Curriculum Structure & Syllabi

(As per National Education Policy 2020)

of

B. Tech.

in

Electronics and Communication Engineering (IoT)

(w.e.f. 2024-25)

Vision

Mission

Program Educational Objectives

Program Outcomes

Program Specific Outcomes

Overall Credit Structure

Curriculum

Syllabus

Offered By

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
MADAN MOHAN MALAVIYA UNIVERSITY OF TECHNOLOGY (MMMUT)
GORAKHPUR-273 010, UP, INDIA
JULY 2026

Department of Electronics and Communication Engineering

CURRICULA & SYLLABI

B. Tech. Electronics and Communication Engineering (IoT)

Vision:

To become a leader of education, research and innovation in the area of Electronics and Communication Engineering and to train students to be innovative and well-prepared professionals in the area of Electronics and Communication Engineering.

Mission:

1. Educate and mentor students to meet the current as well as future challenges by providing them with a firm foundation in both theory and practice of Electronics and Communication Engineering.
2. Create, develop and disseminate new knowledge by top quality applied research in Electronics and Communication Engineering by interacting with government agencies and private industry.
3. Promote a sense of leadership and service to the society.

Program Educational Objectives (PEOs)

PEO-1: Excel in professional career and/or higher education by acquiring knowledge in area of Electronics and Communication Engineering.

PEO-2: Analyse real life problems, design appropriate system to provide solutions that are technically sound, economically feasible and socially acceptable.

PEO-3: Exhibit professionalism, ethical attitude, communication skills, teamwork in their profession and adapt to current trends by engaging in life-long learning.

Programs Outcomes (POs)

B.Tech. Electronics and Communication Engineering students will demonstrate the ability to:

PO-1 **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO-2 **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO-3 **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs

with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO-4 **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO-5 **Engineering tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO-6 **The engineer and the word**: analyse and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment.

PO-7 **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO-8 **Individual and collaborative team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary teams.

PO-9 **Communication**: Communicate effectively and inclusively within the engineering community and society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations considering culture, language, and learning differences

PO-10 **Project management and finance**: Apply knowledge and understanding of the engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO-11 **Life-long learning:** Recognize the need for and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technology and iii) critical thinking in the broadest context of technological change.

Programs Specific Outcomes (PSOs)

PSO-1 An ability to understand the concepts of basic Electronics & Communication Engineering and to apply them to various areas like Signal processing, VLSI, Embedded systems, Communication Systems, Digital & Analog Devices, etc.

PSO-2 Design and develop end-to-end IoT solutions by integrating embedded systems, sensors, and communication protocols, while leveraging data analytics, cloud computing, and machine learning to derive actionable intelligence for real-world applications across diverse domains.

PSO-3 Wisdom of social and environmental awareness along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an entrepreneur.

SYLLABUS AND CREDIT STRUCTURE FOR B. TECH.
ELECTRONICS AND COMMUNICATION ENGINEERING (IOT)
(SESSION 2026-2027 AND ONWARDS)
OVERALL CREDIT STRUCTURE FOR B.TECH. (ECE IoT)

<table>
<tr><th colspan="4">Credit Courses</th></tr>
<tr><th colspan="2">Core Courses (CC)</th><th colspan="2">Electives Courses (EC)</th></tr>
<tr><th>Category</th><th>Min. Credits</th><th>Category</th><th>Min. Credits</th></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>Professional Core (PC)</td><td>48</td><td>Humanities & Social Science Elective (HSSE)</td><td>04</td></tr>
<tr><td>Management (M)</td><td>04</td><td></td><td></td></tr>
<tr><td>Humanities & Social Science (HSS)</td><td>08</td><td></td><td></td></tr>
<tr><td>Minor Project (P)</td><td>06</td><td></td><td></td></tr>
<tr><td>Industrial Practice (IP) (In Industry)/ Major Project (MP) (In University)</td><td>10</td><td></td><td></td></tr>
<tr><td>Sub-total</td><td>120</td><td>Sub-total</td><td>40</td></tr>
<tr><td colspan="2">Grand Total</td><td colspan="2">160</td></tr>
<tr><th colspan="4">Non-Credit Courses</th></tr>
<tr><td colspan="3">One Expert Lecture per semester for students (Mandatory).
(BSM-Ist year), (PC-2nd Year), (T&P-3rd Year)</td><td>Non-Credit</td></tr>
<tr><td colspan="3">Social work/Training of at least 60 hours during break after first/ second semester (Mandatory) (Dean of Extension, Field Outreach and Alumni Relations).</td><td>Non-Credit</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 Alumni Relations).</td><td>Non-Credit</td></tr>
<tr><td colspan="3">Value Added Courses (VAC) / Audit Courses (AC)
Two of the Value-Added Courses / Audit Courses are compulsory.</td><td>Non-Credit</td></tr>
<tr><td colspan="3">Extracurricular Activities Courses (ECA)
Two compulsory courses from the following S. No (ii) to (v) non-credit courses:
(i) Induction Program (compulsory)
(ii) Skill development
(iii) Unity and Discipline (NCC or NSS)
(iv) Sports, Cultural and Games
(v) Personality Development</td><td>Non-Credit</td></tr>
<tr><th colspan="4">Minor Degree (MD) from any Department and Micro Specializations (MS) within the Department</th></tr>
<tr><td colspan="3">• The total number of credits for graduation will be kept to minimum 160 including the 18-20 credits required for Minor Degree Courses.
• Micro specializations will be run by the department in order to aligned to industry careers or higher studies</td><td>Offered as a Professional Electives (PE)</td></tr>
</table>

DEPARTMENT OF ELECTRONICS AND COMMUNICATION EGINEERING (IOT)
MADAN MOHAN MALAVIYA UNIVERSITY OF TECHNOLOGY (MMMUT)
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SEMESTER WISE CREDIT STRUCTURE FOR B. TECH. (ECE IOT)

Category/Semesters	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**
Basic Sciences & Maths (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-140 / 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	BEC-106	Electronic Components Testing and Measurement	2	0	4	4
5.	HSSE	BHS- 102/152	Technical Writing and Professional Communication (TW&PC)	2	1	2	4
			Total	**13**	**2**	**10**	**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	BEC-131 / 181	Engineering Physics	3	0	2	4
3.	EF	BCS-110/160	Introduction to C Programming	3	0	2	4
4.	PS	BEC-157	Electronic Workshop	2	0	4	4
5.	HSS	BHS- 101/151	Universal Human Values (UHV)	3	1	0	4
			Total	**14**	**2**	**8**	**20**
6.	VAC/AC	BEC-170	Design Thinking in Electronics & Communication Engineering	0	0	2	0
7.	ECA-II			-	-	-	**0**

Second Year, Semester III

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	BSM	BSM-216	Applied Probability and Statistics	3	1	0	4
2.	EF	BEC-207	Digital Electronics	3	0	2	4
3.	PC	BEC-208	Network Theory: Analysis & Synthesis	3	1	0	4
4.	PC	BEC-209	Electronic Measurement & Instrumentation	3	0	2	4
5.	PC	BEC-210	Electronic Devices & Circuits Theory	3	1	0	4
			Total	**15**	**3**	**4**	**20**
6.	VAC	AUC-108	Intellectual Property Right	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. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	EF	BEC-259	Electromagnetic Field Theory	3	1	0	4
2.	PC	BEC-260	Signal & System	3	1	0	4
3.	PC	BEC-261	Microprocessor and Applications	3	0	2	4
4.	PC	BEC-263	Introduction to Arduino Uno Programming	3	0	2	4
5.	Students may choose either PE-1 or PE-2 or Both PE-1 and PE-2						
6.	PE		PE-1	3	1/0	0/2	4
7.	PE		PE-2	3	1/0	0/2	4
8.			**Total**	**15-18**	**2-4**	**4-8**	**20-24**
9.	VAC/AC		Constitution of India	2	0	0	0

10.	ECA-IV			-	-	-	0

*Student may choose PE-1 from other departments for minor degree.

Third Year, Semester V

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	PC	BEC-313	Embedded System Design	3	1	0	4
2.	PC	BEC-314	Analog and digital Circuit Design	3	0	2	4
3.	PC	BEC-315	Introduction to Raspberry Pi Programming	2	0	4	4
4.	M	BMS-301	Principles of Industrial Management	3	1	0	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	1/0	0/2	4
6.	PE		PE-2	3	1/0	0/2	4
7.	PE		PE-3	3	1/0	0/2	4
8.	PE		PE-4	3	1/0	0/2	4
9.	PE		PE-5	3	1/0	0/2	4
10.	PE		PE-6	3	1/0	0/2	4
11.	PE		PE-7	3	1/0	0/2	4
12.	PE		PE-8	3	1/0	0/2	4
13.	PE		PE-9	3	1/0	0/2	4
			Total	**12-24**	**1-8**	**0-16**	**16-32**
14.	ECA-V			-	-	-	0

Third Year, Semester VI

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	PC	BEC-360	Digital Communication System	3	0	2	4
2.	PC	BEC-361	Introduction to VLSI	3	0	2	4
3.	PC	BEC-362	Introduction to Deep Learning	3	0	2	4
4.	HSSE	BHS 301/351	Engineering and Managerial Economics	3	1	0	4
5.	P	BEC-451	Minor Project-1	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	1/0	0/2	4
7.	PE		PE-2	3	1/0	0/2	4
8.	PE		PE-3	3	1/0	0/2	4
9.	PE		PE-4	3	1/0	0/2	4
10.	PE		PE-5	3	1/0	0/2	4
11.	PE		PE-6	3	1/0	0/2	4
12.	PE		PE-7	3	1/0	0/2	4

13.	PE		PE-8	3	1/0	0/2	4
14.	PE		PE-9	3	1/0	0/2	4
			Total	**12-24**	**1-8**	**0-16**	**16-32**
15.	ECA-VI			-	-	-	0

Final Year, Semester VII

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	P	BEC-452	Minor Project-2	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	1/0	0/2	4
3.	PE		PE-2	3	1/0	0/2	4
4.	PE		PE-3	3	1/0	0/2	4
5.	PE		PE-4	3	1/0	0/2	4
6.	PE		PE-5	3	1/0	0/2	4
7.	PE		PE-6	3	1/0	0/2	4
8.	PE		PE-7	3	1/0	0/2	4
9.	PE		PE-8	3	1/0	0/2	4
10.	PE		PE-9	3	1/0	0/2	4
			Total	**0-18**	**0-6**	**12-30**	**6-30**
11.	ECA-VII			-	-	-	0

Final Year, Semester VIII

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	IP	IEC-417	Industrial Practice (IP)	0	0	20	10
	Without Industrial Practice (IP)						
2.	MP	IEC-418	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)						
3.	PE		PE-1	3	1/0	0/2	4
4.	PE		PE-2	3	1/0	0/2	4
5.	PE		PE-3	3	1/0	0/2	4
6.	PE		PE-4	3	1/0	0/2	4
7.	PE		PE-5	3	1/0	0/2	4
8.	PE		PE-6	3	1/0	0/2	4
9.	PE		PE-7	3	1/0	0/2	4
10.	PE		PE-8	3	1/0	0/2	4
11.	PE		PE-9	3	1/0	0/2	4
			Total	**0-15**	**0-5**	**20-30**	**10-30**

List of Professional Electives

1.	PE-1	EEC-151	Introduction to Drones	3	1	0	4
		EEC-152	Introduction to Robotics	3	1	0	4
2.	PE-2	EEC-251	Physics of IoT Sensors and Actuators	3	1	0	4
		EEC-253	Basics of Artificial Intelligence	3	1	0	4
3.	PE-3	EEC-351	Dynamics and Control of Drones	3	1	0	4
		EEC-353	Robot Kinematics	3	1	0	4
4.	PE-4	EEC-451	Wireless Sensor Network	3	0	2	4
		EEC-452	Network and Security of IoT	3	1	0	4
5.	PE-5	EEC-551	Autonomous Navigation of Drones	3	1	0	4
		EEC-553	Control of Robotic Systems	3	1	0	4
6.	PE-6	EEC-651	Fog and Edge Computing	3	1	0	4
		EEC-652	Industrial IoT	3	1	0	4
7.	PE-7	EEC-753	Payload and Processing system for Drones	3	1	0	4
		EEC-754	Android Application Development	3	0	2	4
8.	PE-8	EEC-851	Smart Antenna for IoT Applications	3	0	2	4
		EEC-852	Advanced Wireless Communications	3	1	0	4
9.	PE-9	EEC-951	Minor Project			8	4
		EEC-952	Minor Project			8	4

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

S.No.	Subjects	Codes
1.	Constitution of India	AUC101
2.	Indian Culture and Heritage	AUC102
3.	Indian Architecture	AUC103
4.	Indian Festivals	AUC104
5.	Vedic Mathematics	AUC105
6.	Astronomy	AUC106
7.	Arts of India	AUC107
8.	Intellectual Property Rights	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 Environmental Governance: Administration And Adjudication	AUC116
17.	Directive Principles Of State Policy And Fundamental Duties: Constitutional Imperative	AUC117
18.	Introduction To Intellectual Property To Engineers And Technologists	AUC118
19.	Fundamentals of Artificial Intelligence	AUC119
20.	Indian Knowledge Through Classical Languages	IKS101
21.	Indian Knowledge System: Concepts And Applications In Science	IKS102
22.	Indian Knowledge System: Concepts And Applications In Engineering	IKS103
23.	Indian Knowledge System	IKS104

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	ECA	Games & Sports-VI	ECA-431	2	0

	Branches					
3.	Open to all Branches	ECA	Cultural, Art & Literary-VI	ECA-432	2	0

SKILLS-ENHANCEMENT COURSES FOR EXIT (ELECTRONICS & COMMUNICATION ENGINEERING) IOT:

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	BEC-180	Electronics Mechanics	1	0	2	2
2.	Skill Enhancement	BEC-181	Mini Project	0	0	8	4

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	BEC-281	Consumers Electronics	1	0	2	2
2.	Skill Enhancement	BEC-282	Mini Project	0	0	8	4

OR

Equivalent skills-enhancement courses from MOOC/SWAYAM.

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	BEC-331	Industrial Training (6 to 8 weeks)	0	0	12	6
OR							
1.	Skill Enhancement	BEC-393	Smart Antenna	2	0	2	3
2.	Skill Enhancement	BEC-394	Modern Industrial IoT	2	0	2	3

OR

Equivalent skills-enhancement courses from MOOC/SWAYAM.

BSM-110	**:**	**Engineering Mathematics-I**
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 and Two Minor tests 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.

1. Use of basic differential operators in various engineering problems.
2. Understand the concepts of limit theory and nth order differential equations and their applications to our daily life.
3. Solve linear system of equations using matrix algebra.
4. Know about qualitative applications of Gauss, Stoke's and Green's theorem.
5. To know the applications of double and triple integration in finding the area and volume.
6. To inculcate the habit of mathematical thinking and lifelong learning.

Topics Covered

UNIT-I 9

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 9

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 9

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 9

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).

Books & 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.,

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 home assignments, quizzes, minor tests, practical work, viva-voce, practical exam and 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

1. To develop the concepts of basic chemistry.
2. 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.
3. To understand the analytical and conceptual skills required for environmental chemistry research.
4. To understand water treatment for all types of uses and need to protect environment.
5. To understand the specifications of pure water and its purification techniques.
6. To develop the knowledge about Green Chemistry and Green Technology.

Unit 1: **9**

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 2: **9**

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 3: **9**

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 4: **9**

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.

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 $K_3[Fe(CN)_6]$ 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.

Books & 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 Credi*ts*	:	4
Course Assessment methods	:	Continuous assessment through attendance, home assignments, quizzes, practical work, record, viva voce, Minor tests and One Major Theory & Practical 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:

1. Understand the basic properties of electrical elements, and solve problem based on basic electrical circuits & DC network theorems.
2. Understand the fundamental behaviour of AC circuits and solve AC circuit problems.
3. Apply the knowledge gained to explain the behaviour of the circuit at series & parallel resonance of circuit & the effect of resonance.
4. Classify different electrical measuring equipment's and understanding their principles.
5. Understand the basic concepts of magnetic circuits.
6. Explain construction and working principle of transformer.

Topic Covered

UNIT I

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. **9**

UNIT II

Steady- State Analysis of Single-Phase AC Circuits: **9**

AC fundamentals: Sinusoidal, square, and triangular waveforms – Average and effective values, Form and peak factors, Concept of phasor, phasor representation of sinusoidally varying voltage and current, Analysis of 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

Measuring Instruments & Magnetic Circuit: **9**

Types of instruments, Construction and working principles of PMMC and Moving Iron type voltmeters & ammeters, Use of shunts and multipliers.

Magnetic circuit, concepts, analogy between electric & magnetic circuits, B-H curve, Hysteresis, and eddy current losses.

