simulation of a Markov Reward Process (MRP), compute the state value function using Bellman equations, and visualize state transitions and rewards.
4. Implement a Markov Decision Process (MDP) environment and compute state-value and action-value functions using Bellman expectation and optimality equations.
5. Develop Monte Carlo simulation for a simple grid world or custom environment using first-visit and every-visit approaches for estimating value functions.
6. Implement the REINFORCE algorithm for a small environment (like Cart Pole or a custom environment), and demonstrate the effect of baselines and variance reduction techniques using actor-critic methods.

TEXTBOOKS

1. Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction, 2nd Edition, MIT Press, 2018.

REFERENCE BOOKS

1. "Probability, Statistics, and Random Processes for Electrical Engineering", 3rd Edition, Alberto Leon-Garcia

2. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012

ECS-913	:	DEEP LEARNING
Course category	:	PE9
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, practical work, record, viva voce and one minor test and one major examination.
Course Objectives	:	The objective of this course is to introduce students to deep learning algorithms and their applications in order to solve real problems
Course Outcomes	:	

CO1. Understand deep learning
CO2. Use different types of classifiers.
CO3. Describe the feed-forward and deep networks.
CO4. Design single and multi-layer feed-forward deep networks and tune various hyper-parameters.
CO5. Implement deep neural networks to solve a problem
CO6. Analyse performance of deep networks

Topics Covered

UNIT-I **9L**

Introduction: Historical context and motivation for deep learning; basic supervised classification task, optimizing logistic classifier using gradient descent, stochastic gradient descent, momentum, and adaptive sub-gradient method.

UNIT-II **9L**

Neural Networks: Feedforward neural networks, deep networks, regularizing a deep network, model exploration, and hyper parameter tuning.Convolution Neural Networks: Introduction to convolution neural networks: stacking, stridingand pooling, applications like image, and text classification.

UNIT-III **9L**

Sequence Modeling: Recurrent Nets: Unfolding computational graphs, recurrent neural networks (RNNs), bidirectional RNNs, encoder-decoder sequence to sequence architectures, deep recurrent networks, LSTM networks.

UNIT-IV **9L**

Autoencoders: Undercomplete autoencoders, regularized autoencoders, sparse autoencoders, denoising autoencoders, representational power, layer, size, and depth of autoencoders, stochastic encoders and decoders.

LIST OF EXPERIMENTS

1. Implement logistic regression for binary classification using gradient descent and evaluate performance.

2. Apply stochastic gradient descent and momentum to optimize a supervised classification task.
3. Build and train a feedforward neural network on a dataset like MNIST.
4. Apply dropout and L2 regularization to prevent overfitting in a deep neural network.
5. Design and train a CNN for image classification using convolution, pooling, and striding.
6. Perform text classification using a 1D CNN on a sentiment analysis dataset.
7. Implement a simple RNN for character-level sequence prediction.
8. Build a bidirectional RNN and compare performance with a unidirectional RNN.
9. Construct an encoder-decoder LSTM model for machine translation.
10. Train a denoising autoencoder to reconstruct images with added noise.

TEXTBOOKS

1. Goodfellow, I. (2016). Deep Learning. MIT Press.
2. Bunduma, N. (2017). Fundamentals of Deep Learning

REFERENCE BOOKS

1. Heaton, J.(2015). Deep Learning and Neural Networks, Heaton Research Inc.
2. Deng, L., & Yu, D. (2009). Deep Learning: Methods and Applications (Foundations andTrends in Signal Processing). Publishers Inc

ECS-904	:	OPTIMIZATION AND MACHINE LEARNING
Course category	:	PE9
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.
Course Objectives	:	

1. To develop a strong mathematical foundation in linear algebra and calculus required for optimization in machine learning.
2. To introduce convex and non-convex optimization concepts and their role in machine learning models.
3. To understand and implement gradient-based optimization algorithms and their variants.
4. To analyze advanced optimization techniques such as Newton's method and proximal methods for high-dimensional learning problems.
5. To enable students to apply optimization techniques in practical machine learning frameworks such as PyTorch or TensorFlow.

Course Outcomes	:	

CO1. Understand key concepts of linear algebra for machine learning.

CO2. Demonstrate functions relevant to high-dimensional data spaces.
CO3. Analyze convex and non-convex optimization problems.
CO4. Implement gradient descent and its variants.
CO5. Apply and evaluate advanced optimization techniques.
CO6. Utilize eigenvalue and singular value decomposition

Topics Covered

UNIT-I **9L**

Basics of Linear Algebra and Calculus: Subspaces, EigenValue Decomposition, Singular Value Decomposition -Algorithms and Methods, PSD Matrices and Kernel Functions, Vector Calculus.

UNIT-II **9L**

Basics of Linear Algebra and Calculus: Subspaces, EigenValue Decomposition, Singular Value Decomposition -Algorithms and Methods, PSD Matrices and Kernel Functions, Vector CalculusConvex Functions, First and Second Order Conditions for Optimizations, Convex and Non Convex Optimization problems in Machine Learning.

UNIT-III **9L**

Gradient Descent: math, programming basic optimisation problems and their solutions Variants of Gradient Descent: Projected, Stochastic, Proximal, Accelerated, Coordinate Descent, Training a NeuralNetwork.

UNIT-IV **9L**

Variants of Gradient Descent: Projected, Stochastic, Proximal, Accelerated, Coordinate Descent, Training a Neural Network: Theory Newton's Method, Optimization for ML in practice: Pytorch/Tensor Flow.

TEXTBOOKS

1. Stephen Boyd and Lieven Vandenberghe, Convex Optimization, Cambridge University Press, 2004.

2. Suvrit Sra, Sebastian Nowozin, and Stephen J. Wright (Eds.), Optimization for Machine Learning, MIT Press, 2012.

REFERENCE BOOKS

1. Daniel Jurafsky and James H. Martin, Speech and Language Processing, 3rd Edition, Pearson, 2022.
2. Christopher D. Manning, Prabhakar Raghavan, and HinrichSchütze, Introduction to Information Retrieval, Cambridge University Press, 2008.
3. Steven Bird, Ewan Klein, and Edward Loper, Natural Language Processing with Python, O'Reilly Media, 2009

ECS-914	:	DEEP LEARNING AND NEURAL NETWORK
Course category	:	PE9
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.
Course Objectives	:	1. To introduce the fundamental concepts of deep learning, including linear algebra foundations, neural network architectures, loss functions, backpropagation, and gradient-based optimization, along with exposure to popular deep learning frameworks. 2. To enable students to design, train, and optimize deep neural networks, such as feedforward networks, convolutional neural networks, and recurrent neural networks, while applying regularization techniques to improve generalization. 3. To develop understanding of advanced deep learning models and techniques, including transformers, attention mechanisms, transfer learning, generative models, and systematic model tuning using appropriate evaluation metrics. 4. To familiarize students with modern generative AI and large language models, covering multimodal AI systems, ethical considerations, and emerging trends such as diffusion models, federated learning, and neuromorphic computing.
Course Outcomes	:	

CO1. Understand deep learning basics and models.
CO2. Use linear algebra and optimization for neural networks.
CO3. Build models with PyTorch/TensorFlow.
CO4. Tune and apply models to real-world tasks.
CO5. To learn the basics of Generative AI
CO6. Explore AI ethics and emerging trends

Topics Covered

UNIT-I **9L**

Intro to Deep Learning: Uses, Key Ideas, Linear Algebra: Vectors, Matrices, Neural Networks: Neurons, Loss Functions, Backpropagation and Gradient Descent, Basic introduction to PyTorch/TensorFlow/Keras.

UNIT-II **9L**

Feedforward Networks: Build and Train, CNNs: Image Processing Basics, RNNs: Sequences with LSTMs, Optimization: SGD, Adam, Preventing Overfitting: Dropout, Batch Norm.

UNIT-III **9L**

Transformers: Attention, BERT Basics, Transfer Learning: Using Pretrained Models, Generative Models: Intro to GANs, VAEs, Model Tuning: Metrics, Hyperparameters.

UNIT-IV **9L**

Large Language Models: GPT, Prompt Basics, Generative AI: Diffusion Models, Multimodal AI: Vision + Text (e.g., CLIP), AI Ethics: Bias, Fairness, What's Next: Neuromorphic AI, Federated Learning.

LIST OF EXPERIMENTS

1. Implement matrix operations (e.g., dot products) using NumPy and build a simple perceptron with Keras to compute loss functions on a synthetic dataset.
2. Build and train a feedforward neural network using Keras to classify the MNIST dataset. Implement gradient descent and evaluate model accuracy.
3. Create a CNN using Keras for image classification on CIFAR-10. Apply dropout and batch normalization to prevent overfitting and evaluate performance.
4. Implement an LSTM model using Keras for a sequence task (e.g., sentiment analysis on IMDB reviews). Train and visualize loss/accuracy trends.
5. Fine-tune a pretrained BERT model using Keras (via Hugging Face's transformers with Keras API) for text classification on a dataset like Twitter sentiments.
6. Build a simple GAN using Keras to generate synthetic MNIST digits. Implement generator and discriminator networks and visualize generated images.
7. Use a pretrained GPT-2 model with Keras (via Hugging Face's Keras API) for text generation. Experiment with prompt engineering on a small text dataset.

TEXTBOOKS/ REFERENCE BOOKS

1. Goodfellow et al. (2016). Deep Learning.
2. Deisenroth et al. (2020). Mathematics for Machine Learning.
3. Zhang et al. (2023). Dive into Deep Learning

ECS-905	:	ETHICAL HACKING
Course category	:	PE9
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, practical work, record, viva voce and one minor test and one major examination.
Course Objectives	:	1. To introduce the concepts, methodologies, and legal frameworks of ethical hacking and penetration testing. 2. To provide a practical understanding of network architecture, protocols, and how to identify vulnerabilities within them using scanning tools.

		3. To familiarize students with system-level security threats, including malware, password cracking, and privilege escalation techniques. 4. To enable students to perform traffic analysis, packet sniffing, and web application attacks (like SQL injection and XSS) using industry-standard tools. 5. To understand advanced security topics such as hardware security, side-channel attacks, and the application of cryptography in securing digital assets.
Course Outcomes	:	After successful completion of the course, the learners would be able to:
CO1. Understand the fundamentals of ethical hacking. CO2. Configure computer networking, and vulnerability scanning tools. CO3. Know secure hacking environments and perform system-level attacks. CO4.Analyze advanced security topics such as steganography, biometric authentication. CO5.Perform traffic analysis and security testing using tools like Wireshark. CO6. Demonstrate ethical hacking techniques		
Topics Covered		
UNIT-I **9L** Introduction to ethical hacking. Fundamentals of computer networking. TCP/IP protocol stack. IP addressing and routing. TCP and UDP. IP subnets. Routing protocols. IPV- 6, Installation of attacker and victim system. Information gathering using advanced google search, archive.org, netcraft, whois, host, dig, dnsenum and NMAP tool. Vulnerability scanning using NMAP and Nessus.		
UNIT-II **9L** Creating a secure hacking environment. System Hacking: password cracking, privilege escalation, application execution. Malware and Virus. ARP spoofing and MAC attack. Introduction to cryptography, private-key encryption, public-key encryption.		
UNIT-III **9L** Cryptographic hash functions, digital signature and certificate, applications. Steganography, biometric authentication, network-based attacks, DNS and Email security. Packet sniffing using wireshark and burpsuite, password attack using burp suite.		
UNIT-IV **9L** Social engineering attacks and Denial of service attacks. Elements of hardware security: side-channel attacks, physical inclinable functions, hardware trojans. Different types of attacks using Metasploit framework: password cracking, privilege escalation, remote code execution, etc. Attack on web servers: password attack, SQL injection, cross site scripting.		

LIST OF EXPERIMENTS

1. Information Gathering and Scanning Using tools like whois, dig, dnsenum, and Nmap.
2. Perform a vulnerability scan using on a virtual machine and generate a vulnerability assessment report.
3. Password Cracking and Privilege Escalation and demonstrate privilege escalation on a Linux system.
4. Packet Sniffing and Analysis to analyze network packets using Wireshark.
5. Cryptography and Hashing SHA-256 using Python.
6. Web Server Exploitation attacks such as SQL injection or remote code execution.

TEXTBOOKS

1. Data and Computer Communications -- W. Stallings.
2. Data Communication and Networking -- B. A. Forouzan
3. TCP/IP Protocol Suite -- B. A. Forouzan
4. UNIX Network Programming -- W. R. Stallings
5. Introduction to Computer Networks and Cybersecurity -- C-H. Wu and J. D. Irwin
6. Cryptography and Network Security: Principles and Practice -- W. Stallings

REFERENCE BOOKS

1. Jon Erickson, *"Hacking: The Art of Exploitation"*, No Starch Press. (Essential for understanding the core logic of exploits).
2. Patrick Engebretson, *"The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made Easy"*, Syngress.
3. Dafydd Stuttard and Marcus Pinto, *"The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws"*, Wiley.
4. David Kennedy, Jim O'Gorman, Devon Kearns, and Mati Aharoni, *"Metasploit: The Penetration Tester's Guide"*, No Starch Press..

ECS-915	:	COMPUTER FORENSICS
Course category	:	PE9
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, practical work, record, viva voce and one minor test and one major examination.
Course Objectives	:	1. Understand the fundamentals of computer forensics and its applications in law enforcement, corporate, military, and legal contexts, including the role and responsibilities of computer forensics specialists. 2. Explain computer forensics technologies and evidence

		handling techniques, including types of forensic technologies, data recovery methods, backup strategies, and adherence to legal standards such as Daubert guidelines. 3. Develop skills in digital evidence collection, preservation, and documentation, ensuring proper chain of custody, compliance with rules of evidence, and application of ACPO principles. 4. Analyze and validate digital forensic evidence effectively, including identifying relevant data, addressing data-hiding techniques, performing forensic analysis, and understanding legal aspects of forensic investigations.
Course Outcomes	:	

After successful completion of the course, students will be able to:

CO1. Explain the fundamental concepts of computer forensics and the role of digital evidence in legal and organizational investigations.

CO2.Apply computer forensic technologies and tools to acquire, recover, and handle digital evidence following standard procedures.

CO2. Demonstrate proper methods for evidence collection, preservation, duplication, and chain of custody in digital forensic investigations.

CO4. Analyze digital evidence using forensic techniques, including validation of data and detection of data-hiding methods.

CO5. Investigate cyber incidents using network forensics and email forensics techniques, and process digital crime scenes effectively.

CO6. Evaluate forensic tools, methodologies, and legal considerations while keeping up with emerging trends in computer forensics.

Topics Covered

UNIT-I **9L**

Introduction to Computer Forensics and Its Applications: Use of Computer Forensics in Law Enforcement, Computer Forensics Assistance in Human Resources and Employment Proceedings, Computer Forensics Services, Benefits of Professional Forensics Methodology, Steps Taken by Computer Forensics Specialists.

UNIT-II **9L**

Computer Forensics Technology and Evidence Handling: Types of Computer Forensics Technology-Business Computer Forensics Technology, Military Computer Forensics Technology, Law Enforcement Computer Forensics Technology.
Computer Forensics Evidence and Capture: Daubert Guidelines, Data Recovery-Definition, Backup and Recovery, Role of Backup in Data Recovery, The Data Recovery Solution.

UNIT-III **9L**

Evidence Collection, Preservation, and Analysis: Evidence Collection and Data Seizure-Collection Options and Obstacles, Types of Evidence, Rules of Evidence and Chain of Custody, ACPO Principles. Duplication and Preservation of Digital Evidence: Preserving the Digital Crime Scene, Computer Evidence Processing Steps, Legal Aspects of Collecting and Preserving Computer Forensic Evidence
Computer Forensic Analysis and Validation: Determining What Data to Collect and Analyze, Validating Forensic Data, Addressing Data-Hiding Techniques, Performing Remote Acquisitions.

UNIT-IV **9L**

Network Forensics, Crime Scene Processing, and Forensic Tools: Network Forensics Overview-Performing Live Acquisitions, Developing Standard Procedures for Network Forensics, Using Network Tools, Examining the Honeynet Project.Processing Crime at Incident Scenes-Identifying and Collecting Digital Evidence, Processing Private-Sector and Law Enforcement Crime Scenes, preparing for a Search and Securing the Scene, Seizing and Storing Digital Evidence, obtaining a Digital Hash and Reviewing a Case.
Computer Forensic Tools: Evaluating Tool Requirements, Software and Hardware Forensic Tools, Validating and Testing Forensic Software
Email Forensics: Role of Email in Investigations, Understanding Client and Server Roles in Email, Investigating Email Crimes and Violations, Using Specialized Email Forensic Tools.

LIST OF EXPERIMENTS

1. Study the basic concepts of computer forensics and familiarize with various forensic tools used in investigations.
2. Implement buffer over flow attack using C Language.
3. File Recovery Using Forensics Tools
4. Hiding and Extracting Text Behind an Image File.
5. Hiding and Extracting Text Behind an Audio File.
6. Analyze image files for metadata using ExifReader software.
7. Create a bit-by-bit forensic image of a hard drive using EnCase Forensics.
8. Restore and analyze a previously created forensic image of a hard disk.
9. Identify and collect relevant email data from a target system.
10. Simulate fake email scenarios using services like fakesend.com, fakemailer.net, etc.
11. Analyze and extract data from web browsers (history, cookies, cache, etc.)
12. Determine the last activities performed on the system using forensic methods.
13. Compare two files to detect tampering or modifications using Compare IT.
14. Perform live forensic investigation using Autopsy forensic browser.
15. Simulate a phishing attack and analyze how attackers deceive users.

16. Demonstrate SQL Injection vulnerability and its exploitation.

TEXTBOOKS

1. Computer Forensics, Computer Crime Investigation by John R,Vacca, Firewall Media, New Delhi

REFERENCE BOOKS

1. Computer Forensics and Investigations by Nelson, Phillips Enfinger, Steuart, CENGAGE Learning.
2. Real Digital Forensics by Keith J.Jones, Richard Bejitlich, Curtis W.Rose, Addison Wesley Pearson Education

ECS-906	:	INTERACTIVE 3D GRAPHICS
Course category	:	PE9
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, practical work, record, viva voce and one minor test and one major examination.
Course Objectives	:	1.Understand the fundamentals of interactive computer graphics, including coordinate systems, camera transformations, and the 3D rendering pipeline for real-time and pre-rendered graphics. 2.Apply 3D modeling, texturing, and lighting techniques by working with mesh representations, material properties, texture mapping, and standard lighting models to create realistic scenes. 3.Develop shaders, animations, and interactive elements using vertex and fragment shaders, object interaction techniques, basic animation methods, and user interface overlays in 3D environments. 4.Design and optimize interactive 3D applications by using scene graphs, performance optimization techniques, real-time metrics, and emerging technologies such as AR/VR, culminating in a capstone project.
Course Outcomes	:	

CO1. Understand the fundamentals of interactive graphics and 3D rendering pipeline stages.
CO2. Apply camera transformations and coordinate systems for 3D scene setup.
CO3. Model, texture, and light 3D objects using various techniques and file formats.
CO4. Apply shaders to implement real-time effects and animations.
CO5. Implement interactivity in 3D scenes including object manipulation and UI overlays.
CO6. Optimize rendering performance and explore applications in AR/VR and real-time systems

Topics Covered

UNIT-I **9L**

Introduction to interactive graphics: Real-time vs pre-rendered Coordinate systems: World, View, Clip, Screen 3D rendering pipeline overview (Vertex processing to Fragment output) Camera transformation: LookAt, Projection (Perspective & Orthographic) Scene setup: Viewports, Clipping, Field of View (FoV).

UNIT-II **9L**

Modeling, Texturing, and Lighting Mesh representation: Vertices, edges, faces, buffers Importing 3D models (OBJ, FBX, glTF) Texture mapping: UV coordinates, Mipmaps Material properties: Phong, Blinn-Phong, PBR basics Lighting models: Ambient, Directional, Point, Spot.

UNIT-III **9L**

Shading, Animation, and Interactivity Introduction to shaders: GLSL / Shader Graph / HLSLVertex and fragment shader structure Object interaction: Picking, dragging, rotating Basic animations: Keyframes, interpolation, skeleton-based motion User interface overlays in 3D scenes.

UNIT-IV **9L**

Advanced Interactivity and Applications Scene graph and hierarchical modeling Optimization: Culling, Level of Detail (LOD), Batching Real-time performance metrics (FPS, GPU profiling) Introduction to AR/VR and WebXR (optional extension) Capstone project planning.

LIST OF EXPERIMENTS

1. Implement a basic 3D scene with camera setup using LookAt and perspective/orthographic projections.
2. Import and render 3D models with texture mapping using UV coordinates.
3. Apply lighting models like ambient, directional, and point light on 3D objects.
4. Write simple vertex and fragment shaders using GLSL or Unity Shader Graph.
5. Create basic object interaction (drag, rotate, pick) within a 3D scene.
6. Animate a model using keyframes or skeleton-based animation techniques.
7. Optimize scene performance using culling, LOD, and view GPU performance metrics.

TEXTBOOKS

1. Hearn, D., Baker, M. P., & Carithers, W. *Computer Graphics with OpenGL*, 4th Edition. Pearson Education, 2011.
2. Akenine-Möller, T., Haines, E., & Hoffman, N. *Real-Time Rendering*, 4th Edition. CRC Press / Taylor & Francis, 2018.
3. Lengyel, E., *Foundations of Game Engine Development, Volume 1: Mathematics and Graphics*. Terathon Software LLC, 2016.
4. Angel, E., & Shreiner, D. *Interactive Computer Graphics: A Top-Down Approach with WebGL*, 7th Edition. Pearson Education, 2015.

REFERENCE BOOKS

1. "Interactive Computer Graphics: A Top-Down Approach with WebGL" by Edward Angel and Dave Shreiner – Pearson, 7th Edition.
2. "Computer Graphics: Principles and Practice" by John F. Hughes et al. – Addison-Wesley, 3rd

Edition.
3. “Real-Time Rendering” by Tomas Akenine-Möller, Eric Haines, and Naty Hoffman – A K Peters/CRC Press, 4th Edition

ECS-916	:	SENSORS AND ACTUATORS IN AR/VR SYSTEM
Course category	:	PE9
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, practical work, record, viva voce and one minor test and one major examination.
Course Objectives	:	1.To understand the principles, architecture, and hardware components of Augmented Reality (AR) and Virtual Reality (VR) systems. 2.To explain human perception factors, immersion, and depth cues in designing effective AR/VR experiences. 3.To develop knowledge of spatial tracking, 6DoF pose estimation, optical/depth sensing systems, and SLAM techniques. 4.To apply sensor fusion methods, including Kalman filtering, for accurate real-time motion tracking and positioning. 5.To understand actuators and haptic feedback systems and their role in enhancing interaction in immersive environments. 6.To interface sensors and actuators with AR/VR engines and develop interactive real-time AR/VR prototypes.
Course Outcomes	:	

CO1. Understand the components and operation of AR/VR systems.
CO2. Explain human perception factors and depth cues in immersive experiences.
CO3. Apply motion tracking techniques and sensor fusion for real-time positioning.
CO4. Demonstrate use of haptic devices in virtual environments.
CO5. Interface sensors and actuators with AR/VR engines for real-time data-driven experiences.
CO6. Develop interactive AR/VR prototypes and real-time visualization

Topics Covered

UNIT-I **9L**

Overview of AR and VR systems: HMDs, controllers, sensors, displays Human perception and immersion: Field of view, latency, resolution, depth cues Hardware components: IMUs, gyroscopes, accelerometers, magnetometers Position tracking: Optical, inside-out vs outside-in, SLAM basics.

UNIT-II **9L**

Sensors for Spatial Tracking and Motion Capture 6DoF (Degrees of Freedom) tracking and pose estimation Optical tracking systems: IR cameras, markers, MoCap basics Depth sensors: Time-of-Flight, LiDAR, structured light (e.g., Kinect) Sensor fusion and Kalman filtering for accurate motion estimation.

UNIT-III **9L**

Actuators and Haptic Feedback in Immersive Systems Types of actuators: Vibration motors, servo motors, linear actuators Haptic feedback systems: gloves, suits, vests Tactile vs force feedback Applications of haptics in training, gaming, and simulations.

UNIT-IV **9L**

Interfacing and Prototyping for AR/VR Applications Sensor data communication: Serial, Bluetooth, I2C, USB Integrating hardware with Unity/Unreal using plugins/middleware Real-time data acquisition and visualization Prototyping: Building an interactive AR/VR experience using sensors and actuators.

LIST OF EXPERIMENTS

1. Setup and explore an HMD system and evaluate field of view, latency, and resolution.
2. Implement basic tracking using an IMU sensor
3. Perform and visualize orientation data in real time.
4. Integrate a vibration motor or haptic glove with Unity.
5. Fuse sensor data using a Kalman filter for smoother motion tracking.
6. Connect sensors Engine using serial/Bluetooth communication and visualize data.
7. Design a simple AR/VR prototype that integrates user interaction with hardware sensors and actuators.

TEXTBOOKS

1. Understanding Virtual Reality – William R. Sherman & Alan B. Craig
2. Haptics: Science, Technology, and Applications – Springer
3. Augmented Reality: Principles and Practice – Dieter Schmalstieg& Tobias Hollerer
4. Manufacturer datasheets (MPU6050, Kinect, Leap Motion

REFERENCE BOOKS

1. Virtual & Augmented Reality: Concepts, Methodologies, Tools, and Applications – Information Resources Management Association (Ed.), IGI Global, 2018.

Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR (1st Edition) – Steve Aukstakalnis, Addison-Wesley Professional, 2016.

ECS-907	:	BLOCKCHAIN FOR SOCIAL IMPACT: DEMOCRACY & GOVERNANCE
Course category	:	PE9
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.
Course Objectives	:	After successful completion of this course, students will be able to: 1. Understand the fundamental principles of blockchain and distributed ledger technologies, including their architecture, characteristics, and operational components. 2. Explain and compare various blockchain consensus mechanisms such as Proof-of-Work, Proof-of-Stake, and other emerging protocols, with respect to security, scalability, and energy efficiency. 3. Analyze the design and implementation of smart contracts and decentralized applications (DApps) and evaluate their role in enabling trustless and automated systems. 4. Examine the application of blockchain technologies in democratic processes, including e-voting systems, digital identity verification, and transparent governance frameworks. 5. Evaluate different blockchain governance models, including Decentralized Autonomous Organizations (DAOs), quadratic voting, and other innovative decision-making mechanisms across public and private blockchains. 6. Assess the legal, regulatory, ethical, and cybersecurity challenges of blockchain adoption, with emphasis on privacy, data sovereignty, and compliance with existing legal frameworks.
Course Outcomes	:	

CO1. Understand the fundamentals of blockchain technology.
CO2. Analyze the role of smart contracts.
CO3. Decentralized applications in enabling trustless digital systems.
CO4. Evaluate blockchain in democratic processes such as digital identity verification.
CO5. Compare governance structures and decision-making processes.

CO6. Assess legal, ethical, and cybersecurity challenges associated with blockchain

Topics Covered

UNIT-I **9L**

Fundamentals of blockchain and distributed ledger technologies. Consensus mechanisms: Proof-of-Work, Proof-of-Stake, and others. Smart contracts and decentralized applications.

UNIT-II **9L**

Blockchain in Democratic Processes Applications in e-voting systems and digital identity verification Enhancing transparency and accountability in governance. Case studies on blockchain's role in electoral processes. Cornell - Online Education Programs.

UNIT-III **9L**

Governance Models in Blockchain Decentralized Autonomous Organizations (DAOs) and their governance structures. Quadratic voting and other innovative decision-making mechanisms. Comparative analysis of governance in public vs. private blockchains.

UNIT-IV **9L**

Regulatory and Ethical Considerations Legal frameworks governing blockchain applications. Ethical implications of decentralization and data sovereignty. Privacy concerns and cybersecurity challenges.

TEXT BOOKS

1. Narayanan, A., Bonneau, J., Felten, E., Miller, A., & Goldfeder, S. Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction Princeton University Press

2. Antonopoulos, A. M. Mastering Blockchain, O'Reilly Media

REFERENCE BOOKS

1. "Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications" by Imran Bashir
2. "Blockchain: Blueprint for a New Economy" by Melanie Swan

ECS-917	:	BLOCKCHAIN SECURITY AND NEXT GENERATION APPLICATIONS
Course category	:	PE9
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.
Course Objectives	:	1. Students should be able to understand the security and performance-related issues of blockchain. 2. Students should be able to learn techniques and tools to tackle the security related issues of blockchain
Course Outcomes	:	After completion of course, students would be able to:

CO1. To understand the security and performance perspective of blockchain technology.
CO2. To learn and apply security analysis and performance-enhancing techniques related to blockchain.
CO3. To understand difference between different types of coins and tokens related to blockchain technology.
CO4. To understand the benefits of blockchain in banking sector.
CO5. Students should be able to understand the benefits of using blockchain in financial sector.
CO6. Students should understand how decentralized nature of blockchain is impacting banking and financial sector

Topics Covered

UNIT-I **9L**

Security Issues: Blockchain Related Issues, Higher-Level Language (Solidity) Related Issues, EVM Bytecode Related Issues, Real-Life Attacks on Blockchain Applications/ Smart Contracts, Trusted Execution Environments.

UNIT-II **9L**

Security Tools for Smart Contracts: Working, Advantages, And Disadvantages of ToolsOyente, Securify, Maian, Manticore, Mythril, SmartCheck, Verx. Secure Key Management, Quantum Resilience Keys.

UNIT-III **9L**

Performance Related Issues: Transaction Speed, Transaction Fees, Network Size, Complexity, Interoperability Problems, Lack of Standardization. Lack of Supportive Regulations Related to Blockchain Applications. Decentralized Finance (DeFi): Concept, Benefits and Risks Associated with DeFi, Centralized vs Decentralized finance, DeFi Projects, DeFi future trends.

UNIT-IV **9L**

Cryptocurrencies: Concept, Cryptocurrency Mining, Uses of Cryptocurrencies, Tokens, Token vs

Crypto Coin, Concept of ICOs (Initial Coin Offerings), Benefits of Using ICOs, STOs (Security token offerings), ICO vs STO, Cryptocurrency wallets. Decentralized Markets: Concept of Decentralized markets, impact of decentralization on financial market, Decentralized Exchanges (DEX), Security, control and privacy concerns related to DEX, Liquidity and Usability of DEX, best DEXs for trading.

TEXTBOOKS

1. Mastering Ethereum: Building Smart Contracts and Dapps Book by Andreas Antonopoulos and Gavin Wood, Shroff Publisher/O′Reilly Publisher.
2. Melanie Swan, Blockchain: Blueprint for a new economy, Shroff Publisher/O'Reilly Publisher.
3. Ron Quaranta, Blockchain in Financial Markets and Beyond: Challenges and Applications, Risk Books Publisher.
4. Richard Hayen, Blockchain & FinTech: A Comprehensive Blueprint to Understanding Blockchain & Financial Technology. - Bitcoin, FinTech, Smart Contracts, Cryptocurrency.

REFERENCE BOOKS

1. I. Bashir, Mastering Blockchain: A Deep Dive into Distributed Ledgers, Consensus Protocols, Smart Contracts, DApps, Cryptocurrencies, Ethereum, and More, 3rd ed. Birmingham, UK: Packt Publishing, 2020.
2. A. M. Antonopoulos and G. Wood, Mastering Ethereum: Building Smart Contracts and DApps. Sebastopol, CA, USA: O'Reilly Media, 2018.
3. J. Bonneau et al., "SoK: Research Perspectives and Challenges for Bitcoin and Cryptocurrencies," in Proc. IEEE Symposium on Security and Privacy, 2015.

ECS-908	:	SOFTWARE TESTING AND QUALITY ASSURANCE
Course category	:	PE9
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.
Course Objectives	:	1.Understand the fundamentals of software testing, including the role of a software tester, software development models, testing axioms, and commonly used testing terms and definitions. 2.Apply appropriate testing strategies and techniques such as black box testing, white box testing, structural and functional testing, and special testing types to identify software defects effectively. 3.Develop competence in test documentation, security testing, and web application testing, including test planning, test case design, bug

		life cycle management, and use of manual and automated testing tools. 4.Analyze software quality assurance practices and standards, including quality metrics, test management, organizational structures, and industry models such as CMM and ISO 9000 for quality improvement.
Course Outcomes	:	

CO1. Explain fundamental concepts of software testing.
CO2. Apply various software testing strategies and techniques.
CO3. Conduct special testing types such as configuration, compatibility.
CO4. Develop and document comprehensive test plans, test cases, and manage the bug life cycle.
CO5. Utilize software testing tools and automation techniques.
CO6. Understand software quality assurance principles like CMM and ISO 9000.

Topics Covered

UNIT-I **9L**

Introduction to Software Testing: Introduction, Definition of a Bug, Role of a Software Tester, Software Development Model, Software Testing Axioms, Software Testing Terms and Definitions.

UNIT-II **9L**

Fundamentals of Software Testing: Testing Strategies and Techniques, Structural and Functional testing, Static Black Box and Dynamic Black Box Testing Techniques. White Box Testing: Static White Box Testing, Dynamic White Box Testing. Special Types of Testing: Configuration Testing, Compatibility Testing, Graphical User Interface Testing.

UNIT-III **9L**

Documentation and Security Testing: Documentation Testing, Security Testing. Web site Testing: Web Page Fundamentals, Black Box Testing, White Box Testing and Gray Box Testing, Configuration and Compatibility Testing. Testing Tools: Benefits of Automation Testing, Random Testing, Bug Bashes and Beta Testing. Test Planning: Test Planning, Test Cases, Bug life cycle. Software Quality Assurance.

UNIT-IV **9L**

Definition of Quality, Testing and Quality Assurance at Workplace, Test Management and Organizational Structure, Software Quality Assurance Metrics, Quality Management in IT. Organizational Structure: CMM (Capability Maturity Model), ISO 9000, Software Engineering Standards.