UNIT IV

Single-Phase Transformers: **9**

Single Phase Transformer: Principle of operation, Construction, EMF equation, Power losses, Efficiency, O.C & S.C Test and Introduction to auto transformer.

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:

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.

BEC-106		**Electronic Component Testing and Measurement**
Course category	:	Professional Skills (PS-1)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture:2, Tutorial :0 , Practical: 4
Number of Credits	:	4

Course Assessment methods : Continuous assessment through attendance, assignments, quizzes, practical work, record, viva voce and two Test and One Major Theory & Practical Examination

Course Objectives

The objective of this course is to gain knowledge of basic electronic components and develop an understanding of the working principles of different electronic devices such as diode, transistor MOSFET, voltmeter, multimeter, CRO, etc. Also, to identify different electronic components & to develop an understanding of testing of different electronic components.

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

1. Able to memorize the basic concept of electronic circuits using Diode, BJT (Bipolar Junction Transistor), FET (Field Effect Transistor), etc.
2. Able to execute and examine the general characteristics of electronic circuits.
3. Compute different parameters for characterizing different circuits like rectifiers, amplifiers, integrators, etc.
4. Examine the working principle of the digital voltmeter, and mustimeters using the block diagram approach.
5. Able to identify electronic components.
6. Discuss and calculate voltage, current, phase, and frequency using CRO.

Topics Covered

UNIT-I

Semiconductor Diode: Depletion layer, V-I characteristics, ideal and practical Diodes, Diode Equivalent Circuits, Zener Diodes breakdown mechanism (Zener and avalanche) 6

Diode Application: Diode Configuration, Half and Full Wave rectification, Clippers, Clampers etc.

Special Purpose Diodes: Light-Emitting Diodes, Photo Diodes etc.

UNIT-II

Bipolar Junction Transistor: Transistor Construction, Operation, Amplification action. Common Base and Common Emitter Configuration, input/output characteristics, Biasing of transistors-fixed bias and potential divider bias. 6

UNIT-III

Field Effect Transistor: Construction and working of JFETs. Transfer Characteristic and Output Characteristic of JFETs. MOSFET (MOS) (Depletion and Enhancement) Type, Transfer Characteristic and Output Characteristic of MOSFETs. 6

UNIT-IV

Operational Amplifiers and Electronics Instruments: Introduction, Op-Amp basic, Practical Op-Amp Circuits (Inverting Amplifier, Non-inverting Amplifier etc). Working principle of digital Storage Oscilloscope, CRO (its working with block diagram). 6

EXPERIMENTS

Note: Minimum eight experiments are to be performed:

1. To plot the forward / Reverse Characteristics of Si P-N junction diode.

2. To plot the forward/Reverse Characteristics of Zener diode.
3. Study and plot the characteristic of Zener diode as voltage regulator.
4. Study of half wave rectifier and draw the nature of input / output signal. Calculate the value of I_{dc}, I_{rms} and ripple factor.
5. Study of Full wave rectifier and draw the nature of input / output signal. Calculate the value of I_{dc}, I_{rms} and ripple factor.
6. Study of Bridge Rectifier and draw the nature of input / output signal. Calculate the value of I_{dc}, I_{rms} and ripple factor.
7. Draw input-output characteristic curve of n-p-n transistor in CE or CB or CC configuration.
8. Draw the drain and transfer curve of JFET.
9. Study of OP-AMP (741) and calculate the gain in (i) Inverting mode and (ii) non-inverting mode.
10. Study of OP-AMP as a (i) Summer (ii) Integrator (iii) Differentiator; and plot the nature of input & output waveform.
11. To identify the components which are used in electronic circuits. (R, L, C, diode etc).
12. To study the resistance, voltage, current measurement by using of mustimeter.
13. To get familiarization and to study the operation of a function generator instrument and visualize the types of waveforms produced by a function generator.
14. To study the DSO and to find the Amplitude, Time-period and Frequency of a sinusoidal waveform using DSO.
15. Study of Lissajous patterns and measurement of frequency through Lissajous patterns.
16. Measurement of time constant of RC circuit.
17. Measurement of unknown resistance using Wheatstone bridge.

Books & References

1. Electronic Devices and Circuits-Boylestad and Nashelsky, 6e, PHI, 2001
2. Electronic Devices and Circuits, A Mottershead, PHI,2000, 6e
3. Digital Computer Design, Morris Mano, PHI,2003
4. Electronic Instrumentation-H.S. Kalsi, 2e, TMH, 2007

BHS- 102/152 : Technical Writing and Professional Communication (TW&PC)

Course Category : HSS
Prerequisite subject : None
Number of Credits : 4
Contact Hours/Week : Lectures: 2, Tutorial: 1, Practical: 2
Course Assessment Methods : Continuous assessment through Two tests, teacher's assessment (quiz, tutorial, assignment, attendance), and One Major Theory Examination.

Course Objectives: The objectives of this course are to: -

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: -

1. Overcome the problems she/he shall face in oral and written communication.
2. Acquire knowledge of and methods for using technical communication, such as reports, proposals, technical letters, etc.
3. Use and Practice compositions correctly.
4. Give presentations in different sessions and make self-appraisal.
5. 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.

Unit 1: Language and Communication **6**

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.Pre-writing, Drafting, and Re-writing

Unit 2: Towards Technical Writing **6**

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 3: Drafting Skills & Career Correspondence **6**

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 4: Professional Practices with ICT Interface **6**

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: Drafting E-mails, Blogs on social media, Videoconferencing. Managing Profiles on social media. What to Write and Share on social media. Telephone Etiquettes & Phubbing.

List of Practical:

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

Text / Reference Books

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, ModernLanguage 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.

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 and Two Minor tests 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

1. To solve the ordinary differential equations.
2. To solve the partial differential equations using Lagrange and charpit's method.
3. To solve and understand the properties of Bessel`s and Legendre`s differential equation.
4. Application of partial differential equation in real life problems
5. To solve ODE and PDE with the help of Laplace transform
6. To inculcate the habit of mathematical thinking and lifelong learning.

Topics Covered

UNIT-I 9

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 9

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 9

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 9

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.

Books & 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 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.

BEC-157 Electronic Workshop

Course category	:	Professional Skills (PS-2)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 2, Tutorial :0 , Practical: 4
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through attendance, assignments, quizzes, practical work, record, viva voce and two Test and One Major Theory & Practical Examination
Course Objectives		The objective of this course is to develop the skill and working of different circuit board & prototypes of the designed electronics circuits.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course:

1. To identify the circuit components and their application specially for electronics PCB design.
2. Understand the design processes and production methods used in the manufacturing of a printed circuit board.
3. Understand the use and application of chemical itching and drilling in the manufacture of an electronic circuit.
4. Be able to design and manufacture a prototype printed circuit board and use it to assemble and test an electronic circuit.
5. Able to design rectifier and filter and study their practical applications.
6. Able to have knowledge of these circuits using breadboard.

Topics Covered

Unit 1: Introduction to Electronics **6**

Overview of basic electronic components (resistors, capacitors, diodes, transistors, transformers, potentiometers etc.), Introduction to circuits (series, parallel, combination),

Understanding Ohm's Law and Kirchhoff's Laws, Introduction to basic electronic tools (mustimeter, oscilloscope)

Unit 2: PCB Designing Basics **6**

Introduction to PCB (Printed Circuit Board) design, Understanding PCB layout and components placement, Introduction to PCB design software (e.g., Eagle, KiCad, Proteus), Hands-on practice in designing a simple PCB layout

Unit 3: Advanced PCB Designing **6**

Understanding PCB design considerations (trace width, spacing, vias, etc.), Signal integrity and noise reduction techniques, Designing for manufacturability (DFM) and design for testing (DFT), Advanced PCB design software features and techniques

Unit 4: Project-Based Learning **6**

Minor PCB design project, Presentations and demonstrations of the completed projects, Troubleshooting, Feedback and evaluation of the projects

EXPERIMENTS

Note: Minimum eight experiments are to be performed:

1. Winding shop: Step-down transformer winding of less than 5VA.
2. Soldering shop: Fabrication of DC regulated power supply.
3. Printing of circuits on PCB.
4. Design a PCB using Etching & drilling.
5. Coating of etched PCB to protect it from oxidation.
6. Convert the power supply circuit into PCB & simulates its 2D & 3D view.
7. Design a full wave center tapped rectifier & study the effect of capacitive filter & it's output on a virtual oscilloscope.
8. Design a RLC resonance circuit & verify the transient & phase response for different values of R, L&C.
9. Assemble electronic circuit/system on general purpose PCB, test and show the functioning. 10. Construct various electronic circuits on breadboard
11. Identify and test different types of ICs.
12. To study the specifications and working of a Transistor radio kit and perform measurements on it.
13. Study the working of Distortion Meter.
14. To study the working of Spectrum analyzer and determine the bandwidth of different signals.

Books & References

1. Electronics Components and Materials by SM Dhi, Tata McGraw Hill, New Delhi
2. Electronics Device and circuits by Millman and Halkias; McGraw Hill.

BHS- 101/151 : Universal Human Values: Understanding Harmony

Course Category : HSS
Prerequisite subject : None
Number of Credits : 4

Contact Hours/Week : Lectures: 3, Tutorial: 1, Practical: 0

Course Assessment Methods : Continuous assessment through Two tests, teacher's assessment (quiz, tutorial, assignment, attendance), 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: -

1. Ability to understand the interconnectedness of humanity and nature as well as the importance of values in interpersonal relationships.
2. Ability to recognize their role as global citizens and understand the importance of actively contributing to the betterment of society through responsible actions.
3. Ability to engage in critical reflection on their own values and beliefs, challenging assumptions and biases to foster personal growth and development.
4. 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 1 **9**

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 2 **9**

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 3 **9**

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 4 **9**

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.

Text & Reference Books:

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.

Course Code: BEC-170		**Design Thinking in Electronics & Communication Engineering**
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 assignments, attendances, quizzes and practical exam tests.

Course Objectives : Inculcate the fundamental concepts of design thinking

- Develop the students as a good designer by imparting creativity and problem-solving ability
- Conceive, conceptualize, design and demonstrate innovative ideas using prototypes
- To propose a concrete, feasible, viable and relevant innovation project/challenge

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

1. To expose the student with state-of-the-art perspectives, ideas, concepts, and solutions related to the design and execution of projects using design thinking principles.
2. To prepare the mindset and discipline of systemic inspiration driven by a desire to identify new sources of ideas, and new models especially outside their regular working atmosphere.
3. Demonstrate the critical theories of design, systems thinking, and design methodologies
4. Produce great designs, be a more effective engineer, and communicate with high emotional and intellectual impact.
5. Understand the diverse methods employed in design thinking and establish a workable design thinking framework to use in their practices
6. Conceive, organize, lead and implement projects in interdisciplinary domain and address social concerns with innovative approaches

Experiments:

1. Using David Kolb's Model, to identify Experiential Learning Cycle for VLSI design system.
2. To Study all stages in the Design Thinking Process and Prototype and examine any Digital circuit simulation process by Brainstorming prototype.
3. To study Problem Solving and Functional Fixedness and applied on IoT based agricultural system, also comparison Between Eco-Reps and Non-Eco-Reps .
4. By development of scenarios planning and evaluation tools, illustrate an experiment Interactive Drama for an AI based IoT system.
5. Via advanced communication system-based discussions in a group setting be used to assess residents' clinical skills.
6. With the help of Cognitive bias categories in Strengthen communication, to identify Complementary interviews.
7. By creating a Culture of Innovation, to develop different Strategies for Business Growth and Success of Microelectronics & VLSI Design system.
8. Depict an importance of Experimental Prototyping and to Construct a Prototype Experiment for an Electromagnetic Field theory and Antenna system.

9. To identify all Prototype Testing, Design, Test, and Implement Your Ideas with creation of Smart cities.
10. Design and experimentation of 3d printed pattern and wooden pattern for sand casting process.
11. To corelate an Ergonomics and sustainability in the design of everyday use products.
12. A Step-by-Step Guide to Build a Minimum Viable Product (MVP) in terms of Entrepreneurship for Silicon based IC.
13. Experimentation and startup performance /business ideas: Evidence from A/B testing
14. How to translate subjective customer needs into precise target specs? How could the team resolve.
15. What is creative problem-solving & why is it important?
16. How to Build a Functional Product Design Outstanding Feedback Loop in 7 Steps?

Text and Reference Books

1. E. Balaguruswamy (2022) Developing Thinking Skills (The way to Success), Khanna Book Publishing Company.
2. Roger Martin, "The Design of Business: Why Design Thinking is the Next Competitive Advantage",Harvard Business Press , 2009.
3. Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand – Improve– Apply", Springer, 2011

BSM-216/266	**Applied Probability and Statistics**
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 and One Minor tests and One Major Theory Examination
Course Objectives	: The course is aimed to develop the basic statistical 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

1. To understand the basic concepts of probability and probability Distributions.
2. To understand the central tendency, correlation, and correlation coefficient and also regression.
3. To understand the fitting of various curves by method of least square
4. To apply the statistics for testing the significance of the given large and small sample data by using t- test, F- test and Chi-square test.
5. Application of probability and statistics in real life.
6. To inculcate the habit of statistical thinking and lifelong learning.

Topics Covered

UNIT-I 9

Basic Statistics: Frequency distribution, Mean, Median, Mode, Moments, Moment Generating function, Skewness, Types of Skewness, Measurement of Skewness, Kurtosis, and its types. Curve fitting: Method of Least Squares, Fitting of Straight lines, Fitting of Parabola of second degree.

UNIT-II 9

Applied Statistics: Correlation, Correlation coefficient, Spearman's rank correlation coefficient, Regression, Equation of regression lines, linear, and non-linear regression analysis. Relation between Regression Analysis and Correlation Analysis

UNIT-III 9

Probability: Random experiment, outcome, trial and event, Exhaustive events, favourable events, independent events, sample space, classical and empirical definition of probability, addition theorem of probability, multiplication theorem of probability, conditional probability, Baye's theorem.

UNIT-IV 9

Probability Distribution: Discrete and continuous random variable and their properties, distribution functions, Binomial, Poisson and Normal Distribution and evaluation of statistical parameter of these three distributions. **Test of significance:** sampling, large sample test for single proportion, difference of proportions, single mean, difference of means and difference of standard deviation, Chi-square test for goodness of fit.

Books & References

1. D. C. Montgomery and G. C. Runger, Applied Statistics and Probability for Engineers, Wiley.
2. J. L. Devore, Probability and Statistics for Engineering and the Sciences, Cengage Learning.
3. S.M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Academic Press; 5th edition
4. Robert V Hogg, Joseph McKean, Allen T Craig, Introduction to Mathematical Statistics, Pearson Edu.
5. Mood, Graybill and Boes, Introduction to the Theory of Statistics, Tata McGraw-Hill.

Course Code: BEC-207 **Digital Electronics**

Course category	:	Engineering Fundamental (EF-4)
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, minor test and Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Acquired knowledge about basics of digital electronics and solving problems related to number systems and Boolean algebra.
2. Ability to identify, analyze and design combinational circuits.

3. Ability to identify, analyze and design sequential circuits.
4. To design, implement and evaluate various synchronous and asynchronous sequential circuits and applications.
5. Acquired knowledge about internal circuitry and logic behind digital systems.
6. Able to understand State machine design procedure with sequential PLDs.

Topics Covered

UNIT-I **9**

Digital system and Binary numbers: Signed binary numbers, Floating point number, Binary Codes, Cyclic codes, Error detecting and correcting codes, Hamming codes. NAND and NOR implementation, Minimization of circuit using K-map and Tabular method up to five variables, POS and SOP simplification, Logic family- TTL, DTL, ECL, CMOS, HMOS

UNIT-II **9**

Combinational Logic: Analysis and Design procedure for Combinational circuits, Binary adder/subtractor, Binary multiplier, Booth Algorithm, Magnitude comparator, Encoder/Multiplexer, Decoder/Demultiplexer.

UNIT-III **9**

Sequential logic: Sequential circuits, Latches, Flip-flops, Conversion of flip-flops, Analysis of clocked sequential circuits, State reduction and assignments. Registers and counters: Shift registers, Asynchronous counter, Synchronous counter, Sequential circuit analysis and design procedure, Circuit with latches, Hazards.

UNIT-IV **9**

Memory and programmable logic: Read only Memory, Read/Write Memory-SRAM and DRAM. Programmable Logic Devices, -PLAs, PALs and their applications; Sequential PLDs and their applications; State machine design with sequential PLDs: Introduction, to field programmable gate arrays (FPGAs).