TEXTBOOKS

1. Myers, G. J., Sandler, C., & Badgett, T., *The Art of Software Testing*, 3rd Edition.

John Wiley & Sons, 2011.
2.Pressman, R. S., & Maxim, B. R. *Software Engineering: A Practitioner's Approach*, 8th Edition. McGraw-Hill Education, 2015.
3. Ammann, P., & Offutt, J., *Introduction to Software Testing*, 2nd Edition. Cambridge University Press, 2016.
4. Kaner, C., Falk, J., & Nguyen, H. Q., *Testing Computer Software*, 2nd Edition. Wiley Publishing, 1999.

REFERENCE BOOKS

1. Software Testing: Principles and Practices"By: Srinivasan Desikan, Gopalaswamy Ramesh
2."Foundations of Software Testing: ISTQB Certification"By: Dorothy Graham, Erik van Veenendaal, Isabel Evans, Rex Black

ECS-918	:	AGILE SOFTWARE PROCESSES
Course category	:	PE9
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.
Course Objectives	:	1.Understand the foundations of Agile software development, including the Agile Manifesto, principles, values, roles, artifacts, stakeholders, and the business benefits of adopting agile practices. 2.Apply agile project planning and estimation techniques such as user stories, planning poker, prioritization, velocity tracking, and sprint planning to manage iterative and incremental development effectively. 3.Analyze and implement popular agile frameworks and methods, including Scrum, Extreme Programming (XP), Kanban, Lean, and Feature-Driven Development, along with their roles, ceremonies, and lifecycle impact. 4.Develop quality-driven agile software using testing-focused practices, including test-driven development, continuous integration, refactoring, risk-based testing, regression testing, and test automation.
Course Outcomes	:	
CO1. Interpret the concept of agile software engineering and its advantages in software development. CO2. Analyze the core practices behind several specific agile methodologies.		

CO3. Identify the roles and responsibilities in agile projects.
CO4. Apply agile concepts in real life projects
CO5. Access implications of functional testing, unit testing, and continuous integration.
CO6. Determine the role of design principles in agile software design

Topics Covered

UNIT-I **9L**

Need of Agile software development, agile context– Manifesto, Principles, Methods, Values, Roles, Artifacts, Stakeholders, and challenges. Business benefits ofsoftware agility. Project Planning: Recognizing the structure of an agile team– Programmers, Managers, Customers. User stories– Definition, Characteristics and content.

UNIT-II **9L**

Estimation– Planning poker, Prioritizing, and selecting user stories with the customer, projecting team velocity for releases and iterations. Project Design: Fundamentals, Design principles–Single responsibility, Open-closed, Liskov substitution, Dependency-inversion, Interface-segregation Design Methodologies: Need of scrum, Scrum practices –Working of scrum, Project velocity, Burn down chart, Sprint backlog, Sprint planning and retrospective.

UNIT-III **9L**

Daily scrum, Scrum roles– Product Owner, Scrum Master, Scrum Team. Extreme Programming- Core principles, values and practices. Kanban, Feature-driven development, Lean software development. The Agile lifecycle and its impact on testing.

UNIT-IV **9L**

Test driven development– Acceptance tests and verifying stories, writing a user acceptance test, Developing effective test suites, Continuous integration, Code refactoring. Risk based testing, Regression tests, Test automation.

TEXTBOOKS

1. Ken Schawber, Mike Beedle, “Agile Software Development with Scrum”, International Edition, Pearson.
2. Robert C. Martin, “Agile Software Development, Principles, Patterns and Practices”, First InternationalEdition, Prentice Hall.
3. Pedro M. Santos, Marco Consolaro, and Alessandro Di Gioia, “Agile Technical Practices Distilled: Alearning journey in technical practices and principles of software design”, First edition, Packt Publisher

REFERENCE BOOKS

1. Lisa Crispin, Janet Gregory, “Agile Testing: A Practical Guide for Testers and Agile Teams”, Internationaledition, Addison Wesley.
2. Alistair Cockburn, “Agile Software Development: The Cooperative Game”, 2nd Edition

ECS-909	:	SATELLITE IMAGE PROCESSING
Course category	:	PE9
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.
Course Objectives	:	1.Understand the fundamentals of digital image processing systems, including image formation, sampling and quantization, pixel relationships, and basic spatial-domain image enhancement techniques. 2.Apply image restoration and frequency-domain techniques to reduce noise, correct image degradation, perform geometric transformations, and process color images using appropriate mathematical models. 3.Develop skills in image segmentation and object recognition, including edge detection, region-based segmentation, pattern classification, and recognition methods using statistical, neural network, and structural approaches. 4.Analyze and visualize satellite and remote sensing images by interpreting spectral signatures, resolutions, metadata, and applying advanced Python-based visualization and object identification techniques for high-resolution imagery.
Course Outcomes	:	

CO1. Explain the fundamental concepts, system components, and steps involved in digital image processing, including image formation, sampling, quantization, and pixel relationships.
CO2. Apply spatial domain image enhancement techniques such as gray-level transformations, histogram processing, and spatial filtering for image improvement.
CO3. Analyze and implement image restoration techniques using noise models, spatial filtering, Wiener filtering, and geometric transformations.
CO4. Understand and apply Fourier transform concepts and frequency domain methods for image analysis and degradation estimation.
CO5. Perform image segmentation and object recognition using edge detection, thresholding, region-based techniques, statistical classifiers, and neural networks.
CO6. Utilize satellite imagery by interpreting spectral signatures and metadata; apply Python-based tools for visualization and identify objects using high-resolution remote sensing data

Topics Covered

UNIT-I **9L**

Introduction: Examples of fields that use digital image processing, fundamental steps in digital image processing, components of image processing system, Digital Image Fundamentals: A simple image

formation model, image sampling and quantization, basic relationships between pixels .Image enhancement in the spatial domain: Basic gray-level transformation, histogram processing, enhancement using arithmetic and logic operators, basic spatial filtering, smoothing and sharpening spatial filters, combining the spatial enhancement methods.

UNIT-II **9L**

Image restoration: A model of the image degradation/restoration process, noise models, restoration in the presence of noise–only spatial filtering, Weiner filtering, constrained least squares filtering, geometric transforms; Introduction to the Fourier transform and the frequency domain, estimating the degradation function. Color Image Processing.

UNIT-III **9L**

Image Segmentation: Detection of discontinuous, edge linking and boundary detection, thresholding, region–based segmentation. Object Recognition: Patterns and patterns classes, recognition based on decision–theoretic methods, matching, optimum statistical classifiers, neural networks, structural methods – matching shape numbers, string matching.

UNIT-IV **9L**

Visualization of satellite images, spectral signatures, band, width, sub-setting, mosaicking, advance tool in python for data visualization. Applicability of satellite images base on metadata, spatial resolution, spectral, temporal and radiometric resolution. Object identification techniques in high-resolution images.

TEXTBOOKS

1. Computer Processing of Remotely–Sensed Images: An Introduction, by PM Mather, Fourth Edition, Wiley Publishing House.
2. Remote Sensing Digital Image Analysis, by John A. Richard, Sixth Edition, Springer Nature.
3. Digital Image Processing using MATLAB, Gonzales/ Woods/ Eddins, 3rd edition, Gatesmark Publishing, ISBN 9780982085400.
4. Fundamentals of Digital Image Processing, A K Jain, Prentice Hall, 1989, ISBN 0-13-336165-9. 5. Digital Image Processing Rafael C. González, Richard Richard Eugene Woods, Steven L

REFERENCE BOOKS

1. Szeliski, R. *Computer Vision: Algorithms and Applications*. Springer, 2nd Edition, 2022. ISBN: 978-3030343712.
2. Schowengerdt, R. A. *Remote Sensing: Models and Methods for Image Processing*, 3rd Edition. Academic Press (Elsevier), 2007.ISBN: 978-0123694072.

ECS-919	:	SPATIAL DATA QUALITY ASSESSMENT
Course category	:	PE9
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials and one minor test and one major examination.

Course Objectives	:	1.Understand the concepts and dimensions of spatial data quality, including accuracy, precision, completeness, consistency, timeliness, and lineage, and evaluate their impact on spatial analysis and decision-making. 2.Assess positional, attribute, and temporal accuracy of spatial data using appropriate measurement techniques, and identify issues related to completeness and consistency in geospatial datasets. 3.Apply metadata standards and uncertainty modeling techniques to document spatial data quality, analyze error sources, and evaluate error propagation in spatial analysis. 4.Use statistical and practical methods to evaluate spatial data quality in GIS and remote sensing applications, including quality control, validation techniques, and real-world case studies across various domains.
Course Outcomes	:	

CO1. Develop a comprehensive understanding of spatial data quality concepts, dimensions, and standards used in geospatial systems.
CO2. Equip students with methods and statistical techniques to assess positional, attribute, temporal, and logical accuracy of spatial datasets.
CO3. Enable evaluation of completeness, consistency, and uncertainty in spatial databases and GIS applications.
CO4. Provide knowledge of metadata standards and quality documentation frameworks for spatial data governance.
CO5. Introduce error modeling, uncertainty quantification, and quality validation techniques in GIS and remote sensing applications.
CO6. Apply spatial data quality assessment methods to real-world domains such as urban planning, environmental monitoring, disaster management, and transportation systems.

Topics Covered

UNIT-I **9L**

Introduction to Spatial Data Quality: definition of spatial data quality, dimensions of spatial data quality (accuracy, precision, completeness, consistency, timeliness, lineage), Importance and impact of quality in spatial analysis.

UNIT-II **9L**

Positional and Attribute Accuracy: Types of accuracy (absolute, relative), Measuring positional accuracy, Assessing attribute accuracy, Completeness and Consistency: Types of completeness (logical, semantic, coverage), Consistency issues and detection methods. Temporal Accuracy and Timeliness: Time-related aspects of spatial data, Assessing temporal accuracy and relevance.

UNIT-III **9L**

Metadata and Quality Documentation: Role of metadata in spatial data quality, Standards (ISO 19157, FGDC), Creating and evaluating metadata for quality assessment. Error Propagation and Uncertainty Modeling: Types of errors (systematic, random), Error propagation in spatial analysis. Uncertainty quantification techniques.

UNIT-IV **9L**

Statistical Methods for Quality Assessment:Sampling strategies for quality assessment, Statistical testing for accuracy and precision.Quality Assessment in Remote Sensing Data:Radiometric and geometric accuracy, Validation of remote sensing products. Case Studies in Spatial Data Quality:GIS data quality challenges in urban planning, environmental monitoring, disaster management, and transportation, Quality Control and Data Validation Techniques:Automated vs. manual validation methods, Tools and software for spatial data validation.

TEXTBOOKS

1. Fundamentals of Spatial Data Quality,by Devillers, R., &Jeansoulin, R. (Eds.),Springer.
2. Assuring the quality of volunteered geographic information.by Goodchild, M. F., & Li, L. (2012).
3. Fundamentals of Spatial Data Quality, RobertJeansoulin, Rodolphe Devillers, Michael F. Goodchild, ISTE

REFERENCE BOOKS

1. Devillers, R., & Jeansoulin, R. (Eds.). (2006). *Fundamentals of spatial data quality*. ISTE Ltd & John Wiley & Sons.
2. Goodchild, M. F., & Li, L. (2012). Assuring the quality of volunteered geographic information. *Spatial Statistics, 1*, 110–120. https://doi.org/10.1016/j.spasta.2012.02.002
3. ISO. (2013). *ISO 19157: Geographic information — Data quality*. International Organization for Standardization.
4. FGDC. (1998). *Content standard for digital geospatial metadata (FGDC-STD-001-1998)*. Federal Geographic Data Committee.
5. Heuvelink, G. B. M. (1998). *Error propagation in environmental modelling with GIS*. Taylor & Francis.
6. Foody, G. M. (2002). Status of land cover classification accuracy assessment. *Remote Sensing of Environment, 80*(1), 185–201. https://doi.org/10.1016/S0034-4257(01)00295-4
7. Burrough, P. A., McDonnell, R. A., & Lloyd, C. D. (2015). *Principles of geographical information systems* (3rd ed.). Oxford University Press.

Annexure-01
Syllabus of Audit Courses

		CONSTITUTION OF INDIA
Course Code:	:	AUC 101 Credits (0-0-0)
Course Category	:	Audit
Pre-requisite Subject	:	NIL
Contact Hours/Week	:	1/2 Lecture : , Tutorial : , Practical:
Number of Credits	:	0 Credit
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.
COURSE OUTCOME:		
At the end of the course, learners should be able to		
CO1. Student will Identify and explore the basic features and modalities about Indian constitution		
CO2. Students will be able to differentiate and relate the functioning of Indian parliamentary system at the center and state level.		
CO3. Student will be able to differentiate different aspects of Indian Legal System and its related bodies.		
CO4. Analyze constitutional provisions related to citizenship, elections, emergency powers, and amendment procedures.		
CO5. Describe Fundamental Rights, Directive Principles of State Policy, and Fundamental Duties and their significance in democratic governance.		
CO6. Develop awareness of constitutional values, democratic principles, rule of law, and responsibilities of citizens in Indian society.		

UNIT 1–
Introduction and Basic Information about Indian Constitution: Historical Background of the Constituent Assembly, The Preamble of the Constitution, Fundamental Rights, Fundamental Duties, Directive Principles of State Policy, Parliamentary System, Federal System.
UNIT 2-
Union Executive and State Executive: Powers of Indian Parliament Functions of Rajya Sabha, Functions of Lok Sabha, Powers and Functions of the President, Powers and Functions of the Prime Minister, Judiciary.
UNIT 3-
Introduction and Basic Information about Legal System: The Court System in India and Foreign Courtiers (District Court, District Consumer Forum, Tribunals, High Courts, Supreme Court).
UNIT 4-
Intellectual Property Laws and Regulation to Information: Introduction, Legal Aspects of Patents, Filing of Patent Applications, Rights from Patents, Infringement of Patents, Copyright, Information Technology Act, 2000. The Company's Act:

Text/Reference:
1. G. Austin (2004) Working of a Democratic Constitution of India, New Delhi: Oxford University Press.
2. Basu, D.D (2005), An Introduction to the Constitution of India, New Delhi, Prentice Hall.
3. N. Chandhoke & Priyadarshini (eds) (2009) Contemporary India: Economy, Society, Politics, New Delhi: Oxford University Press.
4. N.G Jayal and P.B. Maheta, (eds) (2010) Oxford Companion to Indian Politics, New Delhi: Oxford University Press.

Indian Culture and Heritage

Course Code:	:	AUC 102 Credits (0-0-0) Course Category:
Audit		
Pre-requisite Subject	:	NIL
Contact Hours/Week	:	1/2 Lecture : , Tutorial : , Practical:
Number of Credits		0 Credit
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.

Unit-I
Indian Culture: An Introduction, Characteristics of Indian culture, Significance of Geography on Indian Culture, Society in India, Religion and Philosophy in India.
Unit-II
Indian Languages and Literature, Evolution of script and languages in India, Harappan Script and Brahmi Script, History of Buddhist and Jain Literature.
Unit-III
A Brief History of Indian Arts and Architecture, Indian Art & Architecture: Gandhara School and Mathura School of Art; Hindu Temple Architecture, Buddhist Architecture, Medieval Architecture and Colonial Architecture. Indian Painting Tradition: ancient, medieval, modern Performing Arts: Divisions of Indian classical music: Hindustani and Carnatic, Dances of India: Various Dance forms: Classical and Regional, Rise of modern theatre and Indian cinema.
Unit-IV
Spread of Indian Culture Abroad, Causes Significance and Modes of Cultural Exchange - Through Traders, Teachers, Emissaries, Missionaries and Gypsies, Indian Culture in South East Asia, India, Central Asia and Western World.
Recommended Readings:

1. Barua, B. 1934-37. Barhut Vol. I-III. Calcutta: Indian Research Institute.
2. Cunningham, Alexander 1966. The Bhilsa Topes. Varanasi: Indological Book Corporation.
3. Cunningham, Alexander 1965. The Stupa of Bharhut. Varanasi: Indological Book Corporation.
4. Dallapiccola, L.S.Z. Lallemant. 1980. The Stupa : Its Religious, Historical, and Architectural Significance. Wiesbaden: Franz Steiner Verlag.
5. Dehejia, Vidya 1972. Early Buddhist Rock Temples A Chronological Study. London: Thames and Hudson

Indian Architecture		
Course Code:	:	AUC 103 Credits (0-0-0) Course Category :
Pre-requisite Subject	:	NIL
Contact Hours/Week	:	1/2 Lecture : , Tutorial : , Practical:
Audit	:	
Number of Credits	:	0 Credit
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.
Course outcome		
CO1. This course will help student learn about the development of Indian architecture and its contextual and traditional aspects.		
CO2. The learner will gain knowledge of the development of architectural forms with reference to technology, style and character in various aspects of Hindu architecture.		
CO3. The students will comprehend and relate to the theoretical basis of Budhdhist and Jain Architectures.		
CO4. Recognize important monuments and architectural heritage sites and understand their historical and cultural significance.		
CO5. Apply basic architectural concepts such as design elements, materials, construction techniques, and spatial planning used in Indian structures.		
CO6. Develop appreciation for conservation, preservation of architectural heritage, and the role of architecture in reflecting Indian culture and identity.		