LIST OF EXPERIMENTS

1. Design and verification of following arithmetic circuits using 74xx family ICs.
   i) Half adder and Full adder
   ii) Half subtractor and full subtractor
2. To perform the code conversion- binary to gray and gray to binary and its truth table verification.
3. To design a combinational logic circuit using 74xx family ICs and its truth table verification in both SOP and POS forms.
4. Realization of 2:4 decoders and 4:2 encoder circuit and verification of its truth table.
5. To design and verify the truth table of multiplexer and demultiplexer circuits.
6. To design a 1-bit comparator using 74xx family ICs and to study the performance of4- bit comparator IC7485.
7. Design and verification of basic Flip-Flops using 74xx family ICs and master-slave JK flip-flop using IC7476
8. To realize and verify the truth table of shift register-SIPO/SISO and PISO/PIPO.
9. Design and verification of asynchronous counter design and Mod-n counter.

10. To realize and verify the truth table of synchronous counter design

Books & References

1. Hill & Peterson, "Switching Circuit & Logic Design",Wiley
2. Mano, M. Morris. Digital design. Pearson Educación, 2002.
3. Digital principle and applications Malvino and Leach-(TMH)

Course Code: BEC-208	**:**	**Network Theory: Analysis & Synthesis**
Course category	:	Program Core (PC)
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, assignments, quizzes, minor test and major theory examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Able to apply the electric circuit concept and theorems with nodal and mesh on the complex RL, RC & RLC circuits in time and frequency domain.
2. Able to apply the concept of Laplace Transform to evaluate the system function for single and two port networks.
3. Able to synthesize the LC, RC & RL immittance networks using the Foster and Cauer approaches.
4. Able to realize the synthesize the transfer functions of two port networks and active networks.
5. Able to understand synthesis of RC impedances or RL admittances.
6. Able to implement filter design for various practical applications.

Topics Covered

UNIT-I

Signal and System analysis, Definition and basic circuits concepts, Mesh and nodal analysis, General characteristics of signals and wave forms: step, impulse, ramp, and gate function; Initial and final conditions in circuits, Network Theorem: Maximum Power Transfer Theorem, Milliman's Theorem; Solution of network equations: Transient Response &steady state response, Convolution Integral of basic signals. **9**

UNIT-II

Laplace Transform: Introduction, Region of Convergence, Laplace transform of common basic signals, Properties, Inverse Laplace Transforms, Application of Laplace Transform Techniques to Electrical Circuits analysis, Transform Circuits, Thevenin and Norton's Theorem, Initial and Final Value theorem. **9**

Two-Port Network functions: Introduction, Parameters, Condition for reciprocity and symmetry, Relation between port parameters, Interconnection of two ports networks.

UNIT-III

Element of Realizability: Concepts of Poles and Zeroes, Causality & Stability, Hurwitz polynomials, Positive real functions; Network Synthesis using Cauer and Foster: Properties of real immittance functions, synthesis of LC driving point immittances, Properties of RC driving point impedances, Synthesis of RC impedances or RL admittances, Properties of RL impedances and RC admittances. **9**

UNIT-IV **9**

Transfer function synthesis: Properties of transfer function, Zeroes of Transmission, Synthesis of Y_{21}& Z_{21} with 1-ohm termination, Introduction to Active network synthesis: Operation of filters, filter design, frequency scaling.

Textbooks

1. Franklin F. Kuo, 'Network Analysis and synthesis', 2nd Edition, Wiley India Pvt Ltd.
2. M.E. Van Valkenberg, 'Network Analysis', 2nd Edition, Prentice Hall of India Ltd.
3. M.S. Sukhija, T.K. Nagsarkar, 'Circuits and Networks' 2nd Edition, Oxford University Press.
4. S.P. Ghosh, A.K. Chakraborty, 'Network Analysis and Synthesis' McGraw Hill Education Pvt Ltd.

Course Code: BEC-209 **Electronic Measurement & Instrumentation**
Course category : Program Core (PC)
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, Minor Test and Major Theory Examination
Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

1. Able to explain the quality measurements with electronic instruments.
2. Able to use digital display devices in practical applications.
3. Able to solve and illustrate the numerical problem for DC/AC bridge-based circuits.
4. Able to illustrate the principles of various types of transducers and their applications.
5. Able to explain the construction, principle of operation, and applications of electromechanical and electronic instruments along with Data Acquisition System (DAS).
6. Able to articulate the range of measuring instruments.

UNIT-I **9**

Measuring Instruments: classification, absolute and secondary instruments, Performance Characteristics, Error in measurement, Sources of error, Arithmetic mean, Deviation from the mean, Average deviation, Standard deviation, Limiting errors. PMMC instruments, Expression for the deflecting torque and control torque, Analog to digital (Linear and digital ramp method, successive approximation method) and Digital to analog (R-2R method) converters. Digital Display Devices: LED, LCD, Incandescent Display, LVD (Liquid Vapour Display)

UNIT-II **9**

DC/AC Bridges: General equations for bridge balance, Self-inductance measurement by Maxwell's bridge, Hay's bridge, Capacitance measurement by De Sauty bridge, Schering bridge and Wein Bridge, Method of measuring low, medium and high resistance: Kelvin's double bridge for measuring low resistance, Wheat-stone's bridge, measurement of high resistance, Basics of wattmeter and energy meter

UNIT-III **9**

Transducers: Introduction, Selection Parameters of Transducer, Type of Transducer, Resistive Transducer: Strain Gauges, Inductive Transducer: LVDT, Capacitive Transducer, Photo-electric Transducer: Photo conductor, Photodiode and Photo-Voltaic Cell, Thermoelectric Transducers: RTDs, Thermistor and Thermocouple, Piezoelectric Transducer, Digital Transducer.

UNIT-IV **9**

Electromechanical Instruments: Ammeter, Voltmeter and Ohmmeter, Extension of range using shunts and series resistance. Analog and Digital electronic Instruments: Emitter-follower voltmeters, operational amplifier voltmeter, Digital voltmeter system, Digital mustimeters, Digital frequency meter system. Data Acquisition System, Single and Multichannel DAS, Data Loggers: Block diagram, principle of operation.

LIST OF EXPERIMENTS

1. Study of half-wave and full-wave bridge rectifier using resistive load.
2. To design a series RLC circuit and study the condition of resonance.
3. Study of L.C.R. Bridge and determination of the value of the given components.
4. Study of the distortion factor meter and determination of the % distortion of the given oscillator.
5. Study of the transistor tester and determination of the parameters of the given transistors.
6. Measurement of resistance using the Wheatstone bridge.
7. Measurement of phase difference and frequency using CRO (Lissajous figure).
8. Measurement of low resistance using Kelvin's double bridge.
9. To measure the linear displacement using the LVDT trainer kit.
10. To design an IR sensor-controlled LED on a breadboard.

Optional Experiments

1. Measurement of capacitance by Schering Bridge.
2. To measure the value of an unknown inductance with the help of Anderson's Bridge.
3. Measurement of capacitance by Schering Bridge.
4. To measure the value of an unknown inductance with the help of Anderson's Bridge.

Text & Reference Books

1. H. S. Kalsi, "Electronic Instrumentation", 3rd Ed., McGraw Hill Education (India), 2015.
2. David A. Bell, "Electronic Instrumentation and Measurements", 3rd Ed., Oxford University Press, 2013.

Course Code: BEC-210 **Electronic Devices & Circuits Theory**

Course category : Department Core (PC)

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 Two Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Ability to understand the basic operation and working of different diodes like PIN, Varactor diode etc.
2. To understand the high frequency application of diodes.
3. To understand and use of the device models to explain and calculate the characteristics of the field effect transistors.
4. To be able to understand and analyze the V-I characteristics of different high-power devices.
5. Understand the operation of charge-transfer devices and charge storage device.
6. To be able to implement oscillator circuits.

Topics Covered

UNIT-I **9**

BJT: Review of device structure operation and V-I characteristics, BJT circuits at DC, BJT as amplifier and switch, biasing in BJT amplifier circuit.

Small-signal operation and models, single stage BJT amplifier, BJT internal capacitances and high frequency model, frequency response of CE amplifier. Darlington pair, BJT differential pair, Cascode and Cascade amplifier.

UNIT-II **9**

MOSFET: Review of device structure operation and V-I characteristics, MOSFET Circuits at DC, MOSFET as Amplifier and switch, Biasing in MOS amplifier circuits.

Small-signal operation and models, single stage MOS amplifier, MOSFET internal capacitances and high frequency model, frequency response of CS amplifier.

UNIT-III **9**

Feedback Amplifiers: The general feedback structure, properties of negative feed- back, the four basic feedback topologies, the series-shunt feedback amplifier, the series-series feedback amplifier, the shunt-shunt and shunt-series feedback amplifier.

UNIT-IV **9**

Oscillators: Basic principles of sinusoidal oscillators, RC Phase-shift Oscillator circuits, Resonant-circuit based LC oscillators.

Books & References

1. Milman, Halkias & Jit- Electronics Devices and Circuits- TMH
2. Donald ANeaman, “Semiconductor Physics and Devices Basic Principles”, 3e, TMH India.

Course Code: BEC-259 : Electromagnetic Field Theory

Course category	**:**	Engineering Fundamental (EF)
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, assignments, quizzes, minor test and major theory Examination
Course Outcomes	**:**	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

1. Understanding the basic mathematical concept related to electromagnetic vector fields and principles of electrostatic.
2. Apply the principles of magneto statics to the solutions of the problem relating to magnetic field.
3. Apply Maxwell's equations to solutions of problems relating to uniform plane wave propagation.
4. Understand characteristics and wave propagation on high frequency transmission lines.
5. Carry out impedance transformation on transmission line.
6. Use smith chart to find the solution of various transmission line problems.

UNIT-I **9**

Electrostatics Fields: Various co-ordinate system, Coulombs law and field intensity, Electric field due to charge distribution, Electric flux density, Gauss's Law – Maxwell's equation, Electric dipole and flux lines, Divergence Theorem, Poisson's and Laplace's equation, Energy density in electrostatic fields. Electric field in material space: Properties of materials, Convection and conduction currents, conductors, Polarization in dielectrics, Dielectric Constants, continuity equation and relaxation time, Boundary condition. Method of images.

UNIT-II **9**

Magneto-static fields, Biot-Savart's Law, Ampere's circuit law for a current element, magnetic scalar and vector potential, Magnetic dipole, Magnetic flux density- Maxwell's equation, Maxwell's equation for static fields, Magnetic forces, materials and devices: Forces due to magnetic field, Magnetic torque and moment, a magnetic dipole, Magnetization in materials, magnetic boundary conditions, Magnetic energy. Waves and applications: Faraday's Law, Transformer and motional electromotive forces, Displacement current, Maxwell's equations in differential and integral form.

UNIT-III **9**

Electromagnetic wave propagation: Derivation of wave equation and their general solution, Wave propagation in lossy dielectrics, Plane waves in lossless dielectrics, Plane wave in free space, Plain waves in good conductors, Poynting's theorem, Power and the Poynting vector, Reflection of a plane wave at normal and Oblique incidence.

UNIT-IV **9**

Transmission Lines- Equations of Voltage and Current on TX line, Propagation constant and

characteristic impedance, and reflection coefficient and VSWR, Impedance Transformation on Loss-less and Low loss Transmission line, Power transfer on TX line, Smith Chart, Admittance Smith Chart, Applications of transmission lines: Impedance Matching, use transmission line sections as circuit elements.

Text & Reference Books

1. W. H. Hayt and J. A Buck "Electromagnetic field Theory" 7th Ed. TMH
2. M. N. O. Sadiku, "Elements of Electromagnetics", 4th Ed, Oxford University Press

Course Code: BEC-260 SIGNAL & SYSTEMS

Course category	:	Program Core (PC)
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, Minor test and Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Able to describe the signals and systems mathematically and understand how to perform mathematical operations on signals and systems.
2. Able to analyze spectral characteristics and system properties based on impulse response and Fourier analysis.
3. Apply the Laplace transform for analyzing of continuous-time time signals and systems.
4. Apply the Z- transform for analyzing of discrete-time signals and systems.
5. Able to apply the transformation tools (continuous and discrete) on the analysis of spectral densities, design of system function
6. Able to apply the transformation tools to design system function through its block diagram representation.

Topics Covered

UNIT-I **9**

Signals: Definition, types of signals and their representations: Continuous-time/discrete-time, Periodic/non-periodic, Even/Odd, Energy/Power, Deterministic/Random, One dimensional /Multidimensional, Commonly used signals (in continuous-time as well as in discrete-time): Unit impulse, Unit step, unit ramp (and their interrelationships), Exponential, Rectangular pulse, Sinusoidal; Operations on continuous-time and discrete-time signals (including transformations of independent variables).

Systems: Classification, Linearity, Time-invariance and causality, Impulse response, Characterization of linear time-invariant (LTI) systems, Unit sample response, Convolution summation, Step response of discrete time systems, Stability, Poles and zeros

UNIT-II **9**

Fourier Series (FS) and Fourier Transforms (FT): (i) Fourier series representation and some important properties (ii) Definition, conditions of existence of FT, properties, Magnitude and phase spectra, Some important FT theorems, Parseval's theorem, Inverse FT, relation between LT and FT (iii) Discrete time Fourier transform (DTFT), Inverse DTFT, Convergence, Properties and theorems, Comparison between continuous time FT and DTFT

UNIT-III **9**

Laplace-Transform (LT) and Z-transform (ZT): (i) One-sided LT of some common signals, Important theorems and properties of LT, inverse LT, Solutions of differential equations using LT, Bilateral LT, Regions of convergence (ROC) (ii) One sided and Bilateral Z-transforms, ZT of some common signals, ROC, Properties and theorems, Solution of difference equations using one-sided ZT, s- to z-plane mapping

UNIT-IV **9**

Time and frequency domain analysis of systems: Convolution integral, Co-relations, Signal energy and energy spectral density, signal power and power spectral density, Properties of power spectral density, Analysis of first order and second order systems, continuous-time (CT) system analysis using LT, System functions of CT systems, Block diagram representations; discrete-time system functions, block diagram representation, Illustration of the concepts of system bandwidth and rise time through the analysis of a first order CT low pass filter

Books & References

1. Chi-Tsong Chen, `Signals and Systems', 3rd Ed., Oxford University Press,2004
2. V. Oppenheim, A.S. Willskyand S. Hamid Nawab,'Signals & System', Pearson Education,2nd Ed.,2003
3. P. Ramakrishna Rao, `Signal and Systems' 2008 Ed., Tata McGraw Hill, New Delhi

Course Code: BEC-261	**Microprocessors and Applications**
Course category	: Program Core (PC)
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, assignments, quizzes, practical work, record, viva voce, minor and major theory & practical Examination
Course Outcomes	: The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Able to understand the basic building blocks of Microprocessors.
2. Acquiring knowledge about 8085 Microprocessor and supporting devices.
3. Foster ability to write the assembly language programming using 8085 microprocessors.
4. Foster ability to understand 8086/8088 microprocessors
5. Foster ability to write the assembly language programming using 8086 microprocessors.
6. Foster ability to develop microprocessor-based system using different peripheral devices.

Topics Covered

UNIT-I **9**

Introduction to Microprocessors: Evolution of Microprocessors, Microprocessor Architecture and its operations, Memory devices, I/O Devices, 8-bit Microprocessor (8085): Introduction, Signal Description, Register Organization, Architecture, Basic Interfacing Concepts for Memory and I/O Devices

UNIT-II **9**

8085 Assembly Language Programming: Instruction Classification, Instruction Format, Addressing Modes, 8085 Instructions: Data Transfer operations, Arithmetic operations, Logic Operations, Branch operation, Flow Chart, Writing assembly language programs, Programming techniques: looping, counting and indexing.

UNIT-III **9**

16-bit Microprocessors (8086/8088): Architecture, Physical address segmentation, memory 18 organization, Bus cycle, Addressing modes, difference between 8086 and 8088, Assembly Language Programming of 8086

UNIT-IV **9**

Basic Peripherals & their Interfacing: DMA Controller (8257), Programable Peripheral Interface (8255), Programmable Interrupt Controller (8259), Programmable Interval Timer/ Counter (8253/8254)

LIST OF EXPERIMENTS:

1. Write a program using 8085 Microprocessor for Decimal addition and subtraction of two numbers.
2. Write a program using 8085 Microprocessor for Hexadecimal addition and subtraction of two numbers.
3. Write a program using 8085 Microprocessor for addition and subtraction of two BCD numbers.
4. To perform multiplication and division of two 8-bit numbers using 8085.
5. To find the largest and smallest number in an array of data using 8085 instructions set.
6. To write a program to arrange an array of data in ascending order.
7. Write a program to transfer blocks of data.
8. Write a program to find positive and negative numbers from given series of data.
9. To interface 8253 programmable interval timers to 8085 and verify the operation of 8253 in six different modes.
10. To interface 8255 with 8085 and verify the operation of 8255 in different modes.
11. To interface 8259 with 8085 and verify the operation of 8259.