UNIT 1;

Indus Valley Civilization: Town planning principles, cultural ethos, economy exemplified. The Aryan civilization: With its emphasis on the Vedic town plan.

UNIT 2:

Buddhist Architecture Typology of lats, eddicts, stupas, viharas, and chaityas, both in rock-cut or other wise. The Buddhist philosophy and its imprint

UNIT3;

Hindu Architecture, Indo Aryan: The evolution of the temple form, evolution of the shikhara in north India. The three schools of architecture - the Gujarat, the Khajuraho, and the Orrisan styles, Introduction to Dravidian Hindu Architecture.

UNIT 4:

Jain Architecture : The temple cities of Palitana, Mount Abu and Girnar. Jain Theory The Jain philosophy and its imprint in built form.

TEXT BOOKS /REFERENCE BOOKS

1. Stella Kramrisch, The Hindu temple, Volume 1 & 2, Motilal Banarsidass Publications, 1996.
2. Percy Brown, Indian Architecture (Buddhist and Hindu period), D.B.Taraporewala Sons & co Pvt. Ltd. 1965
3. Volwahsen, Andreas, Living Architecture
4. Satish Grover, The Architecture of India- Volume 2, Vikas, 1980.
5. Henri Stierlin, Anne Stierlin, Hindu India: from Khajuraho to the temple city of Madurai, Taschen, 1998.
6. James Fergusson, History of Indian & Eastern Architecture, 2007
7. C. Batley, Design Development of Indian Architecture, John murray, London, 1934.

Indian Festivals		
Course Code:	:	AUC 104 **Credits (0-0-0)**
Course Category	:	Audit
Pre-requisite Subject	:	NIL
Contact Hours/Week	:	½ Lecture : , Tutorial : , Practical:
Number of Credits	:	0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments,		

quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.
Course Outcomes:
CO1. Students will learn about rich cultural aspects associated with Indian religions.
CO2. The course will give deep insight in to understand the importance of festivals.
CO3. Analyze the social, cultural, and economic impact of Indian festivals on communities and society.
CO4. Recognize the diversity and unity reflected through festivals of different religions, languages, and cultural groups in India.
CO5. Describe traditional practices, rituals, foods, arts, and performances associated with Indian festivals.
CO6. Develop appreciation for cultural heritage, national integration, and the values of harmony and inclusiveness promoted through Indian festivals.

UNIT 1; Indian Festivals:
Introduction to major Indian festivals Bihu, Raksha Bandhan, Onam, Pongal, Holi, Dipawali, Dushehra, Easter, Good Friday, Christmas , Eid-ul-fitr and Eid-ul-Azha , Cultural aspects of festivals .

UNIT 2 ; Characteristics of Indian festivals ;

Seasonal in nature, seasonal festival are Agro based, worships of animals.

UNIT 3;

festivals observed at same time but with different names in different parts of country.

UNIT3 :

Artificial or non religious festivals- like Jaisalmer desert festivals, Mango festivals in Delhi, Elephant festivals in India. Etc.

REFERENCE BOOKS

Discover India; Festival of India by Sonia Mehta
1. Hindu Festival : Origin, sentiments and Rituals by Mukuncharan Das.

VAIDIC MATHEMEATICS		
Course Code:	:	AUC 105 **Credits (0-0-0)**
Course Category	:	Audit
Pre-requisite Subject	:	NIL
Contact Hours/Week	:	1/2 Lecture : , Tutorial : , Practical:
Number of Credits	:	0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.		
Course outcomes:		
CO1. Vedic mathematics methods are used in coding and VLSI implementation of encryption.		
CO2. Vedic mathematics method of division, exponentiation and multiplication are used in internet		
security and cryptographic algorithms for making these calculations faster than before.		
CO3. Arithmetic and logic unit (ALU) is responsible for all mathematical and logical calculations in computers. Some sutras like udharvtriyakbhyam and nikhilam are used for implementing multiplication methods.		
CO4. Digital Signal Processing (DSP) includes face recognition, text speech conversion, image processing and audio -video processing and also filtering of noise. In this area VM methods are very useful to improve the performance of DSP algorithms.		
CO5. Compare Vedic mathematical methods with conventional approaches to evaluate efficiency and applicability.		
CO6. Develop logical thinking, numerical aptitude, and problem-solving skills useful for academic and competitive examinations.		

UNIT-I

Introduction & history of Vedic mathematics, Arithmetic and number, Vedic Maths Formulae, Addition and Subtraction: Addition - Completing the whole , Addition from left to right , Addition of list of numbers - Shudh method , Subtraction - Base method , Subtraction - Completing the whole, Subtraction from left to right

UNIT-II

Multiplication: Ekadhikenpurven method (multiplication of two numbers of two digits), Eknunenpurven method (multiplication of two numbers of three digits), Urdhvatiragbhyam method (multiplication of two numbers of three digits), Nikhilam Navtashchramam Dashtaha (multiplication of two numbers of three digits), Combined Operations Division and Divisibility: Division, Nikhilam Navtashchramam Dashtaha (two digits divisor), Paravartya Yojyet method (three digits divisor) Divisibility: Ekadhikenpurven method (two digits divisor), Eknunenpurven method (two digits divisor)

UNIT-III

Least Common Multiple (LCM) and Highest Common Factor (HCF)

Power and Root Power: Square (two digit numbers), Cube (two digit numbers). Root: Square root (four digit number), Cube root (six digit numbers)

UNIT-IV

Contribution of Indian Mathematicians (In light of Arithmetic) , Aryabhatt , Brahmagupt , Mahaveeracharya , Bharti Krishna Tirtha

Reference Books:

1. Vedic Mathematics, Motilal Banarsi Das, New Delhi.
2. Vedic Ganita: Vihangama Drishti-1, Siksha Sanskriti Uthana Nyasa, New Delhi.
3. Vedic Ganita Praneta, Siksha Sanskriti Uthana Nyasa, New Delhi.
4. Vedic Mathematics: Past, Present and Future, Siksha Sanskriti Uthana Nyasa, New Delhi.
5. Leelavati, Chokhambba Vidya Bhavan, Varanasi.

Bharatiya Mathematicians, Sharda Sanskrit Sansthan, Varanasi.

ASTRONOMY		
Course Code:	:	AUC106 Credite(0-0-0)
Course Category	:	Audit
Pre-requisite Subject	:	NIL
Contact Hours/Week	:	1/2 Lecture : , Tutorial : , Practical:
Number of Credits	:	0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.		
Course Outcome:		
CO1.Understand fundamental concepts of astronomy including the origin, structure, and evolution of the universe, galaxies, stars, and planetary systems.		
CO2.Describe the solar system, motions of celestial bodies, phases of the moon, eclipses, and basic astronomical phenomena.		
CO3. Explain observational astronomy techniques including telescopes, astronomical instruments, and methods of data collection.		
CO4. Analyze basic astrophysical concepts such as light, spectra, gravity, and stellar life cycles.		
CO5. Interpret astronomical data, charts, and sky maps for identifying constellations and celestial objects.		
CO6. Develop scientific curiosity and awareness of recent developments and applications of astronomy in space science and technology.		

UNIT-I

Historical introduction: Old Indian and western – astronomy – Aryabhatta, Tycho Brahe, Copernicus, Galileo – Olbers paradox – solar system – satellites, planets, comets, meteorites, asteroids.
Practical astronomy – telescopes and observations & techniques – constellations, celestial coordinates, ephemeris.
Celestial mechanics – Kepler's laws – and derivations from Newton's laws.
Sun: Structure and various layers, sunspots, flares, faculae, granules, limb darkening, solar wind and climate.

UNIT-II

Stellar astronomy: H-R diagram, color-magnitude diagram – main sequence – stellar evolution – red giants, white dwarfs, neutron stars, black holes – accretion disc – Schwartzchild radius – stellar masses Saha–Boltzman equation – derivation and interpretation. Variable stars: Cepheid, RR Lyrae and Mira type variables – Novae and Super novae. Binary and multiple star system – measurement of relative masses and velocities. Interstellar clouds – Nebulae.

UNIT-III

Transformations Generalized Coordinates, Canonical transformations, Conditions for canonical transformation and problem, Poisson brackets, invariance of PB under canonical transformation, Rotating frames of reference, inertial forces in rotating frames.

UNIT-IV

Relativity and Application Concept of Special Theory of Relativity, Lorentz Transformation, Length Contraction and time dilation, Relativistic addition of velocities, conservation of mass and momentum, Concept of General Theory of Relativity, Equivalence of mass and energy, Relativistic Doppler shift and aberration of light. Lagrangian and Hamiltonian of relativistic particles, Relativistic degenerate electron gas.

Reference Books:

1. "Textbook of Astronomy and Astrophysics with elements of Cosmology", V. B. Bhatia, Narosa publishing 2001.
2. William Marshall Smart, Robin Michael Green "On Spherical Astronomy", (Editor) Carroll, Bradley W Cambridge University Press ,1977
3. Bradley W.Carroll and Dale A. Ostlie. "Introduction to modern Astrophysics" Addison-Wesley, 1996.
4. 'Stellar Astronomy' by K. D Abhayankar.

'Solar Physics' by K. D Abhayankar.

ARTS OF INDIA		
Course Code:	:	AUC 107Credits (0-0-0)
Course Category	:	Audit
Pre-requisite Subject	:	NIL
Contact Hours/Week	:	1/2 Lecture : , Tutorial : , Practical:
Number of Credits	:	0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.		

Course Outcomes:

CO1. Students will be introduced to emergence and development of art traditions upto 6th century C.E. Monuments will be studied in their cultural context.

CO2. Students will able to understand the monuments in their religious, regional and stylistic context. Students will be able to prepare plans of the monuments.

CO3. Analyze the cultural, religious, and social influences that shaped various traditional and contemporary art forms in India

CO4. Recognize prominent artists, art movements, and significant contributions to Indian artistic heritage.

CO5. Appreciate the role of arts in preserving cultural identity, traditions, and values across different regions of India.

Develop creative awareness and critical understanding of artistic expression and the importance of conserving India's artistic heritage.

Unit 1:

Introduction to traditions of Art and Architecture in India . Introduction to Art and Architecture and prelude to historical art. ii. Art of the pre-Mauryan period. iii. Art and Architecture of Mauryan Period iv. Sources of Inspiration of Mauryan Art and Architecture: Foreign and Indigenous.

Unit 2:

Emergence and Development of Structural Stupa Architecture . Origin of Stupa Architecture. ii. Stupa Architecture - Pre-Mauryan and Mauryan periods. iii. North India, Central India, Deccan and Gandhara iv. Structural monasteries and Chaityas.

Emergence and Development of Rock-cut Architecture. Origin of Rock-cut Architecture. ii. Eastern India, Western Deccan, Eastern Deccan, Central India.

Unit 3:

Unit 4: Emergence and Development of Temple Architecture (08 hrs) i. Origin of Temple Architecture- Theoretical aspects. ii. Concept and symbolism of Temple. iii. Archaeological remains of structural temples. iv. Temple Architecture during the Gupta period. v. Temple Architecture during the Vakataka period.

Unit 4:

Sculptural Art and Paintings - Emergence and Development (10 hrs) i. Sculptural Art and Paintings

-Concept and Symbolism. ii. Terracottas, Ivories and Bronzes iii. Paintings iv. Stone sculptures- Gandhara, Mathura, Sarnath and Andhra schools of Art. v. Art during the Gupta-Vakataka period.

Recommended Readings:

1. Barua, B. 1934-37. Barhut Vol. I-III. Calcutta: Indian Research Institute.
2. Cunningham, Alexander 1966. The Bhilsa Topes. Varanasi: Indological Book Corporation.
3. Cunningham, Alexander 1965. The Stupa of Bharhut. Varanasi: Indological Book Corporation.
4. Dallapiccola, L.S.Z. Lallemant. 1980. The Stupa : Its Religious, Historical, and Architectural Significance. Wiesbaden: Franz Steiner Verlag.

Dehejia, Vidya 1972. Early Buddhist Rock Temples A Chronological Study. London: Thames and Hudson

INTELLECTUAL PROPERTY RIGHTS		
Course Code:	:	AUC 108
Credits (0-0-0)		
Course Category	:	Audit
Pre-requisite Subject	:	NIL
Contact Hours/Week	:	1/2 Lecture : , Tutorial : , Practical:
Number of Credits	:	0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.		
Course Outcomes: After the completion of the course the student will be able to		
CO1. Create an understanding on Intellectual Properties and the importance of it.		
CO2. Understand Trademarks and Trade secrets. To create awareness of unfair completion and methods of it.		
CO3. Create awareness on the protection copyrights and patents. Understand the Ownership rights and transfer.		
CO4. Create awareness of Cyber laws, Cyber Crime and get understanding of Privacy of Data.		

CO5. To create awareness international aspects of IPR and the Emerging Trends in IPR.
CO6. Develop awareness of professional ethics, legal responsibilities, and strategies for protecting innovations and intellectual assets.

Course Content

UNIT – I:

Introduction to Intellectual property: Introduction, types of intellectual property—Patent, Trademarks, Copy rights, IPR and World Trade Organization, other international organizations, agencies and treaties, importance of intellectual property rights. Creating Intellectual Property. Intellectual Property Management. Emerging Issues in IPR. Research and Development in India.

UNIT – II:

Fundamentals of Patent: Historical Overview of Patent Law; Concept of Patent; Patentable Inventions; Procedure for Obtaining Patent; Rights and Obligations of Patent Holder; Transfer and Infringement of Patent Rights, Geographical Indications, Case Study: Apple versus Samsung Patent Dispute.

UNIT – III:

Trademarks: Purpose and function of trademarks, acquisition of trademark rights, protectable matter, selecting, and evaluating trademark, trade mark registration processes.

UNIT – IV:

Copy rights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law. Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer.

Textbooks

1. Textbook of Intellectual Property Rights, N.K. Acharya. Asia Law House, ed. 2021.
2. Intellectual property right, Deborah. E. Bouchoux, Cengage learning.
3. Intellectual Property Rights–Pandey Neeraj, Dharni Khushdeep. PHI.
4. Intellectual Property Rights: Text and Cases R. Radhakrishnan, S. Balasubramanian. Excel Books.

Reference Books

1. Intellectual property right – Unleashing the knowledge economy, Prabuddha Ganguli, Tate McGraw Hill ltd.
2. A short course in International Intellectual Property Rights – Karla C. Shippey, World Trade Press.

Intellectual Property Rights – Heritage, Science, & Society under international treaties –A. Subbian, - Deep & Deep Publications – New Delhi.

HUMAN RIGHTS		
Course Code:	:	AUC 109Credits (0-0-0)
Course Category	:	Audit
Pre-requisite Subject	:	NIL
Contact Hours/Week	:	1/2 Lecture : , Tutorial : , Practical:
Number of Credits	:	0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.		
Course Outcomes:		
On completion of the course, students will be able to:		
CO1 Simply put, human rights education is all learning that develops the knowledge, skills, and values of human rights.		
CO2. Strengthen the respect for human rights and fundamental freedoms.		
CO3. Enable all persons to participate effectively in a free society.		
CO4. Learn about human rights principles, such as the universality, indivisibility, and interdependence of human rights.		
CO4. Identify the roles of national and international human rights organizations, institutions, and enforcement mechanisms.		
CO5. Develop awareness of ethical responsibilities, democratic values, and the importance of promoting equality, dignity, and human rights in society.		

UNIT-I

The Basic Concepts: Individual, Group, Civil Society, State, Equality, Justice, Human Values: Humanity, Virtues, Compassion.

UNIT-II

Human Rights and Human Duties: Philosophical and historical foundation of human rights and duties Theories of rights Concept and classifications of human rights and duties Human rights and duties Correlation of rights and duties/responsibilities Tensions between rights inter se, duties inter se, and rights and duties

UNIT-III

Society, Religion, Culture, and their Inter-Relationship: Impact of Social Structure on Human behavior, Roll of Socialization in Human Values, Science and Technology, Modernization, Globalization, and Dehumanization.

UNIT-IV

Social Structure and Social Problems: Social and Communal Conflicts and Social Harmony, Rural Poverty, Unemployment, Bonded Labour, Migrant workers and Human Rights Violations, Human Rights of mentally and physically challenged.

Books & References:

1. Shastry, T. S. N., India and Human rights: Reflections, Concept Publishing Company India (P Ltd), 2005.

Nirmal, C.J., Human Rights in India: Historical, Social and Political Perspectives (Law in India), Oxford India.