Textbooks

1. R. Singh and B. P. Singh: Microprocessor Interfacing and Application, New Age International Publishers, 2nd Edition.
2. D. V. Hall: Microprocessors Interfacing, TMH (2nd Edition).
3. R. S. Gaonkar: Microprocessor Architecture, Programming and Applications with 8085/8080, Penram Publication
4. Y.C. Liu and G.A. Gibson: Microcomputer Systems: The 8086/8088 Family Architecture Programming and Design, PHI 2nd Edition,

Course Code: BEC-263	**:**	**Introduction to Arduino Uno Programming**
Course category	:	Program Core (PC)
Pre-requisite Subject	:	Fundamentals of Electronics Engineering
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through Viva voce, Practical work, attendance, minor test, major & practical examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Students will acquire basic knowledge in Arduino based Embedded System Design.
2. To develop the basic understanding of Microcontrollers, Actuator, Sensor, and Motors in various applications.
3. To develop a significant understanding of how to connect relays LED, LCD, IR, Ultrasonic sensor and servomotors to ARDUINO Board.
4. Design IoT applications in different domain like Filters, resistors, LCD displays etc., and be able to analyze their performance.
5. To understand the basic concept of UART/USART communication.
6. To understand the basic concept of I2C communication.

Topics Covered

UNIT-I 9

Introduction to Embedded Systems, Overview of Arduino Uno board and its architecture, Pin configuration and features of Arduino Uno, Basics of Arduino IDE and programming structure (setup and loop), Digital input and output operations, Comparison of Microcontroller and Microprocessor.

UNIT-II 9

Fundamentals of Sensors and Actuators, Interfacing principles of LEDs, push buttons, and buzzer, working principles of IR sensor, Ultrasonic sensor, and LDR, Temperature sensors: LM35 and DHT11, Basics of motor control using Arduino: DC motor and Servo motor.

UNIT-III 9

Interfacing display modules: 16x2 LCD and 7-segment display, Basics of Serial Communication (UART/USART): concept and applications, Basics of I2C Communication: concept and applications,

Introduction to simple Arduino applications and case studies.

UNIT-IV 9

System design using Arduino, Designing small, embedded projects, Arduino applications in automation: home automation, robotics, agriculture, and IoT, Integration of multiple sensors and actuators, Case studies of Arduino-based systems, Future scope of Arduino in embedded and IoT applications.

LIST OF EXPERIMENTS

1. Experiment of Blinking an LED using Arduino Uno.
2. Interfacing Push Button to control LED (ON/OFF).
3. Displaying Text on 16x2 LCD using Arduino.
4. Control Led brightness using Arduino PWM pins.
5. Interfacing IR Sensor for Object Detection.
6. Experiment to interface Ultrasonic Sensor, Buzzer, and LED with Arduino Uno to design a distance alert system.
7. Temperature and Humidity Monitoring using DHT11 Sensor.
8. Experiment to interface PIR Sensor with Buzzer and LED using Arduino Uno to design a simple security alarm system.
9. Controlling Servo Motor with Arduino.

Textbooks

1. Arduino-Based Embedded Systems: By Rajesh Singh, Anita Gehlot, Bhupendra Singh, and Sushabhan Choudhury.
2. Arduino Made Simple by Ashwin Pajankar
3. Embedded C, Pont, Michael J
4. ARM System Developer's Guide - Designing and Optimizing System Software by: Andrew NSloss, Dominic Symes, Chris Wright; 2004, Elsevier
5. ARM System - On - Chip Architecture, Furber, Steve

Course Code BEC-313		**Embedded Systems Design**
Course category	:	Program Core
Pre-requisite Subject	:	Digital Electronics
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quiz test, viva voce, One minor test and one major theory examination.
Course Objectives		This course introduces embedded systems fundamentals, covering architecture, communication protocols, memory systems, and software development for real-world applications.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. (CO 1-6)

1. Explain the fundamental concepts, functions, characteristics, and application areas of embedded systems.
2. Understand embedded system architectures, processor types, and instruction set designs.
3. Apply knowledge of I/O devices, peripherals, and communication protocols to analyze data transfer and control in embedded systems.
4. Analyze memory system architectures and memory interfacing techniques in embedded systems.
5. Evaluate embedded operating systems, RTOS scheduling algorithms, and device driver approaches.
6. Design and build embedded system solutions for real-world applications such as consumer electronics and automation systems.

Topics Covered

UNIT-I **9**

Definition of embedded system, embedded systems vs. general computing systems, history of embedded systems, classification, major application areas, purpose of embedded systems, characteristics and quality attributes of embedded systems, common design metrics, and processor technology: general purpose processor, application specific processor, single purpose processor.

UNIT-II **9**

Embedded System Architecture: Von Neumann v/s Harvard architecture, instruction set architecture, CISC and RISC instructions set architecture, basic embedded processor, microcontroller architecture, CISC & RISC examples: 8051, ARM, DSP processors.

UNIT-III **9**

Input Output and Peripheral Devices: Timers and counters, watchdog timers, interrupt controllers, PWM, keyboard controller, analog to digital converters, real time clock. Introduction to communication protocols: basic terminologies, concepts, serial protocol: I2C, CAN, firewire, USB. Parallel protocols: PCI bus, IrDA, bluetooth, IEEE 802.11, wireless protocols.

UNIT-IV **9**

Memory System Architecture: Caches, virtual memory, MMU, address translation, memory and interfacing, memory write ability and storage performance. Memory types, composing memory – advance RAM interfacing, microprocessor interfacing I/O addressing, interrupts, direct memory access, arbitration multilevel bus architecture. Embedded System Supporting Technologies: Difference between normal OS and RTOS, scheduling algorithms, Case studies: washing machine, air-conditioning, auto focus camera

Books & References

1. Santanu Chattopadhyay, Embedded system Design, 3rd edition, PHI Learning, 2023
2. Peter Marvedel, Embedded systems Design (Embedded system Foundations of Cyber-Physical System, and Internet of things), Springer, 2021.
3. Raj Kamal, Embedded Systems Introduction, 2nd Ed., TMH publication, 2015.
4. David E Simons, An Embedded Software Primer, Pearson, 1999

Course Code BEC-314 : Analog and Digital Electronic Circuits

Course category	:	Professional Core (PC)
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, quiz test, practical work record, viva voce, One minor test and one major theory & practical examination.
Course Objectives	:	To introduce the fundamentals of transistor amplifiers, operational amplifier circuits, sequential logic circuits and data conversion techniques used in modern electronic systems.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. (CO 1-6)

1. Explain the biasing techniques, small-signal models, and frequency response of BJT and MOSFET amplifiers.
2. Describe operational amplifier characteristics and design circuits for filters, oscillators, and waveform shaping.
3. Compare sequential logic circuits and memory elements including flip-flops, counters, and finite state machines.
4. Analyze digital timing parameters such as propagation delay, setup time, hold time, and critical paths.
5. Evaluate the operation of data conversion circuits including sample-and-hold, ADC, and DAC architectures.
6. Apply analytical and design techniques to solve practical problems in analog and digital electronic systems.

Topics Covered

UNIT-I **9**

Biasing techniques of BJT and MOSFET, DC operating point and stability coupling and multi-stage amplifiers, small signal analysis of BJT amplifiers (Hybrid model, gain calculation, input and output impedance), Small signal analysis of MOSFET amplifiers. Frequency response of amplifiers – low frequency and high frequency response, Effect of coupling and bypass capacitors. Current mirror circuits and applications. Differential amplifiers – operation, characteristics and applications.

UNIT-II **9**

Ideal and practical characteristics of operational amplifiers, Inverting and non-inverting amplifier configurations, summing amplifiers and differential amplifiers using Op-amps, Differentiator and integrator circuits., Active filters – Low pass, High pass, Band pass and Band stop filters. Schmitt trigger circuits, Oscillator circuits using Op-amps (RC oscillator, Wien bridge oscillator, Phase shift oscillator).

UNIT-III **9**

Introduction to sequential circuits and memory elements, Latches and flip-flops – SR, JK, D and T flip-flops, Counters – Asynchronous counters, synchronous counters, up/down counters and ring counters, Shift registers – SISO, SIPO, PISO and PIPO shift registers and applications, Finite State Machines – Moore and Mealy models.

Timing parameters – Propagation delay, setup time, hold time and critical path delay.

UNIT-IV **9**

Sample and hold circuits – working and applications, Analog to Digital Converters (ADC) – Flash ADC, Successive Approximation ADC, Dual slope ADC and Sigma-Delta ADC, Digital to Analog Converters (DAC) – Binary weighted DAC and R-2R ladder DAC, Performance parameters of ADC and DAC – Resolution, accuracy, conversion time and quantization error, Applications of data converters in communication and signal processing systems.

LIST OF EXPERIMENTS:

1. Study and design of BJT amplifier and measurement of voltage gain and frequency response.
2. Study and design of MOSFET amplifier and measurement of gain and input/output characteristics.
3. Analysis of multi-stage amplifier using AC coupling.
4. Measurement of frequency response of transistor amplifier and determination of bandwidth.
5. Study and implementation of current mirror circuit.
6. Study of differential amplifier and measurement of Common Mode Rejection Ratio (CMRR).
7. Implementation of Op-amp based inverting and non-inverting amplifiers.
8. Design and testing of Op-amp based integrator and differentiator circuits.
9. Design and implementation of active filters (Low pass / High pass filter).
10. Study of flip-flops (SR, JK, D, T) and verification of truth tables.
11. Design and implementation of counters and shift registers.
12. Study of data converters – implementation and analysis of DAC and ADC circuits.

Books & References

1. Sedra, A. S. and Smith, K. C., *Microelectronic Circuits*, Oxford University Press.
2. Boyles tad, R. L. and Nashelsky, L., *Electronic Devices and Circuit Theory*, Pearson Education.
3. Millman, J. and Halkias, C. C., *Integrated Electronics: Analog and Digital Circuits and Systems*, McGraw Hill.
4. Morris Mano, M. and Ciletti, M. D., *Digital Design*, Pearson Education.

Course Code: BEC-315	**: Introduction to Raspberry Pi Programming**	
Course category	:	Professional Core (PC)
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, quiz test, practical work record, viva voce, One minor test and one major theory & practical examination.
Course Objectives	:	This course introduces the fundamental concepts of Raspberry Pi and its applications in embedded systems and Internet of Things (IoT). The students will gain hands-on experience in working with Raspberry Pi, Linux

environment, GPIO interfacing, basic Python applications, and development of simple IoT-based applications.

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. (CO 1-6)

1. Understand the architecture, features, and operating environment of Raspberry Pi.
2. Use basic Linux commands and configure Raspberry Pi for different applications.
3. Develop basic Python programs on Raspberry Pi.
4. Perform GPIO programming and interface basic hardware devices with Raspberry Pi.
5. Implement simple communication and IoT-based applications using Raspberry Pi.
6. Develop problem-solving skills for real-time embedded and IoT applications.

Topics Covered

UNIT-I **6**

Introduction to Raspberry Pi, architecture overview, processor and memory, GPIO and interfaces, comparison with microcontrollers, overview of different Raspberry Pi models, pin description, on-board components, introduction to Linux concepts (kernel, shell, file system), installation and configuration of Raspberry Pi OS, booting process, desktop and terminal environment, basic Linux commands, software installation.

UNIT-II **6**

Introduction to programming concepts, fundamentals of Python on Raspberry Pi, program structure and syntax, variables and data types, operators and expressions, conditional statements, loops, functions, modular programming, lists, tuples, dictionaries, string handling, file handling operations, use of libraries and packages, writing Python programs for basic tasks on Raspberry Pi.

UNIT-III **6**

Concept of GPIO, GPIO pin configuration and numbering schemes on Raspberry Pi, digital input and output operations, interfacing LEDs, switches, buzzers, basics of sensors and actuators, PWM signal generation, brightness control and motor speed control, introduction to communication interfaces, I2C protocol, SPI protocol, UART communication, hardware interfacing using RPi.GPIO, simple interfacing applications.

UNIT-IV **6**

Using Raspberry Pi as an IoT device, network configuration, remote access using SSH, headless operation, data acquisition from sensors, data logging on Raspberry Pi, introduction to MQTT, basic device communication, using Node-RED, real-time monitoring applications, home automation systems.

LIST OF EXPERIMENTS:

1. To assemble Raspberry Pi hardware components, install Raspberry Pi OS, and boot the system to access the command line interface.

2. To access Raspberry Pi remotely using SSH in headless mode.
3. To configure and use remote desktop access on Raspberry Pi.
4. To Write a simple Python script to blink an LED connected to GPIO pins.
5. To Write a Python script to read temperature and humidity data from the sensor by connect a DHT11 sensor to Raspberry Pi.
6. To write a Python script to detect motion using the Passive Infrared (PIR) motion sensor to Raspberry Pi.
7. To write a Python script for object detection and distance calculation using ultrasonic sensor to Raspberry Pi.
8. To demonstrate a model which can trigger a command based on light intensity.
9. To Write a Python script to control the servo motor's position to Raspberry Pi.
10. Design and implement a industry monitoring system using Raspberry Pi.
11. To store and log sensor data into a file on Raspberry Pi.
12. To capture images using the Raspberry Pi camera module and save them.
13. To record video using Raspberry Pi camera and store the output file.
14. To Create a simple web server that displays sensor data (e.g., temperature and humidity) on a web page.
15. Design a fully functional system that monitor environmental parameter and trigger an appropriate Actuator.

Books & References

1. Raspberry Pi User Guide, Eben Upton and Gareth Halfacree, John Wiley & Sons, 4th Edition, 2016.
2. Simon Monk, "Programming the Raspberry Pi: Getting Started with Python", January 2012, McGraw Hill Professional
3. Exploring Raspberry Pi, Derek Molloy, John Wiley & Sons, 2016
4. Alex Bradbury and Ben Everard, "Learning Python with Raspberry Pi", Feb 2014, John Wiley & Sons.
5. Michael Margolis, "Arduino Cookbook", First Edition, March 2011, O'Reilly Media, Inc.
6. Internet of Things with Raspberry Pi 3, Packt Publishing, 2018.
7. The Official Raspberry Pi Beginner's Guide, Raspberry Pi Press, Latest Edition.

BMS-301 Principles of Industrial Management

Course category	:	Management (M)
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 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, worksampling 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.

BEC-360 **Digital Communication System**

Course category	:	Professional Core (PC)
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, quiz test, practical work record, viva voce, One minor test and one major theory & practical examination.
Course Objectives	:	The course aims to develop an understanding of the fundamental concepts of digital communication systems, including source encoding techniques, digital modulation schemes, multiplexing and multiple access methods, signal detection in the presence of noise, error performance analysis, and information theory with coding techniques.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. (CO 1-6)

1. Explain the basic elements and signal flow of digital communication systems.
2. Describe PCM, DPCM, and delta modulation techniques and their noise effects.
3. Analyze digital modulation schemes and their detection methods.
4. Evaluate error performance in digital communication systems under noise.
5. Explain multiplexing and multiple access techniques.
6. Apply information theory and coding concepts for channel capacity and error control.

Topics Covered

UNIT-I **9**

Introduction: Elements of digital communication systems, advantages of digital communication systems, Elements of PCM: Sampling, Quantization & Coding, Quantization error, Companding in PCM systems. Differential PCM systems (DPCM). Time Division Multiplexing & Demultiplexing. Delta Modulation: Delta modulation, its draw backs, adaptive delta modulation, comparison of PCM and DM systems, Noise in PCM and DM systems. Illustrative Problems.

UNIT-II **9**

Digital Modulation Techniques: Introduction, ASK modulator, Coherent and Non-Coherent ASK detector, FSK modulator, Spectrum of FSK, coherent reception, non-coherent detection of FSK. BPSK transmitter, Coherent reception of BPSK, DPSK, QPSK. Data Transmission: Base band signal receiver, probability of error, The optimum filter, Matched filter, probability of error using matched filter. Optimum filter using correlator. Probability of error of ASK, FSK, BPSK and QPSK. Illustrative Problems.

UNIT-III **9**

Multiplexing and Multiple Access Technique: Multiplexing: Need, Block diagram of transmitter and receiver with its working principle for Time division multiplexing (TDM), Frequency Division Multiplexing (FDM), Code Division Multiplexing (CDM). Multiple Access techniques: Need, Time division multiple Access (TDMA), Frequency Division multiple access (FDMA), Code Division Multiple Access (CDMA), Space Division Multiple Access (SDMA), Advantages of TDMA over FDMA

UNIT-IV **9**

Information Theory and Coding: Information Theory and Coding: Information Measurement, Average information and information rate, Coding for discrete memory less source, continuous channel capacity, Maximum entropy, Huffman and Shannon Fano coding, Discrete channel capacity, Trade –off between S/N and bandwidth, Error control coding, Block code, Hamming code, Cyclic code, Convolutional code: Tree diagram, State diagram, Trellis diagram.

LIST OF EXPERIMENTS:

1. To construct a pulse amplitude modulation (PAM) and demodulation circuit and to observe the waveform.
2. To understand and implement Pulse Width Modulation (PWM) using IC 555 by varying the amplitude of the modulating signal and plot the relevant waveforms.
3. To understand and implement Pulse Position Modulation (PPM) using IC 555 and plot the relevant waveforms.
4. Study of delta modulation and demodulation and observe the effect of slope overload DCL07.
5. Study of pulse data coding techniques for NRZ formats. Data decoding techniques for NRZ formats. ST21067
6. To Study and implement of amplitude shift keying modulator and demodulator and to observe the waveform.
7. To Study and implement FSK modulator and demodulator and to observe the waveform.
8. Study of phase shift keying modulator and demodulator ST467.
9. Study of single bit error detection and correction using Hamming code. ST2103.
10. Implementing Convolutional Encoder/Decoder using MATLAB.
11. Investigate the characteristics of matched filter and implement matched filter-based signal detection. Investigate eye diagram

Books & References

1. Digital communications - Simon Haykin, John Wiley, 2005
2. Principles of Communication Systems – H. Taub and D. Schilling, TMH, 2003
3. Digital and Analog Communication Systems – K.Sam Shanmugam, John Wiley, 2005.
4. Digital Communications – John Proakis, TMH, 1983. Communication Systems Analog & Digital – Singh & Sapre, TMH, 2004.
5. Modern Analog and Digital Communication – B.P.Lathi, Oxford reprint, 3rd edition, 2004.
6. Singh, R.P. &Sapre, S.D. “Communication Systems: Analog & Digital”, Tata McGraw-Hill.
7. Lathi, B.P, “Modern Digital & Analog Communication Systems”, Oxford University Press.
8. Prokis J.J, “Digital Communications”, McGraw Hill

BEC-361 **Introduction to VLSI**

Course category : Professional Core (PC)
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, quiz test, practical work record, viva voce, One minor test and one major theory & practical examination.

Course Objectives : The course aims to develop an understanding of the fundamental principles of VLSI design, including MOS device operation, CMOS logic circuit design, VLSI design methodologies, hardware description using Verilog HDL, physical layout concepts, and performance analysis in terms of power, delay, and area for integrated circuits.

Course Outcomes : The students are expected to be able to demonstrate the following knowledge and skills after completing this course (CO 1-6)

1. Explain the operation of MOS devices and CMOS fabrication processes relevant to VLSI technology.
2. Analyze CMOS combinational and sequential circuits in terms of functionality, power, and timing performance.
3. Apply VLSI design flow concepts from specification to layout and verification.
4. Develop and simulate digital circuits using Verilog HDL and perform functional verification through test benches.
5. Design basic CMOS layouts and interpret DRC/LVS verification results.
6. Evaluate scaling issues and low-power design techniques in modern VLSI systems.

Topics Covered

UNIT-I **9**

MOS capacitor characteristics. MOSFET operation – cutoff, linear, saturation regions. Threshold voltage, body effect, channel length modulation, mobility degradation. CMOS fabrication – oxidation, diffusion, ion implantation, photolithography. N-well, P-well, twin-tub processes. CMOS inverter structure. Design rules, lambda-based design rules, stick diagrams. Technology scaling, Moore's law, nanometer technology challenges.

UNIT-II **9**

CMOS inverter – Voltage Transfer Characteristics (VTC), noise margins, switching threshold, static and dynamic power dissipation. Propagation delay, rise time, fall time, RC delay model. CMOS NAND, NOR, complex logic gates, pull-up and pull-down networks. Sequential circuits – latches, flip-flops, setup time, hold time, clock skew, metastability. Fan-in, fan-out, power-delay product, interconnect effects.

UNIT-III **9**

VLSI design methodology – specification, architecture, RTL design, synthesis, layout, fabrication. Design abstraction levels – behavioral, RTL, gate-level, layout. Full-custom, semi-custom, FPGA-based design approaches. Verilog HDL – module definition, data types, structural, dataflow, behavioral modeling, continuous assignments, procedural blocks, blocking and non-blocking statements. Test bench development, functional simulation. Logic synthesis, technology mapping, timing constraints, Static Timing Analysis (STA).

UNIT-IV **9**

CMOS layout of inverter, NAND and NOR gates. Euler path method, diffusion sharing, layout optimization. Floor planning, placement, routing, clock tree synthesis. Design Rule Check (DRC), Layout Versus Schematic (LVS). Short channel effects, leakage mechanisms, interconnect delay. Low-power techniques – clock gating, power gating. Fin-FET devices. System-on-Chip (SoC) concepts.

LIST OF EXPERIMENTS:

1. Plot I_d–V_{gs} characteristics of NMOS and PMOS using SPICE and extract threshold voltage.
2. Design and simulate a CMOS inverter in SPICE and obtain its VTC characteristics.
3. Measure propagation delay and power dissipation of a CMOS inverter using SPICE.
4. Implement basic logic gates in Verilog HDL using structural, dataflow, and behavioural modelling and verify using a testbench.
5. Design a Half Adder and Full Adder in Verilog HDL and verify functionality through simulation.
6. Design a 4-bit Ripple Carry Adder in Verilog HDL using structural modeling.
7. Implement a 4:1 multiplexer and 3-to-8 decoder in Verilog HDL and verify using a testbench.
8. Design a magnitude comparator in Verilog HDL and simulate its operation.
9. Design a D Flip-Flop in Verilog HDL and verify timing behavior.
10. Implement a 4-bit synchronous up-counter with asynchronous reset in Verilog HDL.
11. Design a shift register (SISO/SIPO) in Verilog HDL and simulate its operation.
12. Design a Mealy or Moore sequence detector in Verilog HDL and verify using simulation waveforms.
13. Implement a 16×8RAM module in Verilog HDL with read and write control signals.
14. Design a clock divider circuit in Verilog HDL to generate a lower frequency clock from a higher frequency input.
15. Design and verify a 4-bit ALU in Verilog HDL using a testbench.

(*Students are required to perform Min. 8 Experiments)

Books & References

1. Neil H. E. Weste, David Harris, CMOS VLSI Design: A Circuits and Systems Perspective, Pearson India, 2015
2. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, Digital Integrated Circuits: A Design Perspective, Prentice Hall, 2002
3. Sung-Mo (Steve) Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits: Analysis & Design, McGraw-Hill Education, 2003/2018
4. Samir Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, Pearson Education, 2003
5. John P. Uyemura, Introduction to VLSI Circuits and Systems, Wiley India, 2007

BEC-362 Introduction to Deep Learning

Course category	:	Program Core
Pre-requisite Subject	:	Mathematics of Machine Learning
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quiz test, practical work record, viva voce, One minor test and one major theory & practical examination.

Course Objectives : This course introduces core and modern deep learning concepts and techniques for real-world applications. Students will develop practical skills in implementing and optimizing deep learning models.

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course (CO 1-6)

1. Explain ANN structure, forward/backward propagation, activation functions, optimizers, and regularization techniques for deep learning model development.
2. Describe CNN operations (convolution, pooling) and apply popular architectures (AlexNet, VGG, ResNet) for image classification and object detection tasks.
3. Implement Image classification, object detection (e.g., YOLO, R-CNN), encoder-decoder models.
4. Analyze RNN, LSTM, GRU architectures and their applications in IoT time series anomaly detection and human activity recognition.
5. Illustrate Transformer architecture, self-attention mechanism, and basic concepts of LLMs for sequence modeling tasks
6. Demonstrate understanding of VAEs and GANs for generative modeling and data augmentation applications.

Topics Covered

UNIT-I 9

Introduction to Deep Learning and ANNs: Artificial Neural Networks (ANNs): Structure, perceptrons, limitations, forward propagation, backpropagation, activation functions (e.g., ReLU, Softmax), loss functions, optimization techniques (e.g., SGD, Adam), Regularization techniques: L1/L2 regularization, Dropout, Batch Normalization, Hyperparameter tuning, commonly used frameworks (e.g., TensorFlow).

UNIT-II 9

Convolutional Neural Networks (CNNs) Key concepts: convolution, padding, pooling, CNN layers, Architectures: AlexNet, VGG, ResNet, MobileNet. Applications: Image classification, transfer learning, object detection (e.g., YOLO, R-CNN), encoder-decoder models, Data augmentation techniques.

UNIT-III 9

Recurrent Neural Networks (RNNs): RNN architecture and working principles, Variants: LSTM, GRU, Advantages in handling sequential data, Challenges: vanishing and exploding gradients, Application: Time series anomaly detection from IoT sensors, Human activity recognition using wearable IoT devices

UNIT-IV 9

Transformers: Transformer architecture: encoder-decoder model, self-attention, multi-head attention, Applications: NLP tasks such as translation and summarization, Large Language Models (LLMs): BERT, GPT and their applications, Autoencoders and Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs): Basic architecture and applications.

LIST OF EXPERIMENTS:

1. MNIST Digit Classification: Train a simple feedforward neural network on the MNIST dataset using forward and backpropagation, activation functions (ReLU), and optimization (Adam).
2. Image Classification with CNN: Develop and evaluate a CNN model with convolution, pooling, and architectures like AlexNet or VGG on Fashion-MNIST or CIFAR-10 dataset.
3. Transfer Learning with Pre-trained CNN: Fine-tune models like ResNet or MobileNet on a custom image dataset using data augmentation and regularization techniques.
4. Object Detection using YOLO: Implement YOLOv5 or YOLOv8 for real-time object detection on images or video frames, evaluating with mAP metric.
5. IoT Anomaly Detection with LSTM: Train LSTM autoencoder on sensor time series data (e.g., NAB dataset) to detect anomalies using reconstruction error.
6. Human Activity Recognition with GRU: Build GRU model on wearable IoT dataset (UCI HAR) to classify activities like walking, sitting; evaluate with confusion matrix.
7. Sentiment Analysis with RNN: Train LSTM on IMDB movie reviews dataset for binary sentiment classification, handling sequential text data.
8. Transformer for Text Classification: Implement simple BERT-based model using Hugging Face for sentiment analysis on Twitter dataset.
9. Image Segmentation with U-Net: Train encoder-decoder U-Net model on small medical image dataset for semantic segmentation task.
10. GAN for Image Generation: Build basic DCGAN to generate MNIST-like digits; compare generated vs real images visually.

Books & References

1. Christopher M. Bishop & Hugh Bishop "Deep Learning: Foundations and Concepts", Springer, 2023.
2. Ian Goodfellow and Yoshua Bengio and Aaron Courville "Deep Learning", MIT Press, 2016.

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, quiz test and one Minor tests and One Major Theory Examination

Course Objective :

1. To make fundamentally strong base for decision making skills by applying the concepts of economics.
2. 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.
3. 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.
4. Be equipped with the tools necessary in forecasting product demand.
5. Understand and analyze the macro environment affecting the business decision making.
6. 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

1. Students will acquire basic knowledge in Engineering & managerial economics, which allows students to gain theoretical and empirical skill of economics.
2. 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.
3. Students will develop Interdisciplinary skills which can help them to thrive in the life- long changing environment in various fields of Industry of Economics.
4. Students will acquire practical knowledge of economics, the kind of markets, cost theory, various issues of demand and other major economic concepts.
5. Able to explain succinctly the meaning and definition of managerial economics; elucidate on the characteristics and scope of managerial economics.
6. Able to describe the techniques of managerial economics.

Topics Covered

UNIT-I

9

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

9

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 **9**

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 **9**

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

Books & References

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, NewDelhi.
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.

Syllabus for Professional Electives

Course Code: EEC-151 **: Introduction to Drones**

Course category : Program Electives (PE-1)

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, and one Minor test and one Major Theory & Practical Examination.

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

1. Students will acquire basic knowledge in Arduino based Embedded System Design.
2. To develop the basic understanding of Microcontrollers, Actuator, Sensor, and Motors in various applications.
3. To develop a significant understanding of how to connect relays LED, LCD, IR, Ultrasonic sensor and servomotors to ARDUINO Board.
4. Design IoT applications in different domain like Filters, resistors, LCD displays etc., and be able to analyze their performance.
5. To understand the basic concept of UART/USART communication.
6. To understand the basic concept of I2C communication.

Topics Covered

UNIT-I 9

History and evolution of drones: milestones and generations, Classification of drones: fixed-wing, rotary-wing (quadcopters, hexacopters), hybrid drones, Applications: agriculture, defense, surveillance, delivery, environmental monitoring, cinematography, Basic drone components: airframe, motors, ESC (Electronic Speed Controllers), flight controllers, batteries, Types of flight controllers and autopilots, Introduction to drone communication systems and telemetry basics.

UNIT-II **9**

Detailed airframe design principles and material selection (carbon fiber, plastic composites, aluminum), Propulsion systems: brushless DC motors, propellers, thrust and torque concepts, Sensors overview: IMU (accelerometer, gyroscope), magnetometer, GPS modules, barometric pressure sensors, Power systems: battery types (LiPo, Li-ion), power management, battery monitoring and charging systems, Communication interfaces: radio frequency, Bluetooth, Wi-Fi, Zigbee, Introduction to payload systems: cameras, sensors, delivery mechanisms

UNIT-III 9

Aerodynamics fundamentals: lift, drag, thrust, weight, and their relationships, Stability in flight: static and dynamic stability, Degrees of freedom and drone motion: roll, pitch, yaw, Flight modes: manual, stabilized, GPS hold, waypoint navigation, Introduction to flight control algorithms: PID control basics, Manual vs automated flight operation, Pre-flight calibration and setup procedures.

UNIT-IV **9**

Drone safety protocols and risk management, National (DGCA India, FAA USA) and international drone regulations and legal frameworks, Airspace classifications and no-fly zones, Privacy concerns and ethical issues in drone usage, Routine maintenance: battery care, motor inspection, firmware updates, Troubleshooting common issues: signal loss, motor failure, sensor calibration errors, Emerging trends: swarm drones, BVLOS (Beyond Visual Line of Sight) operations.

Books & References

1. Austin, R. Unmanned Aircraft Systems: UAVs Design, Development and Deployment, Wiley, 2010.
2. Zhang, Q. and Yang, L.T., Intelligent UAVs for Mobile Inspection: A Deep Learning Perspective, Springer, 2021.
3. R. K. Sharma, Fundamentals of UAVs and Drone Technology, Khanna Publishing House, 2022.
4. Paul G. Fahlstrom and Thomas J. Gleason, Introduction to UAV Systems, Wiley, 3rd Edition, 2012.
5. Tiwari, R. and Ghosh, A., Drone Technology and Applications, BPB Publications, 2021.

Course Code: EEC-152 **: Fundamentals of Analog and Digital Electronics**

Course category : Program Electives (PE-1)
Pre-requisite Subject : NIL
Contact hours/week : Lecture:3, Tutorial:1, Practical:0
Number of Credits : 4

Course Assessment methods : Continuous assessments through teaching assessment, attendance, home assignments, quizzes, one minor tests and one major theory examination.

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

1. Analyze the characteristics and applications of various types of diodes, including their behavior in rectifiers and switching circuits.
2. Explain the operation, configurations, and biasing techniques of BJTs and FETs, and evaluate their performance in analog applications.
3. Design and implement combinational logic circuits such as adders, subtractors, multiplexers, and encoders.
4. Develop and analyze sequential logic circuits including flip-flops, counters, and shift registers for various digital applications.
5. Apply the concepts of analog and digital electronics to build basic electronic systems and prepare for advanced study in embedded system design.
6. Able to apply the concept of analog and digital electronics in practical scenarios.

Topics Covered

UNIT-I 9

P-N junction diode and its characteristics, Mathematical analysis of built-in potential, depletion width, Diode applications (half-wave and full-wave rectifiers, clippers, clampers), non-ideal diode models, Zener diodes and its applications, Diode capacitance and switching times, Types of diodes (LED, Varactor diode, Schottky diode, Photodiode).

UNIT-II 9

Transistor Basics and applications

BJT: Bipolar Junction Transistor (BJT types, operation, configurations, characteristics), Cut-off and saturation operations, Q point, BJT switching times, Applications of BJT, BJT biasing.

FET: Field Effect Transistor (FET types, operation, configurations, characteristics), MOS structure, CV characteristics, Metal-Oxide Semiconductor FET, Complementary MOSFET (CMOS), FET biasing.

UNIT-III 9

Combinational Logic Circuits

Basics of Boolean Algebra, Logic Gates, Half Adder, Full Adder, Half Subtractor, Full Subtractor, Full adder using half adder, BCD Adder. Carry Look ahead Adder, Multipliers. Multiplexer/Demultiplexers, Encoders and Decoders, Application of universal logic gates.