LOGICAL RESEARCH		
Course Code:	:	AUC 110Credits (0-0-0)
Course Category	:	Audit
Pre-requisite Subject	:	NIL
Contact Hours/Week	:	1/2 Lecture : , Tutorial : , Practical:
Number of Credits	:	0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination		
Course outcome: In this course you should develop the following competencies:		
CO1. To understand about research methodology with its different aspects, about logical reasoning, and types of research.		
CO2. It will also result in knowledge appraisal from data collection to data interpretation.		
CO3. Mathematical reasoning will also help them to acquire several skills required for the placement.		
CO4. Evaluate arguments, identify logical fallacies, and use critical thinking skills to analyze research findings.		
CO5. Use appropriate tools and techniques for literature review, referencing, and preparation of research reports.		
CO6. Demonstrate ethical practices, academic integrity, and effective communication skills in logical research and documentation.		

Course Content

UNIT1-

Research Methodology: meaning, characteristics, Types of research; Process of research; Research methods and Ethical issues in research.

UNIT2-

Logical Reasoning: arguments, deductive and inductive research, quantitative and qualitative research, scientific research; logical approach in research - Venn diagram; Inferences; analogies.

UNIT3-

Data collection, Organization of data, Data analysis and mapping, Parametric and non- parametric; Data Interpretation.

UNIT4-

Mathematical Reasoning, number series, letter series, codes; relationships, classification.

References:

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press. 3.ResearchMethodology–C.R.Kothari
3. Marketing Research- G C Beri

Logical reasoning- R S Agarwal

PROFESSIONAL ETHICS		
Course Code:	:	AUC 111Credits (0-0-0)
Course Category	:	Audit
Pre-requisite Subject	:	NIL
Contact Hours/Week	:	1/2 Lecture : , Tutorial : , Practical:
Number of Credits	:	0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.		
Course Outcomes		
Course Outcomes: After the completion of the course the student will be able to- CO1. Understand the core values that shape the ethical behaviour of a professional.		
CO2. Identify the multiple ethical interests at stake in a real-world situation or practice.		
CO3. Explain the role and responsibility in technological development by keeping personal ethics and legal ethics.		
CO4. Solve moral and ethical problems through exploration and assessment by established experiments.		
CO5. Apply the knowledge of human values and social values to contemporary ethical values and global issues.		
CO6. Demonstrate ethical behavior, accountability, and effective communication skills while working individually and in teams.		

Course Content

Unit I:

Understanding Professional Ethics and Human Values: Morals, values and Ethics – Integrity- Academic integrity-Work Ethics- Service Learning- Civic Virtue Respect for others- Living peacefully- Caring and Sharing- Honestly- courage- Cooperation commitment Empathy-Self Confidence - Social Expectations.

Unit II:

Ethics for Engineers: Ethics – its importance – code of ethics – person and virtues – habits and morals – 4 main virtues – ethical theories – Kohlberg's theory – Gilligan's theory – towards a comprehensive approach to moral behaviour – truth – approach to knowledge in technology.

Unit III:

Environmental Ethics and Sustainability: Problems of environmental ethics in engineering – engineering as profession serving people – engineer's responsibility to environment – principles of sustainability – industrial, economic, environmental, agricultural, and urban sustainability – Sustainable development. - Global Ethical Issues.

Unit IV:

Social Experimentation, Responsibility and Rights: Engineers and responsible experiments – safety and risk – confidentiality – knowledge gained confidentiality – experimental nature of engineering – Intellectual Property Rights – professional rights – employee rights – occupational crime.

Textbooks

1. Mike W Martin, Roland Schinzinger, " Ethics in Engineering", Tata McGraw –Hill.
2. Govindarajan M, Natarajan S, Senthil Kumar V S, "Engineering Ethics" PHI India.

R.R Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and professional Ethics, Excel books, New Delhi.

Reference Books

1. Aarne Vesblind, Alastair S Gunn, "Engineering Ethics and the Enviornment".
2. Edmund G Seebauer, Robert L Barry, "Fundamentals of Ethics for scientists and engineers" Oxford University Press.

B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book

ENVIRONMENTAL LAWS		
Course Code:	:	AUC 112Credits (0-0-0)
Course Category	:	Audit
Pre-requisite Subject	:	NIL
Contact Hours/Week	:	1/2 Lecture : , Tutorial : , Practical:
Number of Credits	:	
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.		
Course Outcomes:		
The course gives students the opportunity to grapple with contemporary legal debates in environment law. Therefore, the learning outcomes of this course can be encapsulated as follows:		
CO1. The primary learning outcome is to sensitize the students towards human activities that adversely affect the environment and the need for regulation of such activities.		
CO2. Students will develop a thorough understanding of practice and procedure followed by various environmental law enforcing agencies/bodies.		
CO3. Students will be able to pursue environmental litigation before the National Green Tribunal and assist the Tribunal as a researcher or in any other capacity.		
CO4. Students will be able to assist industries and projects in obtaining environmental clearance and compliances with other environmental laws.		
CO5. Identify the roles and responsibilities of environmental regulatory bodies, institutions, and enforcement mechanisms.		
CO6. Develop awareness of legal compliance, environmental ethics, and the role of individuals and organizations in protecting the environment.		

UNIT-I

Development of Environmental Laws and Policies in India: Concept of 'environment' and understanding scope of environmental law. Two approaches towards environmental protection- 'Eco-centric approach'and 'Anthropocentric' approach. Impact of IEL on environmental law in India. Significance of Environmental Protection in Five Year Plans. Development of the 'Right to Environment' as a Fundamental Right and challenges.

UNIT-II

Judicial remedies and the role of National Green Tribunal:Civil Remedies i.e. Tortious remedy and Class Action Criminal Law Remedies under relevant provisions of Indian Penal Code, 1860 and Criminal Procedure Code, 1973 Constitutional Law Remedies i.e. Writ Jurisdiction & Public Interest Litigation Statutory Remedies i.e. Remedies under Public Liability Insurance Act 1991, National Environment Tribunal Act, 1995, National Green Tribunal Act, 2010

UNIT-III

Statutory framework for Prevention of Environmental, Air and Water Pollution: Water (Prevention and Control of Pollution) Act 1974 [Framework of the Act, Criminal Liability and Judicial relief under the Act, Constitutional Challenges of Restraining Orders under Section 33] The Air (Prevention and Control of Pollution) Act 1981 [Framework of the Act, Criminal Liability and Judicial relief under the Act, Noise PollutionEnvironment (Protection) Act, 1986 [Framework of the Act, Enforcement mechanisms and Role of Pollution Control Boards, Environment Impact Assessment, Coastal zone regulations Notifications] Law on Waste Management and Handling Procedural environmental rights under various environmental laws Right to Information

Right to public consultation Right of access to justice

UNIT-IV

Statutory framework governing Forest, Wildlife and Biodiversity: Statutory Framework on Forest Preservation [The Indian Forest Act, 1927; Forest (Conservation) Act, 1980; National Forest Policy, 1988; The Scheduled Tribe and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006] Statutory Framework on Wildlife & Biodiversity Protection [The Wildlife (Protection) Act, 1972; Implementation and gaps and Judicial Perspective; Biological Diversity Act, 2002]

Books & References:

1. Shyam Divan & Armin Rosencranz, Environmental Law & Policy in India (2 nded, Oxford University Press, 2014)
2. P. Leelakrishnan, Environmental law in India (4th ed, LexisNexis, 2016)
3. Lavanya Rajamani and Shibani Ghosh, Indian Environmental Law: Key Concepts and Principles (Orient Blackswan, 2019)
4. Gitanjali Nain Gill, Environmental Justice in India: The National Green Tribunal (Routledge, 2017)
5. Patricia Birnie, Alan Boyle and Catherine Redgwell, International Law and the Environment (3rd ed., Oxford University Press, 2009)

Philippe Sands, Principles of International Environmental Law (2nd ed, Cambridge University Press, 2003)

HEALTH LAW		
Course Code:	:	AUC 113Credits (0-0-0)
Course Category	:	Audit
Pre-requisite Subject	:	NIL
Contact Hours/Week	:	½ Lecture : , Tutorial : , Practical:
Number of Credits	:	0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination		
Course Outcome: In this course you should develop the following competencies:		
CO1. Knowledge and understanding of the values and policies underlying Health Law.		
CO2.Knowledge and understanding of substantive law related to health care, health care insurance markets as well as related procedural law.		
CO3.Written and oral communication in the legal context.		
CO4.Analyze legal and ethical issues such as medical negligence, informed consent, confidentiality, and professional accountability.		
CO5.Understand laws related to healthcare standards, patient safety, medical records, and bioethics.		
CO6. Develop awareness of legal compliance, ethical practices, and the role of law in promoting quality healthcare and public welfare		

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Course Content

UNIT-1

BASICS OF HEALTH LAW- Basic of Health and its provider, Origin & Evaluation, All Council Acts.

UNIT-2

NEED FOR HEALTH LAW -Fraudulence, Negligence and Abuse, Human Rights, Rights & Duties of Health Care Provider (Public & Private Activities).

UNIT-3

LEGAL ASPECTS OF HEALTH LAW- Role of Health Policy & Health Care Delivery, General Laws on Health Law (Medical Allied Agencies), Specific Laws on Health Law (NDT, PWD/etc.).

UNIT-4

MEDICAL INSURANCE –Introduction-Various types, Significance and Kind of Medical Insurance/Policies, Insurance & Assurance, General Principles of Law and Contract, Medical Insurance Regulations.

TEXT/ REFERENCES:

1. Jonathan Herring- Medical Law and Ethics
2. Mason and Mc Call Smith- Law and Medical Ethics

S. V. Jogarao- Current Issues in Criminal Justice and Medical Law

National Cadet Corps (NCC)			
Course Code:		:	AUC 114 Credits (0-0-0)
Course Category		:	Audit
Pre-requisite Subject		:	NIL
Contact Hours/Week		:	½ Lecture : , Tutorial : , Practical:
Number of Credits		:	0 Credit
	Course Outcome: In this course you should develop the following competencies:		
	CO1. Imbibe the conduct of NCC cadets.		
	CO2. Respect the diversity of different Indian culture.		
	CO3. Perform his/her role in Nation Building		
	CO4. Do the social services on different occasions.		
	CO5. Practice togetherness and empathy in all walks of their life.		
	CO6. Do the asana and gain the physical& mental fitness		

Course Content

UNIT 1
NCC General
History, Aims, Objective of NCC, NCC as Organization. Incentives of NCC, Duties of NCC Cadet, NCC Camps: Types & Conduct.

UNIT 2
National Integration & Awareness: National Integration: Importance & Necessity, Factors Affecting National Integration, Unity in Diversity & Role of NCC in Nation Building, Threats to National Security

UNIT 3
Social Service and Community Development: Celebration of Days of National & International Importance, Social Service and Community Development Activities to be conducted.

UNIT 4
Health & Hygiene: Yoga- Introduction, Definition, Purpose, Benefits.
Asanas-Padamsana, Siddhasana, Gyan Mudra, Surya Namaskar, Shavasana, Vajrasana, Dhanurasana, Chakrasana, Sarvaangasana, Halasana etc.

Textbooks:
1. R. Gupta, "NCC: Handbook of NCC Cadets for 'A', 'B' and 'C' Certificate Examinations" 1st Edition (English, Paperback, RPH Editorial Board)

Basics of Human Health and Preventive Medicines		
Course Code:	:	AUC 115 Credits (0-0-0)
Course Category	:	Audit
Pre-requisite Subject	:	NIL
Contact Hours/Week	:	1/2 Lecture: , Tutorial : , Practical:
Number of Credits	:	0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.		
Course Outcomes		

CO1. Understand the basic concepts of human health, wellness, and the factors influencing physical and mental well-being.
CO2. Describe common communicable and non-communicable diseases, their causes, symptoms, and preventive measures.
CO3. Explain principles of preventive medicine including vaccination, hygiene, nutrition, and lifestyle management.
CO4. Understand the importance of public health programs, health education, and community-based preventive strategies.
CO5. Identify risk factors related to environment, behavior, and lifestyle that affect individual and community health.
CO6. Develop awareness and responsibility towards maintaining personal health, disease prevention, and promoting healthy practices in society.

UNIT- 1

Health- Definition, dimensions, concept of wellbeing, Physical quality of life index, Spectrum of health, Determinants of health.
Concept of disease- Epidemiological triad, Natural history of disease, Risk factors, risk group, Iceberg of disease, Disease control, Disease elimination, Disease eradication, Monitoring and surveillance- Concept of prevention, Primary, Secondary and Tertiary, Modes of Intervention.

UNIT- 2

Communicable diseases- Type of microorganisms, Mode of transmission, Prevention of infectious diseases, Vaccination/immunization. Diarrheal diseases and dehydration- Prevention and role of ORS. Fever- cause and how to deal with.
Respiratory problems and cough

UNIT - 3

Non communicable diseases/ Lifestyle related disorder- Risk factors, CAD, risk and prevention, Hypertension, Diabetes mellitus, Obesity, Cancer, Accidents.

UNIT – 4

Nutrition and health- Classification of food, Balance diet. Occupational hazards
Mental health and substance abuse Medical Emergencies- BLS and ALS.

Reference Textbook

1. K. Park – "Park's Textbook of Preventive and Social Medicine"
2. Yash Pal Bedi & Pragya Sharma– "Handbook of Preventive and Social Medicine, Seventeenth Edition, CBS Publication".
3. Sunder Lal, Adarsh, Pankaj – "Update on Textbook of Community Medicine Preventive and Social Medicine with Recent Advances" 5th Edition, Publication 2018.
4. Dr. B. Saha- "Preventive and Social Medicine Communicable Disease Hygiene".
5. Rabindra Nath Roy, Indernil Saha- "Mahajan and Gupta Textbook of Preventive and Social Medicine" 4th Edition, Japee

CONSTITUTION OF INDIA AND ENVIRONMENTAL GOVERNANCE: ADMINISTRATION AND ADJUDICATION		
Course Code	**:**	AUC 116 Credits (0-0-0)
Course Category	**:**	VAC (Audit)
Pre-Requisite Subject	**:**	NIL
Contact Hours/ Week	**:**	1 / 2 Lecture, Tutorial, Practical
Number of Credits	**:**	0 Credit
Course Assessment Method	Continuous assessment through Tutorial classes, Home Assignments, Quizzes, Practical, Viva-Voce, Attendance, Minor Tests and One Major Theory Examination.	
COURSE OUTCOME		
At the end of the course, learners should be able to:		
CO1- Understand the fundamental principles of environmental governance.		
CO2- Understand Constitutional perspectives of environmental governance in India.		
CO3- Procedural compliance under environmental legislations and role of Judiciary and quasi- judicial bodies in environmental governance.		
CO4- Develop an understanding of bio-diversity conservation, climate change, forest protection, waste management and other issues.		

COURSE CONTENTS

UNIT-I: Foundations of Environmental Law and Governance
Principles and Legal Instruments of Environmental Governance
Emerging Trends in Environmental Law

UNIT- II:
Constitution of India and the articles relating Environment
Pollution Control Laws and Administrative processes
Environment Protection Act and Administrative processes
Waste Management Laws and Role of Municipalities and other agencies

UNIT- III:
Basics of Forest Management in India
Judiciary and its role
Biodiversity Laws and its Application; ABS Guidelines

UNIT- IV:
Wildlife Protection and management in India Adjudicatory Mechanisms- Supreme Court, High Court, National Green Tribunal

BOOKS AND REFERENCES

- Philippe Sands, Principles of International Environmental Law, Cambridge, 2018
- Indian Environmental Law: Key Concepts and Principles, ed. Shibani Ghosh, Orient BlackSwan (2019).
- NawneetVibhaw, Environmental Law: An Introduction, LexisNexis (2016).
- Shyam Divan and Armin Rosencranz, Environmental Law and Policy in India: Cases, Material & Statutes
- Justice T S Doabia (2010) Environmental and Pollution Laws in India, Lexis Nexis Butterworths Wadhwa. Chapters 10 and 11.
- S Ghosh, S Lele, N Henle, Appellate Authorities under Pollution Control Laws in India: Powers, Problems and Potential, LEAD 2018
- Ritwick Dutta and Bhupender Yadav (2012) Supreme Court on Forest Conservation, Universal Law Publishing. Introduction (The Court's Journey through Forests) and Chapter1.
- Gitanjali Gill, Environmental Justice in India: The National Green Tribunal, Routledge (2016)
- Abhayraj Naik and Parul Kumar, India's Domestic Climate Policy is Fragmented and Lacks Clarity, available at https://www.epw.in/engage/article/indias-domestic-climate-policy-fragmented-lacks-clarity
- Suggested Documentaries- Climate Change the Facts, BBC (April, 2019)

DIRECTIVE PRINCIPLES OF STATE POLICY AND FUNDAMENTAL DUTIES: CONSTITUTIONAL IMPERATIVE		
Course Code	**:**	AUC 117 Credits (0-0-0)
Course Category	**:**	VAC (Audit)
Pre-Requisite Subject	**:**	NIL
Contact Hours/ Week	**:**	1 / 2 Lecture, Tutorial, Practical
Number of Credits	**:**	0 Credit
Course Assessment Method	Continuous assessment through Tutorial classes, Home Assignments, Quizzes, Practical, Viva-Voce, Attendance, Minor Tests and One Major Theory Examination.	

COURSE OUTCOME

At the end of the course, learners should be able to:

CO1- Understand the fundamental concepts behind Directive Principles of State Policy.