UNIT-IV 9

Sequential Logic Circuits

Latches, Edge Triggered Flip Flops: SR, D, JK, Master slave JK. Synchronous and Asynchronous counters, Up/Down Counters, Design of Synchronous counters, Cascaded Counters, Counter applications. Shift register functions, Serial in/serial out shift registers, serial in parallel out/shift registers, Parallel In/Parallel out shift registers, bidirectional Shift registers, Shift register counters, Shift register Applications.

Books & References

Textbook:

1. Adel S. Sedra, Kenneth C. Smith, "Microelectronic Circuits", Oxford University Press, 7th Edition, 2017.
2. Robert Boylestad, Louis Nashelsky, "Electronic Devices and Circuit Theory", Prentice Hall, 11th Edition, 2015.
3. Digital Design 5e, Mano / Ciletti, Pearson.
4. Digital Circuits and Design 5e, Salivahanan, Oxford.

References:

1. Jacob Millman, Christos C. Halkias, "Integrated Electronics: Analog and Digital Circuits and Systems", Tata McGraw Hill, 2nd Edition, 2017.
2. Donald A. Neamen, "Microelectronics: Circuit Analysis and Design", McGraw Hill, 5th Edition, 2012.
3. Digital Electronics: Principles and Integrated Circuits, Maini, Wiley.
4. Digital Electronics, Kharate, Oxford.
5. Digital Design: Principles and Practices, 4e, Wakerly, Pearson.

Course Code: EEC-251	**:**	**Introduction to Robotics**
Course category	:	Program Electives (PE-2)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture:3, Tutorial:1, Practical:0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessments through teaching assessment, attendance, home assignments, quizzes, two minor tests and one major theory examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

1. To express his views as per terminologies related to Robotics technology.
2. To apply logic for selection of robotic subsystems and systems.
3. To analyze basics of principles of robot system integration.
4. To understand ways to update knowledge in the required area of robotic technology.
5. Apply knowledge of robot programming methods and control commands such as WAIT, SIGNAL, and DELAY in developing basic robotic applications.

Topics Covered

UNIT-I 9

Introduction to robotics: Brief History, Basic Concepts of Robotics such as Definition, Three laws, Elements of Robotic Systems i.e. Robot anatomy, DOF, Misunderstood devices etc., Classification of Robotic systems on the basis of various parameters such as work volume, type of drive, etc., Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device etc., Introduction to Principles & Strategies of Automation, Types & Levels of Automations, Need of automation, Industrial applications of robot.

UNIT-II 9

Grippers and Sensors for Robotics: Grippers for Robotics - Types of Grippers, Guidelines for design for robotic grippers, Force analysis for various basic gripper systems.

Sensors for Robots - Types of Sensors used in Robotics, Classification and applications of sensors, Characteristics of sensing devices, Selections of sensors. Need for sensors and vision systems in the working and control of a robot.

UNIT-III 9

Drives and Control for Robotics: Drive - Types of Drives, Types of Transmission Systems, Actuators and its selection while designing a robot system. Control Systems: Types of Controllers, Introduction to closed loop control

UNIT-IV 9

Sequential Logic Circuits

Latches, Edge Triggered Flip Flops: SR, D, JK, Master slave JK. Synchronous and Asynchronous counters, Up/Down Counters, Design of Synchronous counters, Cascaded Counters, Counter applications. Shift register functions, Serial in/serial out shift registers, serial in parallel out/shift registers, Parallel In/Parallel out shift registers, bidirectional Shift registers, Shift register counters, Shift register Applications.

Books & References

1. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education (2014)
2. Asitava Ghoshal, Robotics: Fundamental concepts and analysis, Oxford University Press (2006)
3. Dilip Kumar Pratihar, Fundamentals of Robotics, Narosa Publishing House, (2019)
4. R. K. Mittal, I. J. Nagrath, Robotics and Control, TATA McGraw Hill Publishing Co Ltd, New Delhi (2003)
5. S. B. Niku, Introduction to Robotics – Analysis, Contro, Applications, 3rd edition, John Wiley & Sons Ltd., (2020)
6. J. Angeles, Fundamentals of Robotic Mechanical Systems Theory Methods and Algorithms, Springer (1997)
7. Mikell Groover, Mitchell Weiss, Roger N. Nagel, Nicholas Odrey, Ashish Dutta, Industrial Robotics 2nd edition, SIE, McGraw Hill Education (India) Pvt Ltd (2012)
8. R. D. Klafter, Thomas A. Chmielewski, and Mechael Negin, Robotic Engineering – An Integrated Approach, EEE, Prentice Hall India, Pearson Education Inc. (2009).

Course Code: EEC-253 : Physics of IOT Sensors and Actuators

Course category	:	Program Electives (PE-2)
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, and one Minor test and one Major Theory & Practical Examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Analyze the behavior of various sensor types, including their sensing mechanisms and limitations.
2. Design and implement signal conditioning circuits for interfacing sensors with microcontrollers or IoT devices.
3. Evaluate different communication protocols and methods used for transmitting sensor data in IoT systems.
4. Analyze the characteristics and functionalities of actuators commonly used in IoT applications.
5. Design and implement basic control algorithms for actuator systems in IoT environments.
6. Integrate sensors and actuators into IoT systems for specific applications.

Topics Covered

UNIT-I **9**

Introduction to IoT and Sensor Networks, Overview of IoT architecture and applications, Characteristics and challenges of IoT sensor network, Fundamentals of Sensors, Sensor classification and characteristics, Sensing principles: resistive, capacitive, inductive, optical, etc

UNIT-II **9**

Sensor calibration and error analysis, Signal Conditioning and Processing, Analog signal conditioning techniques, ADC (Analog-to-Digital Conversion) basics, Digital signal processing for sensor data. Communication in IoT Systems, Wired and wireless communication protocols (e.g., Bluetooth, Wi-Fi, Zigbee)

UNIT-III **9**

IoT communication architectures (client-server, peer-to-peer), Data transmission and security considerations, Actuators in IoT, Types of actuators: motors, solenoids, relays, etc., Principles of operation and characteristics.

UNIT-IV **9**

Control mechanisms for actuators, Integration of Sensors and Actuators, Sensor and actuator interfacing with microcontrollers and IoT devices, IoT system design considerations, Case studies and applications.

Books & References

Textbook:

"Principles of IoT Sensors and Actuators" by Clarence W. de SILVA, CRC Press (Taylor & Francis Group)

References:

1. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things" by David Hanes and Gonzalo Salgueiro
2. "Sensors and Actuators: Engineering System Instrumentation" by Clarence W. de Silva
3. "Internet of Things (IoT): A Hands-On Approach" by Arshdeep Bahga and Vijay Madisetti

EEC-351		**Dynamics and Control of Drones**
Course category	:	Professional Elective
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, quiz test, viva voce, One minor test and one major theory examination.

Course Objectives This course introduces the fundamentals of drone dynamics and control, covering rigid body motion, aerodynamic modeling, linear and nonlinear control system design for UAV stability and navigation.

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. (CO 1-6)

1. Understand the fundamentals of drone dynamics including linear and rotational motion.
2. Analyze the forces and moments acting on various types of drones during flight.
3. Explain and model the longitudinal and lateral dynamics of multirotor and fixed-wing UAVs.
4. Demonstrate knowledge of control system design techniques used for UAV stability and navigation.
5. Apply PID and adaptive control strategies for drone flight control.
6. Understanding simulation tool: MATLAB-Simulink/PX4/SITL and designing dynamic models and controllers for drones.

Topics Covered

UNIT-I **9**

Reference frames and coordinate systems (inertial, body-fixed), Newton-Euler equations of motion for rigid bodies, Force and moment generation by rotors, Modeling aerodynamic forces and moments, Simplified linearized models for control design, Modeling assumptions and limitations.

UNIT-II **9**

Concepts of stability: Lyapunov stability, BIBO (Bounded Input Bounded Output) stability, Open-loop vs closed-loop control systems, Transfer functions and block diagrams, PID controllers: proportional, integral, derivative actions, tuning methods (Ziegler-Nichols, trial and error), State-space representation: state variables, inputs, outputs, Controllability and observability basics.

UNIT-III **9**

Attitude estimation using sensor fusion (Complementary and Kalman filters), Design of attitude controllers: roll, pitch, yaw stabilization, Altitude hold and vertical speed control, Position control: GPS-based navigation control loops, Actuator dynamics and control allocation for multi-rotors, Fail-safe and redundancy mechanisms in control systems.

UNIT-IV **9**

Nonlinear control methods: sliding mode control, backstepping control, Adaptive control to handle changing payloads and disturbances, Robust control to manage uncertainties and external disturbances, Fault detection and isolation techniques, Real-time implementation issues and computational constraints, Simulation tools: MATLAB/Simulink, Gazebo, PX4 SITL

Books & References

1. Learning ROS for Robotics Programming – Aaron Martinez and Enrique Fernandez, Packt Publishing, 2015.
2. Programming for Drones: Using DroneKit-Python and ArduPilot – Agus Kurniawan, PE Press, 2017.

3. Autonomous Navigation and Deployment of UAVs for Communication, Surveillance and Delivery – Yasir Faheem and Sajjad Rizvi, Springer, 2022.
4. Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy – Lentin Joseph, Apress, 2018.
5. Drone Programming with ArduPilot and Python: Build and Control Autonomous Drones Using Open Source Software – Ty Audronis, Packt Publishing, 2024.

EEC-353 Robot Kinematics

Course category : Program Elective

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, quiz test, viva voce, One minor test and one major theory examination.

Course Objectives This course enables students to understand robot positioning and orientation using coordinate frames and transformations, perform direct and inverse kinematic analysis, and determine joint configurations for industrial robots

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. (CO1-6)

1. Understand the position, orientation, and coordinate transformations of robot manipulators.
2. Apply direct kinematics using D–H representation for SCARA and articulated robots.
3. Solve inverse kinematics problems for SCARA and six-axis articulated robots.
4. Analyze robot dynamics using velocity, acceleration, and Jacobian matrix.
5. Integrate kinematic and dynamic concepts for modeling and motion analysis of robots.
6. Select and apply appropriate kinematic and dynamic methods to optimize robot performance in industrial applications.

Topics Covered

UNIT-I **9**

Introduction: Position and orientation of objects, objects coordinate frame, rotation matrix, Euler angles (roll, pitch and yaw angles), coordinate transformations, joint variables and position of end effector.

UNIT-II **9**

Direct Kinematics: Dot and cross products, coordinate frames, rotations, homogeneous coordinates, link coordinates, D–H representation, the ARM equation. Direct kinematic analysis for four axis SCARA robot and six axis articulated robots.

UNIT-III **9**

Inverse Kinematics: Introduction to Inverse Kinematics, general properties of solutions, inverse kinematics of four axis SCARA robot and six axis articulated robot.

UNIT-IV **9**

Robot Dynamics: Basic Introduction to Robot Dynamics, Basic concepts of forces, torques, and motion in robot links. Velocity and acceleration of robot links, Linear and angular velocity, angular acceleration, and their computation. Jacobian matrix and its applications.

Books & References

1. S K Saha, “Introduction to Robotics”, 2nd edition, McGraw Hill Education (India) Pvt. Ltd., 2014.
2. Robert J Schilling, “Fundamentals of Robotics, Analysis and Control”, Prentice Hall, 2007.

3. Reza N Jazar, “Theory of Applied Robotics: Kinematics, Dynamics and Control”, 2nd Ed. Springer, 2010.
4. Peter Corke, “Robotics, Vision, and Control: Fundamental Algorithms in MATLAB”, Springer, 2013.
5. John J Craig, “Introduction to Robotics: Mechanics and Control”, Pearson, 2018.
6. K S Fu, et al, “Robotics: Control, Sensing, Vision and Intelligence”, Tata McGraw Hill, 2008.
7. Springer Handbook of Robotics, B Siciliano, O Khatib, editors, 2nd Ed., Springer, 2016

EEC-451 Wireless Sensor Networks (WSN)

Course category	:	Professional Electives (PE)
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, quiz test, practical work record, viva voce, One minor test and one major theory & practical examination.
Course Objectives	:	The course aims to develop an understanding of the basic concepts and characteristics of Wireless Sensor Networks, including their architecture, design goals, MAC protocols, routing metrics, network layer protocols, and QoS-based routing mechanisms.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. (CO 1-6)

1. Explain the challenges, design goals, and architecture of Wireless Sensor Networks.
2. Describe the channel encoding techniques and modulation mechanisms used in WSNs.
3. Compare contention-free and contention-based MAC protocols.
4. Analyze routing metrics and network layer protocols.
5. Evaluate QoS-based routing protocols for wireless sensor networks.
6. Analyze the performance and energy efficiency of Wireless Sensor Networks for practical applications.

Topics Covered

UNIT-I **9**

Introduction: Wireless sensor Network introduction, Components of a wireless sensor network, Wireless Sensor Node components, Classification of sensor networks, Characteristics, Applications, Challenges, Comparison between wireless sensor networks and wireless mesh networks, IoT and WSN Integration: Role of WSN in IoT applications. Limitations, Design challenges, Hardware architecture.

UNIT-II **9**

Basic Architectural Frame-work: Physical Layer, Basic Components, Source Encoding, Channel Encoding, Modulation. Network Architecture-Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts.

UNIT-III **9**

Medium Access Control: Wireless MAC Protocols, Characteristics of MAC Protocols in Sensor Networks, Contention-Free MAC Protocols, Contention-Based MAC Protocols, and Hybrid MAC Protocols. Location discovery, quality, other issues, S-MAC, IEEE 802.15.4.

UNIT-IV **9**

Network Layer: Routing Metrics, Flooding and Gossiping, Data-Centric Routing, Proactive Routing, On-Demand Routing, Hierarchical Routing, Location-Based Routing. QoS-Based Routing Protocols: Node and Network Management: Power Management, Local Power

Management aspects, Dynamic Power Management, Conceptual Architecture, Security, Research challenges and future trends in WSN

List of Experiments:

1. Study of Wireless Sensor Node Using NodeMCU (ESP32)
2. Wireless Transmission and Output Verification of Sensor Data between Two sensor Nodes
3. Real-Time Output Monitoring of Wireless Sensor Data on Serial monitor/Web Interface
4. Monitoring of Environment Sensor Data Using Wireless Sensor Network
5. Wireless Sensor Data Logging and Display at Receiver Node
6. Basic WSN Node Deployment: Simulate random deployment of sensor nodes in a 2D field
7. LEACH Clustering Simulate LEACH protocol for cluster head selection.
8. Network Lifetime Simulation: Simulate network lifetime based on energy depletion

Books & References

1. Waltenegus Dargie, Christian Poellabauer, ―Fundamentals of Wireless Sensor Networks: Theory and Practice, Wiley 2010
2. Mohammad S. Obaidat, Sudip Misra, ―Principles of Wireless Sensor Networks, Cambridge, 2014
3. LoWPAN: The Wireless Embedded Internet, Zach Shelby, Carsten Bormann, Wiley
4. Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Dr. Ovidiu Vermesan, Dr. Peter Friess, River Publishers
5. Ian F. Akyildiz, Mehmet Can Vuran , ―Wireless Sensor Networks, Wiley 2010
6. C S Raghavendra, K M Sivalingam, TaiebZnati, ―Wireless Sensor Networks, Springer, 2010
7. C. Sivarmmurthy& B.S. Manoj, ―Adhoc Wireless Network, PHI-2004

EEC-452 Network and Security for IoT

Course category	:	Professional Electives (PE)
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, quiz test, viva voce, One minor test and one major theory examination.
Course Objectives	:	This course aims to build a strong understanding of cybersecurity principles in Cyber-Physical Systems and the Internet of Things (IoT). It equips students with knowledge of cryptographic foundations, privacy-preserving mechanisms, trust models, and secure IoT architectures.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course (CO 1-6)

1. Explain the IoT security lifecycle, vulnerabilities, and countermeasures in Cyber-Physical Systems.
2. Describe cryptographic primitives like block ciphers, hash functions, and ECC for IoT.
3. Compare privacy-preservation schemes for vehicular networks and mobile sensor applications.
4. Analyze network robustness, malware propagation, and Sybil attacks in IoT ecosystems.
5. Evaluate authentication frameworks, trust models, and secure path generation for IoT.
6. Analyze lightweight security and privacy-preserving aggregation for Green IoT.

Topics Covered

UNIT-I **9**

Foundations & Lifecycle: Cyber-physical systems (CPS), security engineering, IoT security lifecycle, vulnerabilities, and countermeasures. Network robustness: Sybil attack detection in vehicular networks, malware propagation, and smart home attack vectors.

UNIT-II **9**

Cryptographic Primitives: Block ciphers, message integrity, and authenticated encryption. Hash functions, Merkle trees, Elliptic Curve Cryptography (ECC), Public-key Infrastructure (PKI), and digital signature algorithms.

UNIT-III **9**

Privacy & Data Dissemination: Privacy-preserving data dissemination, location privacy in Internet of Vehicles (IoV). Lightweight schemes for personal IoT applications: Mobile Wireless Body Sensor Networks (WBSN) and participatory sensing.

UNIT-IV **9**

Authentication & Trust Models: Computational security, time-series data aggregation, and secure path generation for Green IoT. Security protocols for access networks, trust frameworks, and policy-based informed consent in IoT.

Books & References

1. Awad, Ali Ismail, et al. Internet of Things Security and Privacy: Practical and Management Perspectives, 1st edition, CRC Press, 2024.
2. Mishra, Preeti, et al. Internet of Things Security: Attacks, Tools, Techniques and Challenges, 1st edition, Elsevier, 2025.
3. Islam, SK Hafizul, et al. IoT Security: Fundamentals and Key Enabling Technologies, 1st edition, Elsevier, 2025
4. Zahra, Syed Rameem, et al. Security and Privacy in the Internet of Things, 1st edition, Routledge, 2024.

EEC-551 **Autonomous Navigation of Drones**

Course category	:	Professional Electives (PE)
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, quiz test, viva voce, One minor test and one major theory examination.
Course Objectives	:	This course focuses on the principles and algorithms that enable drones to navigate environments without human intervention. It covers sensor integration, environment perception, localization and mapping (SLAM), and advanced path planning techniques for complex obstacle avoidance.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. (CO 1-6)

1. Understand the fundamental components and scope of autonomous navigation in UAVs.
2. Analyze and integrate various sensors like LIDAR, IMU, and cameras for situational awareness.
3. Implement localization techniques and understand the principles of SLAM.
4. Design and evaluate path planning algorithms, including Dijkstra's, RRT, and PRM.
5. Develop trajectory optimization strategies for smooth and efficient flight.

6. Utilize simulation frameworks like ROS, Gazebo, and AirSim for testing autonomous behaviors.

Topics Covered

UNIT-I **9**

Definition and scope of autonomous navigation in UAVs, Overview of sensors for navigation: GPS, IMU, LIDAR, sonar, optical flow sensors, cameras, Environment perception and situational awareness, Concept of path planning and obstacle avoidance, Coordinate systems and map representations: occupancy grids, point clouds.

UNIT-II **9**

GPS-based localization and its limitations, Inertial navigation systems (INS) and sensor fusion techniques, Simultaneous Localization and Mapping (SLAM) concepts: feature extraction, data association, Visual SLAM and LiDAR-based mapping, Obstacle detection: clustering and segmentation techniques, Real-time constraints in mapping and localization.

UNIT-III **9**

Classical algorithms: Dijkstra's algorithm, Sampling-based algorithms: Rapidly-exploring Random Trees (RRT), Probabilistic Road Maps (PRM), Trajectory planning: polynomial trajectories, minimum snap trajectories, Dynamic re-planning and obstacle avoidance during flight, Multi-agent path planning basics (for swarm drones), Cost functions and optimization criteria.

UNIT-IV **9**

Integration of navigation with flight control systems, Software architecture for autonomous navigation: middleware and ROS framework, Simulation environments for testing: Gazebo, AirSim, RotorS, Hardware-in-the-loop (HIL) and software-in-the-loop (SIL) testing, Case studies: autonomous delivery drones, precision agriculture drones, Challenges in real-world deployment: weather, GPS denial, communication loss.

Books & References

1. Yasir Faheem and Sajjad Rizvi, Autonomous Navigation and Deployment of UAVs for Communication, Surveillance and Delivery, Springer, 2022."
2. Sebastian Thrun, Wolfram Burgard, and Dieter Fox, Probabilistic Robotics, MIT Press, 2005."
3. Lentin Joseph, Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy, Apress, 2018."
4. Nikolaus Correll, Bradley Hayes, et al., Introduction to Autonomous Robots, MIT Press, 2022."
5. Ty Audronis, Drone Programming with ArduPilot and Python: Build and Control Autonomous Drones Using Open Source Software, Packt Publishing, 2024."
6. Nitin Goyal, et al., Internet of Things: Robotic and Drone Technology, CRC Press, 2024."

EEC-553	**Control of Robotic System**
Course category	: Program Elective
Pre-requisite Subject	: Nil
Contact hours/week	: Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	: 4
Course Assessment methods	: Continuous assessments through teaching assessment, attendance, home assignments, quiz test, two minor tests and one major theory examination

Course Objectives This course aims to develop an understanding of fundamental robotic systems, automation principles, and control system concepts including feedback, transfer functions, and frequency response. It also focuses on analyzing linear control techniques and exploring robotic actuators, sensors, and motion control for effective robot operation.

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. (CO1-6)

1. Describe fundamental concepts of robotics, including system elements, DOF, classification, and principles of automation.
2. Analyze open-loop and closed-loop control systems using differential equations, transfer functions, and stability analysis techniques such as Routh-Hurwitz and Root Locus.
3. Evaluate frequency response methods including Bode, Nyquist, and Polar plots, and design phase lead and phase lag compensators.
4. Develop state-space models and examine controllability and observability of linear control systems.
5. Apply P, PI, and PID controllers for linear and basic nonlinear control systems.
6. Select appropriate actuators and sensors, and apply suitable control schemes for robotic manipulator motion control.

Topics Covered

UNIT-I **9**

Introduction to robotics: Basic Concepts of Robotics, Elements of Robotic Systems i.e. Robot anatomy, DOF, Classification of Robotic systems, Principles & Strategies of Automation, Types & Levels of Automations, Need of automation.

UNIT-II **9**

Basics of control system: Concept of control system, Classification of control systems - Open loop and closed loop control systems, Effects of feedback, Feedback Characteristics. Differential Equation, Transfer function, Frequency response, R-H test, Root locus design, phase lead and phase-lag design, Bode, Polar, Nyquist Plot

UNIT-III **9**

Linear Control: Concept of states, Introduction to state variables, state vector, and their significance in modeling dynamic systems, state space model, Controllability and Observability, P,PI & PID Controller, Principles, design, and application of Proportional, Proportional-Integral, and Proportional-Integral-Derivative controllers in control systems. Basics of Nonlinear system.

UNIT-IV **9**

Robotics Control: Robotic Actuators, Sensors and Motion Control: Types of actuators – Electrical, Hydraulic and Pneumatic actuators, Comparison of actuators, DC and AC servo motors, Stepper motors. Sensors in robotics – Position, Velocity, Acceleration, Force and Torque sensors, Proximity and tactile sensors, Vision sensors, Sensor characteristics and selection , Basic introduction to motion control. Control schemes used for a robotic manipulator – PID control.

Books & References

1. **Saha, S. K.** *Introduction to Robotics* (2nd ed.). Tata McGraw-Hill Education, 2014.
2. **Ghoshal, A.** *Robotics: Fundamental Concepts and Analysis*. Oxford University Press, 2006.

3. **Pratihar, D. K.** *Fundamentals of Robotics*. Narosa Publishing House, 2019.
4. **Mittal, R. K., & Nagrath, I. J.** *Robotics and Control*. Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2003.
5. **Niku, S. B.** *Introduction to Robotics: Analysis, Control, Applications* (3rd ed.). John Wiley & Sons Ltd., 2020.
6. **Angeles, J.** *Fundamentals of Robotic Mechanical Systems: Theory, Methods, and Algorithms*. Springer, 1997.

EEC-651 Fog and Edge Computing

Course category : Professional Electives

Pre-requisite Subject : Introduction to IoT

Contact hours/week : Lecture: 3, Tutorial: 1, Practical: 0

Number of Credits : 4

Course Assessment methods : Continuous assessment through tutorials, attendance, home assignments, quiz test, viva voce, One minor test and one major theory examination.

Course Objectives : This course introduces the fundamentals of fog and edge computing and their role beyond cloud systems. It focuses on resource management, IoT–fog programming, protocols, and data handling across 5G, fog and edge

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course (CO 1-6)

1. Understand the fundamentals of fog computing, its architecture, advantages, business models, and how it differs from cloud computing.
2. Analyze the limitations of cloud computing and explain the opportunities and challenges in fog computing environments.
3. Identify and evaluate resource management, optimization, and research challenges in fog computing systems.
4. Apply fog computing concepts to IoT programming, protocols, data management, and 5G network slice orchestration.
5. Understand edge computing principles and how edge assists low-end and high-capability IoT nodes.
6. Apply fog and edge computing to real-world applications such as mobile offloading, augmented reality, video analytics, and distributed learning.

Topics Covered

UNIT-I **9**

Introduction to Fog Computing: Fundamentals of Fog Computing, Limitations of Cloud Computing, Differences between Cloud and Fog Computing, Advantages, Business Models, Architecture, Opportunities, and Challenges.

UNIT-II **9**

Challenges in Fog Resources: Taxonomy and Characteristics, Resource Management Challenge; Optimization Challenges, Research Challenges and Research Directions, Miscellaneous Challenges.

UNIT-III **9**

IoT, Protocols and Management in Fog Computing: IoT and Fog Programming, Paradigms, Fog Protocols, Management and Orchestration of Network Slices in 5G, Fog, Edge and Clouds, Data Management and Analysis in Fog Computing, Case Studies.

UNIT-IV **9**

Edge Computing and Applications of Fog/Edge: Introduction to Edge Computing Origins of Edge, Edge Helping Low-End IoT Nodes, Architecture, Edge Helping Higher-Capability. Applications of Fog and Edge Computing Mobile Offloading, Edge Helping the Cloud, Edge for Augmented Reality, Data Processing on the Edge, Dispersed Learning with Edge/Fog Computing, Video Analytics on the Edge, Edge Computing Applications.

Books & References

1. Buyya, Rajkumar, and Satish Narayana Srirama, Fog and Edge computing: Principles and Paradigms, 2019, 1st edition, John Wiley & Sons, USA.
2. Wei Change and Jie Wu, Fog/Edge Computing for Security, Privacy and Applications, Springer, 2021.

EEC-652 : Industrial IoT

Course category : Program Elective

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, quiz test, viva voce, One minor test and one major theory examination.

Course Objectives : This course focuses on the opportunities and challenges of the Industrial Internet of Things (IIoT), particularly in business expansion, system architecture, and cybersecurity. It equips students with practical knowledge to address these challenges and succeed in the evolving IIoT landscape.

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course (CO 1-6)

1. Understand basic IoT Concept, sensing, actuation, and IoT
2. Understand Industry 4.0 Principles and Cyber Physical System
3. Identify major IIOT applications and interpret simple industrial case studies
4. To understand the structure of Industrial IoT architectures, the role of IIOT layers, reference architectures, and industrial communication technologies such as MQTT, CoAP, OPC-UA, and industrial networking concepts
5. Analyze IIOT data acquisition and processing methods, compare cloud, edge, and fog computing models, and apply essential IIOT security principles including authentication, encryption, and secure communication
6. Evaluate cloud-enabled IoT applications and case studies and identify future trends such as digital twins and edge AI for real-world IoT solutions.

Topics Covered

UNIT-I **9**

Basics of Industrial IoT: Introduction of IIoT, IIoT vs Automation, challenges, and applications of IIoT, benefits of IIoT, Industrial Internet System, applications and advantages of industrial internet, Industrial sensing, and actuations: smart sensor, function of smart sensor, industrial sensor calibration, examples of industrial sensor. Industrial Processes: Industrial revolution, challenges for industrial processes in industry 4.0, features of industry 4.0, 5C architecture, smart factory of future, different sector of industry 4.0.

UNIT-II **9**

Business models and Reference Architecture for IIoT: Introduction of business model and its component, need of new business model, types of business model, business opportunities in IIoT, challenges of IIoT business model. Introduction of IIRA, Industrial Internet Consortium (IIC), IIRA-architecture patterns.

Key Enablers of IIoT: Connectivity, Industrial communication, communication infrastructure, Device to device communications, introduction of Tactile Internet, URLLC, mm Wave communication.

UNIT-III **9**

IIoT Analytics and Data Management: Introduction of IIoT analytics, IIoT analytics: application of Machine Learning and Deep Learning in IIoT, types of machine learning algorithms, integration of machine learning with IIoT, applications of IIoT with machine learning, AI vs Machine learning vs Deep learning. Limitations of machine learning, Deep learning, Deep learning in IIoT, cloud computing in IIoT. Industry 4.0 objective, Industry 4.0 requirements from IIoT. Fog computing for IIoT.

UNIT-IV **9**

Advanced Technologies and IIoT Applications: Software -Defined Networking (SDN), securities in IIoT, Factories and assembly line, food industry, Healthcare, IIoT healthcare architecture, drivers of IIoT in power plant, challenges of IIoT in power plant, inventory management and quality control, plant security and safety, facility management, oil, chemical and pharmaceutical industry, UAVs in industry.

Books & References

1. Dr. Guillaume Girardin, Antoine Bonnabel, Dr. Eric Mounier, 'Technologies Sensors for the Internet of Things Businesses & Market Trends 2014 -2024', Yole Development Copyrights ,2014.
2. Industrial Internet of Things: Cyber manufacturing System, Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer Publication).
3. Sabina Jeschke, Christian Brecher, Tobias Meisen, Dennis Özdemir, Industrial Internet of Things: Cyber manufacturing Systems, Springer, 2017
4. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016
5. The Internet of Things: Key Applications and Protocols, ISBN: 978-1-119-99435-0, 2nd Edition, Willy Publications

EEC-753 **Payload and Processing system for Drones**

Course category	:	Professional Elective (PE)
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, quiz test, viva voce, One minor test and one major theory examination.

Course Objectives : This course aims to provide a comprehensive understanding of drone payloads, including specialized sensors and communication modules, alongside the high-performance onboard processing systems required for real-time IoT data analytics.

Course Outcomes : The students are expected to be able to demonstrate the following knowledge and skills after completing this course (CO 1-6)

1. Identify and categorize various payload types for specific drone applications like surveillance, agriculture, and delivery.
2. Evaluate the specifications and integration requirements of high-resolution cameras, LiDAR, and thermal sensors.
3. Analyze the architecture and selection criteria for onboard processing units like Jetson Nano, Raspberry Pi, and FPGAs.
4. Implement power management strategies for payloads to balance flight endurance and processing demands.
5. Design data acquisition and edge-computing workflows for real-time IoT sensor data processing.
6. Understand the communication protocols and hardware-software interfaces for seamless payload-to-ground station connectivity.

Topics Covered

UNIT-I **9**

Introduction to drone payloads: classification and weight-power constraints. Imaging payloads: RGB cameras, multispectral, hyperspectral, and thermal sensors. Non-imaging payloads: LiDAR, ultrasonic sensors, and atmospheric sensors. Gimbals and stabilization mechanisms: 2-axis and 3-axis systems. Mounting techniques and vibration damping.

UNIT-II **9**

Overview of onboard computers: Microcontrollers vs. Single Board Computers (SBCs). Architecture of ARM-based processors (Raspberry Pi, Orange Pi) and GPU-accelerated modules (NVIDIA Jetson series). FPGA-based processing for low-latency tasks. Interface protocols: GPIO, UART, I2C, SPI, and USB-C for payload integration. Memory management for real-time data logging.

UNIT-III **9**

Payload communication: MAVLink protocol, Radio Frequency (RF) links, and Satellite communication. Integration with IoT gateways: 4G/5G and LoRaWAN for long-range data transmission. Edge computing on drones: Local data filtering and preprocessing before transmission. Cloud-drone integration for remote payload control and telemetry.

UNIT-IV **9**

Power distribution systems for high-drain payloads. Battery technologies (LiPo, Li-ion) and Battery Management Systems (BMS). Energy harvesting basics for long-endurance drones. Software integration: Driver development for specialized sensors. Case studies: Payloads for precision agriculture (NDVI), industrial inspection (ultrasonic), and search-and-rescue (IR/AI-enabled).

Books & References

1. Nitin Goyal, et al., Internet of Things: Robotic and Drone Technology, CRC Press, 2024.

2. Yasir Faheem and Sajjad Rizvi, Autonomous Navigation and Deployment of UAVs for Communication, Surveillance and Delivery, Springer, 2022.
3. Ty Audronis, Drone Programming with ArduPilot and Python, Packt Publishing, 2024.
4. Douglas M. Marshall, et al., Introduction to Unmanned Aircraft Systems, CRC Press, 2021.