CO2- Evolution and the adoption of the DPSP through the Constituent Assembly debates.

CO3- Learn how the three organs of the governance play role in shaping and achieving DPSP.

CO4- Understand the basics and relevance of Fundamental Duties.

CO5- Evaluate the relationship between Indian Knowledge System and Fundamental Duties.

COURSE LAYOUT

UNIT-I:

Evolution and Concept of Directive Principles of State Policy, Incorporation of the Directive Principles of State Policy: Constituent Assembly Debates

UNIT-II:

Salient Features of the Directive Principles of State Policy under the Indian Constitution, The Legislative, the Executive and the Judiciary on the Directive Principles of the State Policy

UNIT III:

The Legislative, the Executive and the Judiciary on the Directive Principles of the State Policy (Cont.,), Evolution and Relevance of the Fundamental Duties

UNIT-IV:

Relationship between Fundamental Duties and Indian Knowledge System, The Legislative, the Executive and the Judiciary on Fundamental Duties

BOOKS AND REFERENCES

- H.M. Seervai, Constitutional Law of India, Vol. I and 2, Universal Law Publishing (LexisNexis) 4th Edition, 2015
- Samaraditya Pal, India's Constitution: Origins and Evolution, Vol. 3, LexisNexis, 2015 Constituent Assembly Debates, Loksabha Secretariat
- Justice R C Lahoti, Fundamental Duties: A Forgotten Chapter of the Constitution, LexisNexis, 2015
- NCRWC, A Consultation Paper on Effectuation of Fundamental Duties of Citizens, 2001
- Granvile Austin, The Indian Constitution: A Cornerstone of a Nation, Oxford Clarendon Press, 1966.

INTRODUCTION TO INTELLECTUAL PROPERTY TO ENGINEERS AND TECHNOLOGISTS		
Course Code	**:**	AUC 118 Credits (0-0-0)
Course Category	**:**	VAC (Audit)
Pre-Requisite Subject	**:**	NIL
Contact Hours/ Week	**:**	1 / 2 Lecture, Tutorial, Practical
Number of Credits	**:**	0 Credit
Course Assessment Method	Continuous assessment through Tutorial classes, Home Assignments, Quizzes, Practical, Viva-Voce, Attendance, Minor Tests and One Major Theory Examination.	

COURSE OUTCOME

After the completion of the course the learners should be able to:

CO1: Create an understanding on Intellectual Properties and the importance of it.

CO2: Learn basics of Patents, Trademarks and copyrights.

CO3: Create awareness on the filing, protection copyrights and patents and understand the Ownership rights and their transfer.

CO4: Understand trade secrets and able to compare their positives and negatives traits.

CO5:, Aware of emerging trends in IPR, and learn about IP management.

COURSE LAYOUT

UNIT -I:

Introduction to Intellectual Property, Types of intellectual property—Patent, Trademarks, Copy rights, IPR and World Trade Organization, Other international organizations,

UNIT -II:

Basics of Patent, Patent filing procedure, Obligations of Patent Holder, Basics of Copyright-Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration Industrial Design, Emerging issue

UNIT -III:

Trademark basic, Purpose and function of trademarks, acquisition of trademark rights, protectable matter, selecting, and evaluating trademark, trade mark registration processes GI basic**,** IC Layout Design

UNIT –IV:

Trade secret**,** Comparative analysis, IP management

BOOKS AND REFERENCES:

- THE ECONOMIC STRUCTURE OF INTELLECTUAL PROPERTY LAW, William M. LANDES, Richard A. Posner, Harvard University Press, 2003.
- Intellectual Property and Development: Theory and Practice, Rami M. Olwan, Springer
- Narayanan, P (2006) Intellectual Property Law. 3rdedition. Eastern Law House
- Colston, C., Middleton, K. 2004 Modern Intellectual Property Law. 2nd Edition. Cavendish Publishing Ltd
- Cornish W, Llewelyn, D (2003) Intellectual Property: Patents, Copyrights, Trademarks and Allied rights. Fifth edition. Sweet and Maxwell.
- William M. Landes & Richard A. Posner, Indefinitely Renewable Copyright, 70 U. CHI. L. REV. Goldstein, Kitch and Perlman, 2006, Selected Statutes and International Agreements on Unfair Competition, Trademark, Copyright, and Patent
- Paul Goldstein, 2002, Copyright, Patent, Trademark and Related State Doctrines: Cases and Materials on Intellectual Property Law, Revised 5th edition, New York, NY: Foundation Press, 1025 pages.
- T.K.Bandyopadhyay and Saurabh Bindal, “Introduction to Intellectual Property” 1st edition Eastern Book Company, 2015

AUC119	:	**Fundamentals of Artificial Intelligence**
Course category	:	Audit Course
Pre-requisite Subject	:	Basic Programming Knowledge
Contact hours/week	:	Lecture: 2, Tutorial: 0, Practical:0
Number of Credits	:	0
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials, course-based project, one minor test and one major examination
Course Objectives	:	The course aims to: 1. Introduce fundamental concepts of Artificial Intelligence. 2. Develop basic Python programming skills for AI applications. 3. Build foundations in data analysis and preprocessing. 4. Provide understanding of machine learning concepts. 5. Expose students to AI use cases in various engineering domains.

Course Outcomes : After successful completion of this course, students will be able to:

CO1. Understand fundamental concepts of Artificial Intelligence and intelligent systems.
CO2. Apply Python libraries for data handling and visualization.
CO3. Perform data preprocessing and exploratory data analysis.
CO4. Understand basic machine learning concepts and evaluation metrics.
CO5. Identify and analyze AI applications in various engineering domains.
CO6. Develop simple AI-based solutions using data preprocessing, visualization, and basic machine learning models.

Topics Covered

UNIT I: Introduction to AI and Python Programming **6**

Overview of Artificial Intelligence: History, scope, types of AI, Applications of AI in modern technology, Python Basics: Data types, variables, operators, Control Structures: Conditional statements, loops, Functions and Modules, Data Structures: Lists, tuples, dictionaries, sets, File Handling Introduction to NumPy, Pandas, Matplotlib.

UNIT II: Exploratory Data Analysis **6**

Types of Data: Numerical and Categorical**,** Steps in Exploratory Data Analysis**,** Descriptive Statistics**,** Data Visualization Techniques**,** Introduction to Data-driven Decision Making.

UNIT III: Data Preprocessing and Introduction to Machine Learning **6**

Data Cleaning and Deduplication, Handling Missing Data, Data Transformation: Normalization, Scaling, Binning, Introduction to Supervised and Unsupervised Learning (Conceptual Only), Model Evaluation Metrics: Accuracy, Precision, Recall, F1-score.

UNIT IV: AI Use Cases in Engineering **6**

Predictive maintenance and fault detection in industrial systems using sensor data, Smart infrastructure monitoring, Process optimization, quality inspection, and automation in manufacturing environments, Intelligent decision support systems for healthcare, environmental monitoring, and cybersecurity applications.

TEXTBOOKS

1. **Aurélien Géron**, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, O'Reilly
2. **Wes McKinney**, *Python for Data Analysis*, O'Reilly
3. **Ethem Alpaydin**, *Introduction to Machine Learning*, MIT Press
4. **Jake VanderPlas**, *Python Data Science Handbook*, O'Reilly

REFERENCE BOOKS

1. **Ian Goodfellow, Yoshua Bengio, Aaron Courville**, *Deep Learning*, MIT Press
2. **Sebastian Raschka**, *Machine Learning with Python*, Packt
3. **Stuart Russell & Peter Norvig**, *Artificial Intelligence: A Modern Approach*, Pearson
4. **Andreas C. Müller & Sarah Guido**, *Introduction to Machine Learning with Python*, O'Reilly.

INDIAN KNOWLEDGE THROUGH CLASSICAL LANGUAGES		
Course Code	**:**	**IKS 101 Credits (0-0-0)**
Course Category	**:**	**VAC (Audit)**
Pre-Requisite Subject	**:**	**NIL**
Contact Hours/ Week	**:**	**1 / 2 Lecture, Tutorial, Practical**
Number of Credits	**:**	**0 Credit**
Course Assessment Method	**Continuous assessment through Tutorial classes, Home Assignments, Quizzes, Practical, Viva-Voce, Attendance, Minor Tests and One Major Theory Examination.**	

COURSE OUTCOME:

At the end of the course learners shall be able to:

CO1- Students will be able to read, understand, and interpret the core texts of Sanskrit, Pali, Prakrit, and other Indian languages.

CO2- Students will analyze the historical and cultural significance of Indian philosophy, science, art, and social practices.

CO3- Students will develop the ability to apply the principles of Indian scriptures and folk traditions to modern contexts.

CO4- Students will critically evaluate the contributions of the Indian Knowledge Tradition in fields like medicine, architecture, and science.

CO5- Students will be equipped to promote and preserve the Indian Knowledge Tradition through innovative and creative approaches.

COURSE CONTENTS

Unit I:

Sanskrit Language-Based Indian Knowledge Tradition

Objective:

To understand the fundamental principles, philosophies, and their significance in the Indian Knowledge Tradition through the Sanskrit language and its literature.

Course Content:

1. Linguistics and Literature:
   - Introduction to Sanskrit language, its grammar (morphology, phonetics), and vocabulary (words, meanings, synonyms, and prosody).
   - Key texts: Vedas (Rigveda, Yajurveda, Samaveda, Atharvaveda), Upanishads, Mahabharata, Ramayana, Puranas, and their significance.
2. Philosophy and Religion:
   - Indian philosophical systems (Yoga, Vedanta, Nyaya, Vaisheshika, Mimamsa, Sankhya).
   - Core concepts of the Bhagavad Gita and Brahmasutra.
   - Jain and Buddhist philosophies (methods, principles, and statements).
3. Science and Mathematics:
   - Mathematics: Contributions of Aryabhata, Bhaskaracharya, and Shulba Sutras.
   - Architecture: Sushruta Samhita, Charaka Samhita.
   - Ayurveda and Rasashastra (Chemistry): Contributions to medical and chemical sciences.
4. History, Culture, and Society:
   - Elements of history and culture in Sanskrit literature.
   - Kautilya's Arthashastra (practical approach).
   - Contributions of Kalidasa, Bhavabhuti, and Kabir.
   - Musicology: Gandharvacharya, Sangita Ratnakara.

Unit II: Pali Language-Based Indian Knowledge Tradition

Objective:

To understand the Buddhist perspective of the Indian Knowledge Tradition through the Pali language and its literature.

Course Content:

1. Linguistics and Literature:
   - Introduction to Pali language, its structure, grammar, and vocabulary.
   - Primary, secondary (various sutras, commentaries), and tertiary Pali literature.
2. Philosophy and Religion:
   - Buddhist philosophy: Truth and reality, the Eightfold Path, Nirvana.
   - Buddhist meditation practices and their psychological aspects.
3. Architecture and Art:
   - Buddhist architecture: Stupas (Sanchi, Amaravati), viharas, universities (Nalanda, Takshashila, etc.).
   - Buddhist art: Gandhara and Mathura styles, Buddhist iconography.

Unit III: Prakrit Language-Based Indian Knowledge Tradition

Objective:
To understand the Jain perspective of the Indian Knowledge Tradition through the Prakrit language and Jain literature.

Course Content:
1. Linguistics and Literature:
   - Introduction to Prakrit language, its dialects (Shauraseni, Magadhi, Ardhamagadhi).
   - Jain Agamas: Acharanga Sutra, Sutrakritanga, and other texts.
2. Philosophy and Religion:
   - Jain philosophy: Anekantavada (non-absolutism), Syadvada (relativity), and principles of religion.
   - Jain ethics and principles of non-violence.
3. Science and Mathematics:
   - Jain mathematics and cosmology.
   - Contributions of Jainism to astronomy and religion.
4. Culture and Art:
   - Jain architecture: Dilwara temples, Ranakpur.
   - Jain painting and sculpture.
- Jain music and literary traditions.

Unit IV: Indian Knowledge Tradition Based on Other Indian Languages and Folk Traditions

Objective:
To understand the Indian Knowledge Tradition through Tamil, Telugu, Kannada, and other Indian languages, as well as folk traditions.

Course Content:
1. Linguistics and Literature:
   - Tamil and Telugu literature: Bhakti literature, Tirukkural, and Shaiva-Vaishnava poetry.
   - Folk literature: Kabir, Gita, and oral traditions.
2. Folk Culture and Traditions:
   - Folk arts: Madhubani, Warli.
   - Folk music and dance: Bihu, Garba, Lavani.
   - Folk festivals, rituals, and oral traditions.
3. Education and Technology:
   - Tamil Siddha medicine and traditional knowledge systems.
   - Traditional water management and folk practices.
   - Folk astronomy and meteorology.
4. Social and Economic Traditions:
   - Traditional occupations and practices.
   - Folk beliefs and community life.
   - Regional festivals and their cultural significance.

Resources:
- Primary texts: Vedas, Upanishads, Puranas, Jain Agamas, Buddhist texts.
- Modern reference books: Works on Indian culture, history, and traditions.
- Digital resources: Digital libraries and online resources for Indian languages.
- Regional manuscripts and traditional knowledge systems.

INDIAN KNOWLEDGE SYSTEM: CONCEPTS AND APPLICATIONS IN SCIENCE		
Course Code	**:**	**IKS 102 Credits (0-0-0)**
Course Category	**:**	**VAC (Audit)**
Pre-Requisite Subject	**:**	**NIL**
Contact Hours/ Week	**:**	**1 / 2 Lecture, Tutorial, Practical**
Number of Credits	**:**	**0 Credit**
Course Assessment Method	**Continuous assessment through Tutorial classes, Home Assignments, Quizzes, Practical, Viva-Voce, Attendance, Minor Tests and One Major Theory Examination.**	
COURSE OUTCOME		
At the end of the course, learners should be able to:		
CO1- Understand the basic concepts of Science in Indian Knowledge Systems.		
CO2- Get an overview of aspects in which ancient science played impactful role.		
CO3- Develop an insight for utilizing the scientific knowledge into contemporary fields.		

COURSE CONTENTS

UNIT -I:

Indian Knowledge System – An Introduction
The Vedic Corpus- Vedas, Upanishads, Schools of philosophy
Buddhist Corpus- Tripitakas, Jataka Tales
Jaina Corpus- Agamas
Wisdom through the Ages

UNIT- II:

Number Systems and Units of Measurement
Mathematics- Overview, Vaidic and Later age mathematics
Astronomy- Overview and contributions

UNIT-III:

Knowledge Framework and classifications
Linguistics- Panini & Sanskrit, Pali and Prakrit

UNIT IV:

Health Wellness and Psychology
Town Planning and Architecture

BOOKS AND REFERENCES:

Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavana R.N. (2022), "Introduction to Indian Knowledge System: Concepts and Applications", PHI Learning Private Ltd. Delhi.

ADDITIONAL READINGS:

- Pride of India: A Glimpse into India's Scientific Heritage, Samskrita Bharati, New Delhi.
- Sampad and Vijay (2011). "The Wonder that is Sanskrit", Sri Aurobindo Society, Puducherry.
- Acarya, P.K. (1996). Indian Architecture, MunshiramManoharlal Publishers, New Delhi.
- Banerjea, P. (1916). Public Administration in Ancient India, Macmillan, London.
- Kapoor Kapil, Singh Avadhesh (2021). "Indian Knowledge Systems Vol – I & II", Indian Institute of Advanced Study, Shimla, H.P.

Verma. Keshav Dev. (2012) Vedic Physics, Motilal Banarsidass Publishers.

INDIAN KNOWLEDGE		CONCEPTS AND APPLICATIONS IN

SYSTEM		ENGINEERING
Course Code		IKS 103 Credits (0-0-0)
Course Category		VAC (Audit)
Pre-Requisite Subject		NIL
Contact Hours/ Week		1 / 2 Lecture, Tutorial, Practical
Number of Credits		0 Credit
Course Assessment Method	Continuous assessment through Tutorial classes, Home Assignments, Quizzes, Practical, Viva-Voce, Attendance, Minor Tests and One Major Theory Examination.	

COURSE OUTCOME
At the end of the course, learners should be able to:
CO1- Understand the basic concepts of Engineering in Indian Knowledge Systems.
CO2- Get an overview of aspects in which ancient Engineering played an impactful role.
CO3- Develop an insight for utilizing the scientific knowledge into contemporary fields.
CO4- Understand the role of Engineering in town planning in ancient India.
CO5- Understand the interrelation of Astronomy and Architecture.

COURSE LAYOUT

UNIT-I:

Indian Knowledge System – An Introduction
The Vedic Corpus

UNIT-II:

Number System and Units of Measurements
Mathematics
Astronomy

UNIT-III:

Engineering and Technology: Metals and Metalworking
Engineering and Technology: Other Applications

UNIT-IV:

Town Planning and Architecture
Knowledge Framework and Classification
Linguistics

BOOKS AND REFERENCES:

Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavana R.N. (2022), "Introduction to Indian Knowledge System: Concepts and Applications", PHI Learning Private Ltd. Delhi.

ADDITIONAL READINGS:

- Pride of India: A Glimpse into India's Scientific Heritage, Samskrita Bharati, New Delhi.
- Sampad and Vijay (2011). "The Wonder that is Sanskrit", Sri Aurobindo Society, Puducherry.
- Bag, A.K. (1979). Mathematics in Ancient and Medieval India, Chaukhamba Orientalia, New Delhi.
- Datta, B. and Singh, A.N. (1962). History of Hindu Mathematics: Parts I and II, Asia Publishing House, Mumbai.
- Kak, S.C. (1987). "On Astronomy in Ancient India", Indian Journal of History of Science, 22(3), pp. 205–221.
- Subbarayappa, B.V. and Sarma, K.V. (1985). Indian Astronomy: A Source Book, Nehru Centre, Mumbai.
- Bag, A.K. (1997). History of Technology in India, Vol. I, Indian National Science Academy, New Delhi.
- Acarya, P.K. (1996). Indian Architecture, Munshiram Manoharlal Publishers, New Delhi.
- Banerjea, P. (1916). Public Administration in Ancient India, Macmillan, London.
- Kapoor Kapil, Singh Avadhesh (2021). "Indian Knowledge Systems Vol – I & II", Indian Institute of Advanced Study, Shimla, H.P.

Course Code	**:**	**IKS 104 Credits (0-0-0)**
Course Category	**:**	**VAC (Audit)**
Pre-Requisite Subject	**:**	**NIL**
Contact Hours/ Week	**:**	**1 / 2 Lecture, Tutorial, Practical**
Number of Credits	**:**	**0 Credit**
Course Assessment Method		**Continuous assessment through Tutorial classes, Home Assignments, Quizzes, Practical, Viva-Voce, Attendance, Minor Tests and One Major Theory Examination.**

COURSE OUTCOME

At the end of the course, learners should be able to:

CO1- Understand the history, nature and basic philosophy of Indian Knowledge System.

CO2- Develop basic understanding of ancient epistemological approaches.

CO3- Get an overview of literary and scriptural corpus of ancient India and its education system.

CO4- Develop an insight in scientific approaches relevant in contemporary times.

CO5- Understand ancient India's Governance and Public Administration.

COURSE LAYOUT

Unit 1- History of Indian Knowledge System
Genesis of Bhartiya Knowledge System
History of IKS
IKS: Nature, Philosophy and Character
India's Epistemology
Knowledge Frameworks & Classification

Unit 2- Literary Aspects of IKS
Ancient Scriptures
Ancient Education
Educating Sciences
Chandashastra (Prosody)
Bhasa Va Vyakarana (Language and Grammar)
Bharata's Natyashastra (Science of Drama, Dance and Music)
Khagol Vijnana (Astronomy)
Vastukala (Architecture)
Ayurveda
Krishi Vijnana (Agricultural) Practices

Unit 3- Scientific approaches of IKS & Torch-bearers
Dhatu Vijnana (Metallurgy)
Ganita: Mathematics in India
Yuddha Vidhya (Military Sciences)
Niyuddha Kala (Martial Arts)
Environmental Sciences

Unit 4- Governance in IKS & Way Forward
Science of Consciousness in Ancient India (Cognitive Science)
Anviksiki (Logic and Disputation)
Governance & Public Administration
IKS way forward

BOOKS AND REFERENCES:

- Introduction to Indian Knowledge System: Concepts and Applications, Archak, K.B. (2012). Kaveri Books, New Delhi.ISBN-13:978-9391818203
- Introduction To Indian Knowledge System: Concepts and Applications, Mahadevan, B.Bhat, Vinayak Rajat,Nagendra Pavana R.N.PHI, ISBN: 9789391818203
- Glimpse into Kautilya's Arthashastra Ramachandrudu P. (2010), Sanskrit Academy, Hyderabad ISBN:9788380171074

"Introduction" in Studies in Epics and Purāṇas, (Eds.), KM Munshi and N Chandrashekara

- Aiyer Bhartiya Vidya Bhavan

Annexure-02
Detailed Syllabus of Extra Curricular Activities (ECA) Courses under Counsel of Student Activities

Skill Development- I (ECA-151)		
Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Participation and Training
Course Outcome: Students are expected to learn and develop their skill and their personality through the activities and trainings under the council and should be well versed with the listed		
activities and events.		

UNIT- 1
Introduction to TSC and IEEE: An introduction to technical sub-council and IEEE. An overview of IEEE and the events conducted by them.

UNIT- 2
Robotics Classes: Informative classes conducted on by the students of IEEE about Bot modelling and electronics as well as embedded. It is conducted for both Wired and Wireless Robotics.

UNIT- 3
Introduction to Workshops by IEEE: Workshop is a brief intensive course for a small group which emphasizes problem solving. A number of workshops are conducted by IEEE like Ethical hacking, Soft skills, Artificial Intelligence etc.

UNIT- 4
Events under TechSrijan: Techsrijan is the annual techno-management fest held every year like Enigma, Robotics, Incognito, Quizzes, World Parliament, etc.

Unity and Discipline (NCC)-I (ECA-171)		
Course Category	:	NCC
Pre Requisite	:	NIL
Contact/Hours of Work	:	2
Hours/Week Number of Credits	:	0
Course Assessment Method	:	Lecture & Practical
Course Outcome	:	After completing this course, the students will be able to Imbibe the conduct of NCC cadets. Do the social services on different occasions.

UNIT -1
Introduction of NCC: History, Aims, Objective of NCC.

UNIT -2
NCC as Organization. Incentives of NCC, Duties of NCC Cadet.

UNIT -3
Celebration of Days of National & International Importance, Social Service and Community Development Activities

UNIT- 4
NCC Parade on Independence Day.

National Service Scheme-I (ECA-172)		
Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2
Hours/Week Number of Credits	:	0
Course Assessment Method	:	Continuous assessment through National Service Scheme related
tasks, participation in different events organized, attendance, home assignments.		
Course Outcome : The students are expected to be able to demonstrate		
the following knowledge, skills and attitudes in achieving NSS motto after completing this course:		
CO1. The Motto of NSS "Not Me but You", reflects the essence of democratic living and upholds the need for self-less service.		
CO12. NSS helps the students' development & appreciation to other person's point of view and also show consideration towards other living beings.		

CO3. The philosophy of the NSS is a good doctrine in this motto, which underlines on the belief that the welfare of an individual is ultimately dependent on the welfare of the society as a whole and therefore, the NSS volunteers shall strive for the well-being of the society.

Introduction to National Service Scheme:

UINIT-I:
History and its Objectives

UNIT-II:
Organizational structure of N.S.S. at National, State, University and College Levels

UNIT-III:
Advisory committee and their functions with special reference to University CSA, Program officer, N.S.S. group leader and N.S.S. volunteers in the implementation.

UNIT-IV:
Organization/ Participation in "Tree-Plantation Drive"

GAMES & SPORTS-I (ECA-181)		
Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	Physical Education at 12th standard
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Training and Practices.
Course Outcome	:	The students are expected to be able to perform the following Knowledge, skills, and attitudes after completing this course.
CO1. Understand the concept of skill. Acquire the required motor skills.		
CO2.Demonstrate and assess various techniques of starts and finish. Interpret the rules & regulations. Acquire skill of marking track.		

Track & Field-

UNIT- 1
INTRODUCTION:
Historical development
National
International
Structure and functions of Controlling Bodies
National
International

UNIT- 2
FUNDAMENTAL SKILLS:
Starting techniques: Standing start, Crouch start and its variations, Proper use of blocks.
Finishing Techniques: Run, Through, Forward lunging, Shoulder Shrug.

UNIT- 3
FUNDAMENTAL SKILLS-II:
Various patterns of Baton Exchange.
Understanding of Relay Zones.
Rules & their interpretation.

UNIT- 4
FUNDAMENTAL SKILLS-III:
Drills and Lead-up Games.
Marking and Layout of Track & Field

Books & References

1. Latest Official Rule Books of International Federation
2. Coaching Manuals of International Federation
3. Official Website

Culture, Art & Literary-I (ECA-182)		
Course category	:	Cultural, Art &Literary
Pre-requisite Subject	:	NIL
Contact hours/week	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Methods	:	Practical Participation
Course Outcomes	:	Students are expected to develop their soft skills and their
		Personality through cultural and literary activities.

UNIT-1

Workout, Warm up, Stretching, Introduction to various dance forms, Dance form – Bollywood, Footwork, Body Movement, Theatre History, Literature and Aesthetics, Introduction to Acting, Yoga(Breathing, Exercise, Voice Control and Sound Modulation).

UNIT-2

Introduction to music, Basic Terminologies related to music, Origin of sound, Historical study of musical terms, Basic Introduction to Fine Arts, Roll of FAC in cultural sub-council, Basics of Fine Arts and Types, File extension, Editing software, Resources for stock images and video.

UNIT-3

MALVIKA: Basic knowledge of designing software (I) : Adobe In Design ,Photoshop ,Notice Making, Article writing.

UNIT-4

TIRESIA: Basic knowledge of designing software (I): Adobe In Design, Photoshop, Interview skills, Vocabulary development, Knowledge about technical advancements, knowledge of campus activities.

Skill Development- II (ECA-201)		
Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2
Hours/Week Number of Credits	:	0
Course Assessment Method	:	Practical Participation and Training
Course Outcome	:	Students are expected to learn and develop their skill and their personality through the activities and trainings under the council and should be well versed with the listed activities and events.

UNIT- 1

Introduction to TSC and SAE: An introduction to technical sub-Council and SAE. An overview of SAE and the events conducted by them.

UNIT- 2

Aeromodelling Classes: Informative classes and workshop conducted on by the students of SAE about Drone and remote-controlled modeling and electronics as well as embedded.

UNIT -3

Introduction to Workshops by SAE: *Workshop* is a brief intensive course for a small group which emphasizes problem solving. A no. of workshops is conducted by SAE like Aeromodelling workshop, Bridge modeling etc.

UNIT- 4

Events under TechSrijan by SAE: Techsrijan is the annual techno-management fest held every year. SAE conducts a number of events in TechSrijan like Junkyard Wars, Bride Kriti, El Tiro etc.

Unity and Discipline (NCC)-II – (ECA- 221)		
Course Category	:	NCC
Pre Requisite	:	NIL
Contact/Hours of Work	:	2
Hours/Week Number of Credits	:	0
Course Assessment Method	:	Lecture & Practical
Course Outcome	:	After completing this course, the students will be able to respect the diversity of different Indian culture. Do the social services on different occasions.

UNIT- 1
National Integration & Awareness, Importance & Necessity
UNIT- 2
Factors Affecting National Integration, Unity in Diversity
UNIT -3
Celebration of Days of National & International Importance, Social Service and Community Development Activities
UNIT- 4
NCC Parade on Republic Day.

National Service Scheme- II (ECA-222)		
Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2
Hours/Week Number of Credits	:	0
Course Assessment Method	:	Continuous assessment through National
Service Scheme related		tasks, participation in different events organized, attendance, home assignments.
Course Outcome : The students are expected to be able to demonstrate the following knowledge, skills and attitudes in achieving NSS motto after completing this course:		

CO1. The Motto of NSS "Not Me but You", reflects the essence of democratic living and upholds the need for self-less service.
CO2. NSS helps the students' development & appreciation to other person's point of view and also show consideration towards other living beings.
CO3. The philosophy of the NSS is a good doctrine in this motto, which underlines on the belief that

the welfare of an individual is ultimately dependent on the welfare of the society as a whole and therefore, the NSS volunteers shall strive for the well-being of the society.

UNIT-I:
National Integration, Need and importance of National integration

UNIT-II:
Various obstacles in the way of National Integration, such as caste, religion, language and provisional problems etc.

UNIT-III:

NSS related Activities: Awareness to various activities under NSS.

UNIT-IV:

Organization/Participation in "Cleanliness Drive" at home, hostel, Department and University

UNIT-V:
Organization/Participation in "Winter cloth collection and distribution toneedy people"

GAMES & SPORTS-II (ECA-231)		
Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	Physical Education at 12th standard
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Training and Practices.
Course Outcome	:	The students are expected to be able to perfothe
		following Knowledge, skills and attitudes after completing this course.
CO1.Understand the concept of skill. Acquire the required motor skills.		
CO2.Demonstrate and assess various techniques of starts and finish. Interpret the rules & regulations. Acquire skill of marking track.		

Basketball-

UNIT- 1

INTRODUCTION:

Historical development

National

International

Structure and functions of Controlling Bodies

National

International

UNIT- 2

FUNDAMENTAL SKILLS- I:

Player stance and ball handling.

Passing-Two Hand chest pass, Two hand Bounce Pass, One Hand Baseball pass, Side Arm Pass, Over Head pass, Hook Pass.

Receiving-Two Hand receiving, One hand receiving, Receiving in stationary position, Receiving while jumping, Receiving while running.

UNIT- 3

FUNDAMENTAL SKILLS- II:

Dribbling-How to start dribble, how to drop dribble, High dribble, Low dribble, Reverse dribble, Rolling dribble.

Shooting-Lay-up shot and its variations, one hand set shot, one hand jump shot, Hook shot, and Free throw.

Individual Defensive-Guarding the man with and without the ball, pivoting.

UNIT- 4

FUNDAMENTAL SKILLS-III:

Drills and Lead-up Games.

Marking and Layout of Court.

Books & References

Latest Official Rule Books of International Federation

Coaching Manuals of International Federation

Official Website

Culture, Art & Literary-II (ECA-232)		
Course category	:	Cultural, Art &Literary
Pre-requisite Subject	:	NIL
Contact hours/week	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Methods	:	Practical Participation
Course Outcomes	:	Students are expected to develop their soft skills and their personality through cultural and literary activities.

UNIT-1

Intro to basics of sketching, Painting, Craft, Sculpturing.

Sketch-Tools of sketching, Types of Sketching- Pencil/ Pen/ Color Pencil/ Charcoal/ Graphite/Ink/ Chalk / Digital Sketch. History of Indian Music, About life and contributions of Indian Musician sand Musicologists.

Two forms of Indian Classical Music (Hindustani/Karnataka).

UNIT-2

Introduction to Theatre Technique and Design, Character Analysis and practical on principle of Stanislavski Method (relaxations, concentration of attention and emotion memory), Workout, Warm up, Stretching, Dance Form- Hip-Hop, Footwork, Body movement, Choreography, Equipment, Types of lenses, building web site using template.

UNIT-3

ARUNODAY: Development of thinking ability with JAM (Just a Minute), Word Building, Letter rearrangement, Knowledge of spellings, Syllables, Critical thinking skill development, Vocabulary development, Thought expressing skill development, public speaking skill development.

UNIT-4

SPELLCZAR: Word building, Vocabulary development, Decision making ability development, Coordination capabilities.

Skill Development- III (ECA-251)		
Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2
Hours/Week Number of Credits	:	0
Course Assessment Method	:	Practical Participation and Training
Course Outcome	:	Students are expected to learn and develop their skill and their personality through the activities and trainings under the council and should be well versed with the listed activities and events.

UNIT- 1

Introduction to TSC and UIC: The University Innovation Cell supports and provides opportunity for Innovation works. You will get to learn about the things they do and promote.

UNIT -2

Introduction to Innowizion: Every year University Innovation Cell organizes a national level event that provides opportunities for students across all disciplines to team up and use their creativity, passion, and knowledge of technology. Events like I-Expo and I-Quiz.

UNIT- 3

Introduction to Spectra: It is a special event organized by University Innovation Cell which foster an opportunity for students to showcase their creativity and talent. It comprises of three events InQUIZitive, Replica and MindBuzz.

UNIT- 4

Learnings and Innovation: Innovation increases your chances to react to changes and discover new opportunities. It can also help foster competitive advantage as it allows you to build better products and services for your customers in the industry.

Skill Development- IV (ECA-301)		
Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2
Hours/Week Number of Credits	:	0

Course Assessment Method	:	Practical Participation and Training
Course Outcome	:	Students are expected to learn and develop their skill and their personality through the activities and trainings under the council and should be well versed with the listed activities and events.

UNIT- 1

Introduction to TSC and SEB: The Social Engineers Board (SEB) tries to achieve its goals by series of various events conducted throughout the academic year, both inside and outside the university.The members of the board are highly motivated individuals striving for noble cause, and voluntarily take initiatives which ensure betterment of the people and society in any way possible.

UNIT- 2

Introduction to Drishya: A career counselling event by college final year, and an event designed to crave out the creativity inside the students and their ability to make something novel out of normality in situation

UNIT- 3

Introduction to Dhishan: Bringing out the oration skill and leadership personality among the students by providing them chance to stand and represent themselves by this event.

UNIT -4

Introduction to Paravartan and NGOs: Paravartan consists of a audio visual round and the second round is a skit presentation developing character of a student. They also collab with NGOs for social works.

Skill Development- Vth (ECA-351)		
Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2
Hours/Week Number of Credits	:	0
Course Assessment Method	:	Practical Participation and Training
Course Outcome	:	Students are expected to learn and develop their skill and their personality through the activities and trainings under the council and should be well versed with the listed activities and events.

UNIT- 1

Introduction to TSC and E CELL: E-Cell of Madan Mohan Malaviya University of Technology promotes entrepreneurship abilities among the students of the university and conducts events to promote these ideas.

UNIT- 2

Introduction to Fresher's Talk: A creative talk with the freshers of our university in which the fresher students provide some insights of what and how are they feeling about the college and its environment.

UNIT- 3 Introduction to Start Up Week: Understanding the aspects of and entrepreneurial background and train to become one, through various personality developing as well as professionally balanced events.

UNIT- 4

Entrepreneurship Development: It is the process of enhancing the skillset and knowledge of entrepreneurs regarding the development, management and organization of a business venture while keeping in mind the risks associated with it. Students will learn and cultivate skills which will promote entrepreneurship.

Skill Development-VIth (ECA-401)		
Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2
Hours/Week Number of Credits	:	0
Course Assessment Method	:	Practical Participation and Training
Course Outcome	:	Students are expected to learn and develop their skill and their personality through the activities and trainings under the council and should be well versed with the listed activities and events.

UNIT- 1

Introduction to TSC and Robotics Club: Robotics Club speaks a name for itself in this domain with a sheen of itself that has been set by the high standards of the club members and strict adherence to the tagline Transforming ideas into reality, Events Details

UNIT- 2

Introduction to Web D Classes: Classes on web development helps students to develop skills like Front-end and Back-end development which they can use to make websites.

UNIT -3

Introduction to Engineers Week: a seven-day event paying tribute to all the engineers across the globe by conducting a no. of exciting events for technical development of students.

UNIT- 4

Robomania: Develop the knowledge of robotics and circuitry in the students through training of students on circuits and the conduction of Robo Wars, Electronic chess, diffusion of a bomb

in a set up made by students, demonstration of live game of the virtual events of NFS and Tekken, Lazer strike, Designing of Lazer maze.

Unity and Discipline (NCC)-III – (ECA-271)		
Course Category	:	NCC
Pre Requisite	:	NIL
Contact/Hours of Work	:	2
Hours/Week Number of Credits	:	0
Course Assessment Method	:	Lecture & Practical
Course Outcome	:	After completing this course, the students will be able to perform his/her role in Nation Building. Do the social services on different occasions.

UNIT- 1
Role of NCC in Nation Building.
UNIT- 2
Threats to National Security.
UNIT -3
Celebration of Days of National & International Importance, Social Service and Community Development Activities
UNIT- 4
NCC Parade on Independence Day.

Unity and Discipline (NCC)-IV- (ECA-321)		
Course Category	:	NCC
Pre Requisite	:	NIL
Contact/Hours of Work	:	2
Hours/Week Number of Credits	:	0
Course Assessment Method	:	Lecture & Practical
Course Outcome	:	After completing this course, the students will be able to perform his/her role in Nation Building. Do the social services on different occasions.

UNIT -1
Contribute to environmental awareness and conservation activities.

Develop Leadership Qualities.

Do the social services on different occasions.

Environmental Awareness and Conservation.

UNIT -2
Leadership Development: Important Leadership traits, Indicators of leadership.

UNIT- 3
Celebration of Days of National & International Importance, Social Service and Community Development Activities
UNIT -4 NCC Parade on Republic Day.

National Service Scheme- III (ECA-272)		
Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2
Hours/Week Number of Credits	:	0
Course Assessment Method	:	Continuous assessment through National
Service Scheme related	:	tasks, participation in different events organized, attendance, home assignments.
Course Outcome: The students are expected to be able to demonstrate the following knowledge, skills and attitudes in achieving NSS motto after completing this course:		
CO1: The Motto of NSS "Not Me but You", reflects the essence of democratic living and upholds the need for self-less service.		
CO2: To help the students' development & appreciation to other person's point of view and also show consideration towards other living beings.		
CO3: The philosophy of the NSS is a good doctrine in this motto, which underlines on the belief that the welfare of an individual is ultimately dependent on the welfare of the society as a whole and therefore, the NSS volunteers shall strive for the well-being of the society.		

UNIT-I:

Special Programme in NSS-I

Legal awareness

Health awareness

First-aid

UNIT-II:

Special Programme in NSS-II

Career guidance

Leadership training-cum-Cultural Programme

Globalization and its Economic Social Political and Cultural impacts.

UNIT-III:

Special Camping programme in NSS-I
Nature and its objectives
Selection of campsite and physical arrangement
Organization of N.S.S. camp through various committees and discipline in the camp.

UNIT-IV:

Special Camping programme in NSS-I
Activities to be undertaken during the N.S.S. camp.
Use of the mass media in the N.S.S. activities.

National Service Scheme- IV (ECA-322)		
Course Category **NIL**	:	Extra-Curricular Activities Pre-Requisite :
Contact/Hours of Work	:	2
Hours/Week Number of Credits	:	0
Course Assessment Met	:	Continuous assessment through National Service Scheme related tasks, participation in different events organized, attendance, home assignments.
Course Outcome	:	The students are expected to be able to demonstrate
the following knowledge, skills and attitudes in achieving NSS motto after completing this course:		
CO1. The Motto of NSS "Not Me but You", reflects the essence of democratic living and upholds the need for self-less service.		
CO2. NSS helps the students' development & appreciation to other person's point of view and also show consideration towards other living beings.		
CO3. The philosophy of the NSS is a good doctrine in this motto, which underlines on the belief that the welfare of an individual is ultimately dependent on the welfare of the society as a whole and therefore, the NSS volunteers shall strive for the well-being of the society.		

UNIT-I: N.S.S. Regular Activities-I
Traffic regulation
Working with Police Commissioner's Office
Working with Corporation of Gorakhpur District

UNIT-II: N.S.S. Regular Activities-II
Working with Health Department
Blind assistance
Garments collection and distribution

UNIT-III: N.S.S. Regular Activities-III
Non-formal Education
Environmental Education Awareness and Training (EEAT)'
Blood donation

UNIT-IV: N.S.S. Regular Activities-IV
Adopted Village related works
Disaster/Pandemic management

GAMES & SPORTS-III (ECA-281)		
Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	Physical Education at 12th standard
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Training and Practices.
Course Outcome	:	The students are expected to be able to perform the following Knowledge, skills and attitudes after completing this course
CO1.Understand the concept of skill.Acquire the required motor skills.		
CO2.Demonstrate and assess various techniques of starts and finish. Interpret the rules & regulations.Acquire skill of marking track		

Volleyball-

UNIT- 1
INTRODUCTION:
Historical development
National
International
Structure and functions of Controlling Bodies
National
International

UNIT- 2 FUNDAMENTAL SKILLS-I:
Service-Under Arm Service, Tennis Service, Floating Service.
Overhead finger pass.
The Dig (Under Arm pass).

UNIT- 3 FUNDAMENTAL SKILLS –II:
Back court defense.
Defensive and Offensive strategies.
Smash
Block–individual and team.

UNIT- 4 FUNDAMENTAL SKILLS-III:
Drills and Lead-up Games.
Marking and Layout of Field.

Books & References
1.Latest Official Rule Books of International Federation
2.Coaching Manuals of International Federation
3.Official Website

GAMES & SPORTS-IV (ECA-331)		
Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	Physical Education at 12th standard
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Training and Practices.
Course Outcome	:	The students are expected to be able to perform the following Knowledge, skills and attitudes after completing this course

Hockey- **UNIT-1** Understand the concept of skill.Acquire the required motor skills. Demonstrate and assess various techniques of starts and finish. Interpret the rules & regulations. Acquire skill of marking track for running events.
INTRODUCTION: Historical development National International Structure and functions of Controlling Bodies National International
UNIT- 2 FUNDAMENTAL SKILLS-I: Player stance & Grip, Rolling the ball, Dribbling. Push, Stopping. Hit, Flick, Scoop. Reverse hit.
UNIT- 3 FUNDAMENTAL SKILLS-II: Passing–Forward pass, square pass, triangular pass, diagonal pass, return Pass. Goalkeeping–Hand defense, foot defense. Positional play in attack and defense.

UNIT- 4 FUNDAMENTAL SKILLS-III:

Drills and Lead-up Games.

Marking and Layout of Court.

Books & References

1. Latest Official Rule Books of International Federation
2. Coaching Manuals of International Federation

Official Website

GAMES & SPORTS- V (ECA- 381)		
Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	Physical Education at 12th standard Contact/Hours of Work 2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Training and Practices.
Course Outcome	:	The students are expected to be able to perform the following Knowledge, skills and attitudes after completing this course.

CO1. Understand the concept of skill.
CO2. Acquire the required motor skills.
CO3. Demonstrate and assess various techniques of starts and finish.
CO4. Interpret the rules & regulations.
CO5. Acquire skill of marking track for running events.

UNIT 1 YOGA- HOLISTIC HEALTH:

Health- Concept of Health, its importance in human life.

Components of health.

UNIT-II YOGA AND ITS IMPORTANCE:
Definition of Yoga.
Importance of Yoga in daily life.
Aims and Objective of yoga.
Misconception of yoga.

UNIT-III SURYA NAMASKAR:
Benefits of Surya Namaskar
Practices of Surya Namaskar

Unit- IV YOGA PRACTICES:
Asana- Meditative
Sukhasana
Padmasana
Swastikasana
Cultural- Trikonasana, Makarasana, Bhujangasana, Sarpasana, Dhanurasana.
Pranayama- Yogic Breathing, Anulom-Vilom.

Books & References

1. Indra Devi, "Yoga For You", Gibbs, Smith publishers, Salt Lake City, 2002
2. Domen& Publishers, New Delhi-2001.
Yoga se Arogya, Indian Yoga Society, Sagar.

Games & Sports -VI (ECA- 431)		
Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	Physical Education at 12th standard Contact/Hours of Work 2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Training and Practices.
Course Outcome	:	The students are expected to be able to perform the
		following Knowledge, skills and attitudes after completing this course.

1. Understand the concept of skill.
2. Acquire the required motor skills.
3. Demonstrate and assess various techniques of starts and finish.
4. Interpret the rules & regulations.
5. Acquire skill of marking track for running events.

UNIT- 1

Badminton INTRODUCTION:
Historical development
National
International
Structure and functions of Controlling Bodies
National
International.

UNIT-II

FUNDAMENTAL SKILLS-I:
Racket parts, Racket grips, Shuttle (dimensions).
The basics stances.
Basic foot movements.

UNIT-III

FUNDAMENTAL SKILLS-II:
The basic strokes-Serves.
Forehand-overhead and underarm.
Backhand-overhead and underarm.
Types of games-Singles, doubles, including mixed doubles.

Unit- IV FUNDAMENTAL SKILLS-III:

Drills and Lead-up Games.
Marking and Layout of Court.

Books & References

1. Latest Official Rule Books of International Federation
Coaching Manuals of International Federation Official Website

Culture, Art & Literary-III (ECA-282)		
Course category	:	Cultural, Art &Literary
Pre-requisite Subject	:	NIL
Contact hours/week	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Methods:		Practical Participation
Course Outcomes **soft skills and**	:	Students are expected to develop their soft skills and their personality through cultural and literary activities.

UNIT-1

Photo editing (Photoshop)

Ras- (Sringar Ras, Hasya Ras, Rodra Ras, Karun Ras, Vir Ras, Adbhut Ras, Vibath Ras, Bhayanak Ras, Shaant Ras)

UNIT-2

Workout, Warmup, Stretching, Pranam, Types of classical dance forms and their outfits, Dance form- Kathak, Hand movements, Choreography, Basic knowledge of Talas for Instance Teental, Dadra and Kherwa, Practice of AUM and vocal exercises of sargam (sa, re, ga, ma, pa, dha, ni) of 45. Alankaras, Styles of Sketching-Line/ Hatching/Blending/Scribbles/Tattoo/Doodling/Cartoon/Graffiti/Typography/Calligraphy/Ca ricat Ure

UNIT-3

ANNUAL DEBATE COMPETITION: General Knowledge & Current Affairs, Public speaking skill development, Oratory skill development, Sense of Team spirit, Knowledge of language, Social Study, Development of presentation skills.

UNIT-4

TWIST AND TWAIN: Development of imaginative power and creativity, Development of vocabulary, Development of writing skills, Thinking skill development.

Culture, Art & Literary-IV (ECA-332)		
Course category	:	Cultural, Art &Literary
Pre-requisite Subject	:	NIL
Contact hours/week	:	2 Hours/Week
Number of Credits	:	0
Course Assessment methods	:	Practical Participation
Course Outcomes	:	Students are expected to develop their soft skills and their Personality through cultural and literary activities.

UNIT-1

Video editing, Basic knowledge about musical instruments (Tabla, flute, guitar etc.) about Swarmalika and two bragas-Bhupaliand Yaman.

UNIT-2

Monologue, reciting a poem, reading short stories, developing speech skill, Mime, Working on scene with partner and in a group, Painting-Tools of painting, Styles of painting- Abstract/Imagination/Expression/Cubism/Indian/Chinese/Japanese, All the theory covered upto Praveshi ka Purna, define and explain Kataaksha,Primalu, Nartan Bhedas- Nritta Nrutya and Natya, define Tandav and Lasya, Fourty pesof neck movements according to Abhinaya Darpan, Eight types of eye movements according to Abhinaya Darpan, Define and differentiate "FolkDance" and "Modern Dance" (Uday Shankar style), Life story of: Bindadin Maharaj, Kalka Prasadji, Harihar Prasadji& Hanuman Prasadji, Specialty of Jaipur and Lucknow Gharana,Definition and uses of the following Asanyukta Hasta Mudras: Sarpsheersha, Murga-sheersha, Simha-Mukha, Kangula, Alapadma, Chatura, Bhrama, Hansasya, Hansa-paksha, Sandausha, Mukula, Tamrachuda, Vyagraha, Trishula, Sanyukta HastaMudra: Anjali, Kapota, Karkata, Swastik, Dola, Pushpaputa, Utsanga, Shivalinga, Katakawardhan, Kartari-swastk, Shakata, Shankha.

UNIT-3

VAGMITA1: Development of oratory skill, Development of poetry writing skill, Alankar, Ras, Creative thinking ability development.

UNIT-4

VAGMITA 2: How to overcome camera consciousness, enhancement of the expression and presentation of the participants, development of the public speaking skill, Knowledge of tone adjustment while presenting.

Culture, Art & Literary-V (ECA-382)		
Course category	:	Cultural, Art &Literary
Pre-requisite Subject	:	NIL
Contact hours/week	:	2 Hours/Week
Number of Credits	:	0
Course Assessment methods	:	Practical Participation
Course Outcomes	:	Students are expected to develop their soft skills and their personality

UNIT-1

Types of painting-Oil painting/ Watercolor painting/ Pastel painting/ Acrylic painting/ Digital painting/Spray Painting, Basic of Contemporary Dance, Foot Position and Transference, Center Technique, Travelling Technique, Dance, Dance (A) Peter Pan, dance (B) Emergence of a Butterfly.

UNIT-2

Improvisation, Elementary knowledge of Acting, Body language, Rhythm, Clarity and fluency in dialogue delivery, Understanding the depth of character, about terms related to Hindustani music like Naad, Shuruti, Saptak, Thaat, Vaadi, Samvadi, Photography Skill.

UNIT-3

MALAVIYAN THINKER: Creative thinking, how to pen down thoughts of our mind, Development of writing skill, Development of Expression, Public Speaking skill development.

UNIT-4

ABHYUDAYA: Multidimensional skill development: Technical skill development with software like Adobe Photoshop, MS word, MS PowerPoint, MS Excel, Content Writing skill development, public addressing, public engagement, Team work Mechanism, Leadership qualities, Time management, art and craft, Pottery, Oratory skill development, Presentation skill, Event management.

Culture, Art & Literary-VI (ECA-432)		
Course category	:	Cultural, Art &Literary
Pre-requisite Subject	:	NIL
Contact hours/week	:	2 Hours/Week
Number of Credits	:	0
Course Assessment methods	:	Practical Participation
Course Outcomes	:	Students are expected to develop their soft skills and their

UNIT-1

Cinematography, Basic knowledge of Thaat system, Raga formation rules, 5 Ragas- Bhupali, Yaman, Bihag, Kafi, Deskar.

UNIT-2

Introduction to Nukkad, Mono Act, Skit, Introduction to Comedy, Tragic Comedy, Tragedy, Melodrama, Craft- Tools of craft, Types of Craft- paperwork/ Wood work/ foam work/ Cloth work, Popping/ Introto music theory, Angles and Movement/Music Theory, Direction and Levels/Rhythms for Grooves, Twists and isolated movements/8 Count Phrasing, Footwork/Floats and Glides, Waves/Movements Dynamics, Waves 2/Musical Phrasing, Putting it all together.

UNIT-3

WRITING SKILLS: Invitation making, Notice making, Article writing.

SKILL FOR INTEVIEWER: How to take formal interview, approaching the personality, Questions preparation, management, platform selection, public engagement.

UNIT-4

INTERVIEW SKILLS FOR INTERVIEWEE: Body language, Attire, Hand gestures, voice tone, Language, General Interview Questions- How to introduce yourself.