EEC-754 Android Application Development

Course category	:	Professional Elective (PE)
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, quiz test, practical work record, viva voce, One minor test and one major theory & practical examination.
Course Objectives	:	The course aims to develop an understanding of the Android platform, including UI design, API integration, and data management, with a specific focus on building mobile interfaces for interacting with IoT devices and sensor networks.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge and skills after completing this course (CO 1-6)

1. Explain the Android architecture and development environment setup relevant to mobile and IoT ecosystems.
2. Analyze and Design interactive Android user interfaces using XML, Material Design, and UI widgets.
3. Develop functional applications using Intents, Activity lifecycles, and Fragment-based dynamic UIs.
4. Utilize Android APIs for data persistence (Room/SQLite) and networking (REST/JSON) to communicate with IoT endpoints.
5. Implement hardware-specific features including device sensors, GPS, and background services for real-time monitoring.
6. Evaluate and Deploy feature-rich applications using modern practices like MVVM, Jetpack Compose, and cloud integration.

Topics Covered

UNIT-I **9**

Overview of mobile app development, Android platform features, and architecture. Setting up Android Studio, SDK, and AVD. Project structure, AndroidManifest.xml, and Gradle. Core components: Activities, intents, and application lifecycle. UI Basics: XML-based layouts, Views, and ViewGroups.

UNIT-II **9**

UI Widgets: Buttons, TextView, EditText, ListView, RecyclerView, and ScrollView. Event Handling: User inputs and gestures. Fragments: Lifecycle and communication between fragments. Styles, Themes, and Animations. Material Design components for advanced UI development.

UNIT-III **9**

Data Persistence: SharedPreferences, SQLite, and Room database. Files and Content Providers. Networking: HTTP requests, REST APIs, and JSON parsing for IoT device

communication. Firebase Integration: Real-time database and authentication. Multimedia: Audio, video playback, and Camera APIs.

UNIT-IV **9**

Background Services: Services, foreground services, and background tasks for continuous data monitoring. Broadcast Receivers and Notifications. Sensors and Location: Accessing device sensors, GPS, and location services for IoT tracking. Publishing: Google Play Store deployment. Emerging Topics: Jetpack Compose, MVVM architecture, and Kotlin Coroutines.

LIST OF EXPERIMENTS:

1. Install Android Studio and create a "Hello World" application to understand project structure.
2. Develop an application demonstrating the activity lifecycle using Logcat.
3. Create a login screen using EditText, Button, and Toast for user input validation.
4. Design a calculator app to perform arithmetic operations using buttons and text views.
5. Implement navigation between screens using explicit and implicit intents.
6. To implement navigation between two screens using explicit intents in an Android application.
7. To use implicit intents to open system applications like the phone dialer, web browser, and camera.
8. Design a form using UI widgets (CheckBox, RadioButton, Spinner) to configure IoT device parameters.
9. Access device GPS/Sensors to display real-time coordinates or movement data.
10. Implement a background service that mimics a data logger for a sensor network.

Books & References

1. Margaret Kozak Polk, Coding Android Apps, CRC Press, 2025.
2. Harun Wangereka, Mastering Kotlin for Android 14, Packt, 2024.
3. Forrester, Boudjnah et al., How to Build Android Applications with Kotlin, 3rd Edition, Packt, 2025.
4. Wei-Meng Lee, Beginning Android Programming with Kotlin, Wiley, 2020.

EEC-851		**Smart Antenna for IoT Applications**
Course category	:	Professional Elective
Pre-requisite Subject	:	Electromagnetic Field Theory
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical:2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quiz test, practical work record, viva voce, One minor test and one major theory & practical examination.
Course Objectives		This course introduces Smart Antenna fundamentals, covering architecture, communication protocols, memory systems, and software development for real-world applications.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. (CO 1-6)

1. Explain radiation principles, antenna characteristics, and fundamental governing equations.
2. Analyze smart antenna architectures to improve signal reception and interference rejection.
3. Design beamforming algorithms and configurations for resource-constrained IoT environments.
4. Evaluate MIMO techniques, RAKE receivers, and mutual coupling effects in IoT networks.
5. Implement massive MIMO, hybrid arrays, and analog subarray hardware for 5G IoT.
6. Assess performance of wearable, textile, and 3D-printed antennas through parameter measurements.

Topics Covered

UNIT-I **9**

Electromagnetic radiation and basic antenna theory including monopole and dipole antennas, radiation characteristics, and antenna parameters. IoT communication basics including transmitter/receiver, link budget, free space path loss, receiver sensitivity, noise sources, and basic receiver sensitivity calculation.

UNIT-II **9**

Introduction to smart antennas, architecture, types, advantages, and limitations. Smart antenna configurations including beamforming, adaptive arrays, switched beam systems, and Butler matrix. Uplink/downlink processing, diversity techniques, and applications in wireless communication.

UNIT-III **9**

Introduction, MIMO antenna design, RAKE receiver size, mutual coupling effects, dual-antenna performance improvements, downlink capacity gains, principles of MIMO systems: SISO, SIMO, MISO, MIMO, hybrid antenna array for mmWave massive MIMO, massive hybrid array architectures, hardware design for analog subarray.

UNIT-IV **9**

Microstrip antenna, wearable antenna, textile antenna, 3D printing antenna, role of materials, measurement of antenna parameters such as gain, radiation pattern and polarization.

LIST OF EXPERIMENTS:

1. Introduction to Electromagnetic Simulation Environment Using ANSYS HFSS Software
2. Design and Simulation of Half-Wave Dipole Antenna and Analysis of Radiation Characteristics Using HFSS
3. Design and Performance Analysis of Monopole Antenna for IoT Frequency Band Using HFSS
4. Design and Simulation of Microstrip Patch Antenna for IoT Applications Using ANSYS HFSS
5. Parametric Analysis and Optimization of Antenna Dimensions Using HFSS Software
6. Return Loss (S11) and VSWR Analysis of Antenna Using ANSYS HFSS
7. Far-Field Radiation Pattern, Gain and Directivity Analysis of Antenna Using HFSS

8. Bandwidth Enhancement and Impedance Matching Techniques for Antennas Using HFSS
9. Design and Simulation of Compact / Wearable Antenna for IoT Applications Using ANSYS HFSS (Demonstration)
10. Mini Project: Design, Simulation and Performance Evaluation of an IoT Antenna Using ANSYS HFSS

Books & References

1. T1: Kraus, John D. & Mashefka, Ronald J., "Antennas for All Applications", Tata McGraw Hill.
2. T2: Balanis, C. A., "Antenna Theory: Analysis and Design", TMH.

EEC-852 **Advanced Wireless Communication**

Course category	:	Professional Elective
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, quiz test, viva voce, One minor test and one major theory examination.
Course Objectives	:	To provide fundamental knowledge of wireless and cellular communication principles and radio propagation mechanisms. To study the architecture and key technologies of 3G, 4G, and 5G mobile communication systems.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. (CO 1-6)

1. Explain the fundamental concepts of cellular communication systems, including frequency reuse, interference, and equalizers.
2. Analyze the characteristics of mobile radio channels and evaluate modulation, multiple access, and diversity techniques used in wireless systems.
3. Describe the architecture, features, and services of 3G mobile communication systems such as UMTS and CDMA2000.
4. Examine the design and operation of 4G LTE networks, including OFDMA, MIMO, EPC architecture, and mobility management.
5. Interpret the architecture and key enabling technologies of 5G networks, including 5G NR, Massive MIMO, beamforming, and network slicing.
6. Evaluate advanced and emerging trends in mobile communication systems, including IoT integration, small cells, and Beyond 5G technologies.

Topics Covered

UNIT-I **9**

Free space propagation, Reflection, diffraction, and scattering, Line-of-Sight (LOS) and Non-Line-of-Sight (NLOS) communication, Free space path loss model, Two-ray ground reflection model, Log-distance path loss model, Shadowing and slow fading, Multipath propagation, Fast fading, Delay spread, Doppler spread, Coherence bandwidth and coherence time, Frequency reuse, Cell splitting and sectoring, Co-channel and adjacent channel interference, Equalizers.

UNIT-II **9**

Limitations of 2G and need for 3G, 3G standards: UMTS and CDMA2000, WCDMA technology and spreading codes, 3G network architecture (UTRAN and Core Network, Packet-switched and circuit-switched domains, Handover mechanisms in 3G, Power control in CDMA systems, 3G services: multimedia, mobile internet, video calling

UNIT-III **9**

Need for 4G and evolution from 3G, LTE and LTE-Advanced architecture, E-UTRAN and Evolved Packet Core (EPC), OFDMA (downlink) and SC-FDMA (uplink), MIMO systems in LTE, All-IP network concept, Carrier aggregation and high data rate services, QoS and mobility management in LTE

UNIT-IV **9**

Need for 5G and performance requirements, 5G use cases: eMBB, URLLC, mMTC, 5G New Radio (NR) architecture, Spectrum bands: Sub-6 GHz and mmWave, Massive MIMO and beamforming, Network slicing, RAN (C-RAN, Open RAN), Network virtualization (SDN, NFV), Small cells and heterogeneous networks IoT integration in 5G, Security challenges in 5G networks, Introduction to Beyond 5G (B5G) concepts.

Text and Reference Books

Text Books:

1. T. S. Rappaport, *Wireless Communications: Principles and Practice*, 2nd Edition, Pearson Education.
2. Theodore S. Rappaport et al., *Wireless Communications and Applications (or 5G Wireless Communications)*, Pearson / Prentice Hall.
3. Jochen Schiller, *Mobile Communications*, 2nd Edition, Pearson Education.
4. Vijay K. Garg, *Wireless Communications and Networking*, Morgan Kaufmann / Elsevier.

Reference Books:

1. Erik Dahlman, Stefan Parkvall, and Johan Sköld, *4G LTE/LTE-Advanced for Mobile Broadband*, Academic Press.
2. Erik Dahlman, Stefan Parkvall, and Johan Sköld, *5G NR: The Next Generation Wireless Access Technology*, Academic Press.
3. A.Goldsmith, *Wireless Communications*, Cambridge University Press.

Syllabus of Skill-Based Courses

Electronics Mechanic (BEC-180)

Course Code: BEC- 180

Course Name: Electronics Mechanic

Course Category: Skill Development

Pre-requisite Subject: Basic Science and Mathematics

Contact hours/week: Lecture: 1, Tutorial: 0, Practical: 2 (L-T-P: 1-0-2)

Number of Credits: 2

Course Assessment methods:

Continuous assessment through and practical work, lab record maintenance, attendance, viva-voce during lab sessions, and final theory examination and practical examination.

Course Outcomes (COs):

Upon successful completion of this course, students will be able to:

1. Understand and apply safety procedures in an electronics workshop and identify, test & utilize basic hand tools.
2. Identify, test, and understand the characteristics of passive components (resistors, capacitors).
3. Perform soldering and desoldering operations on PCBs.
4. Understand, test, and characterize basic semiconductor devices (diodes, transistors).
5. Construct and test basic electronic circuits like rectifiers, transistor switches, amplifiers, and oscillators.
6. Understand and verify the functionality of basic digital logic gates and ICs like Op-Amp IC 741.

UNIT-I:

Fundamental electrical concepts (AC/DC, voltage, current, resistance, Ohm's Law), passive components (resistors, capacitors - types, identification, combinations), soldering/desoldering techniques, basic switches (2)

UNIT-II:

Semiconductor fundamentals (P-type, N-type, PN junction), diodes (working, characteristics, testing), and basic power supply concepts (rectification, half-wave, full-wave, bridge rectifiers, filters). (2)

UNIT-III:

Transistors (BJT - NPN/PNP, terminals, biasing), transistor as a switch, Common Emitter amplifier (basic introduction) (2)

UNIT-IV:

Digital electronics (analog/digital signals, binary/decimal), logic gates (AND, OR, NOT, NAND, NOR, XOR - symbols, truth tables, ICs), operational amplifiers (Op-Amp IC 741 - block diagram, inverting/non-inverting amplifiers).
(2)

List of Experiments:

Experiment 1: Workshop Familiarization & Basic Testing

a) Practice identifying and safely using common hand tools.
b) Construct a simple series test lamp and learn its safe usage for checking mains electrical supply.

c) Understand and practice workshop safety precautions.

Experiment 2: Passive Component Testing

a) Identify resistors and determine their values using color codes and verify with a digital multimeter.
b) Identify different types of capacitors and perform basic tests using a multimeter or an LCR meter.

Experiment 3: Soldering & De-soldering Practice

a) Practice soldering electronic components onto a PCB.
b) Practice de-soldering components from a PCB.
c) Attempt to repair a broken PCB track and test continuity.

Experiment 4: Rectifier Circuit Construction & Testing (anyone from a, b, c)

a) Test PN junction diodes using a multimeter.
b) Construct and test a half-wave rectifier circuit.
c) Construct and test a full-wave rectifier circuit.

Experiment 5: Transistor Testing & Switching Circuit (anyone from a, b)

a) Identify BJT terminals and test functionality using a multimeter.
b) Construct and test a transistor switching circuit.

Experiment 6: Basic Amplifier Circuit

- Construct and test a single-stage Common Emitter (CE) transistor amplifier.

Experiment 7: Logic Gate Verification (anyone from a, b)

a) Identify and test basic logic gate ICs using a digital IC tester or trainer kit.
b) Construct circuits to verify the truth tables of basic logic gates.

Experiment 8: IC Application Circuit (Op-Amp)

- Construct and test an inverting amplifier circuit using an Op-Amp IC 741.

Books:

1. How to diagnose and fix everything Electronics by Michael Jay Geier, TMH.
2. Integrated electronics by Jacob Millman, Christos Halkias, Chetan D Parikh, TMH.

BEC-281 : **CONSUMER ELECTRONICS**

Course category	:	PS
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 1, Tutorial: 0, Practical: 2
Number of Credits	:	2

Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Two Minor tests and One Major Theory Examination
Course Objectives	:	The course is aimed to Carryout trouble shooting of different basic consumer electronic products like TV, Audio

COURSE OUTCOMES

After completion of the subject, the students will be able to:

1. Able to understand the various type of microphones and loud speakers.
2. Able to identify the various digital and analog signal.
3. Able to describe the basis of television and composite video signal.
4. Able to describe the various kind of colour TV standards and system.
5. Able to compare the various types of digital TV system.
6. Able to understand the various type of consumer goods.

TOPICS COVERED

Unit I: Audio Systems

Microphones and Loudspeakers, Concept to fidelity, Noise and different types of distortion in audio system. 3

Unit II: Television

Basics of Television, Colour Television, PAL TV Receiver, NTSC, PAL, SECAM 3

Unit III: Digital Transmission and Reception

- Digital satellite television, Direct-To-Home (DTH) satellite television, CCTV, High Definition (HD)-TV., Introduction to Liquid Crystal and LED Screen Televisions, Basic block diagram of LCD and LED Television and their comparison. 3

Unit IV: Introduction to different type of domestic/commercial appliances

- Operation of Micro-wave oven
- Food Processors
- Digital Electronic Lock
- Vacuum cleaner
- Xerox Machine
- Scanner 3

LIST OF PRACTICALS

1. To plot the directional response of a Microphone
2. To plot the directional response of a Loud Speaker
3. To study public address system and its components.
4. To perform fault identification in TV.
5. Installation of Dish Antenna for best reception.
6. Installation of CCTV system.
7. To study the various parameters in the Smartphone and Tablet, PC

RECOMMENDED BOOKS

1. Modern Television Practice by R. R. Gulai; New Age International Publishers.
2. Audio Video Systems by R. G. Gupta; McGraw Hill Education System.
3. Audio Video Systems Principles Practices and Troubleshooting by Bali & Bali; Khanna Publishing Company
4. Consumer Electronics by S. P. Bali; Pearson Education, New Delhi
5. e-books/e-tools/relevant software to be used as recommended by AICTE/NITTTR, Chandigarh.

BEC-393	**:**	Smart Antenna
Course category	:	Skill Enhancement
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 2, Tutorial:0, Practical: 2
Number of Credits	:	2
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 Smart Antenna fundamentals, covering architecture, communication protocols, memory systems, and software development for real-world applications.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course. (CO 1-6)

1. Explain radiation principles, antenna characteristics, and fundamental governing equations.
2. Analyze smart antenna architectures to improve signal reception and interference rejection.
3. Design beamforming algorithms and configurations for resource-constrained IoT environments.
4. Evaluate MIMO techniques, RAKE receivers, and mutual coupling effects in IoT networks.
5. Implement massive MIMO, hybrid arrays, and analog subarray hardware for 5G IoT.
6. Assess performance of wearable, textile, and 3D-printed antennas through parameter measurements.

Topics Covered 6

UNIT-I

Electromagnetic radiation and basic antenna theory including monopole and dipole antennas, radiation characteristics, and antenna parameters.

UNIT-II 6

Introduction to smart antennas, architecture, types, advantages, and limitations. Uplink/downlink processing.

UNIT-III 6

Introduction, MIMO antenna design, RAKE receiver size, mutual coupling effects, dual-antenna performance improvements, principles of MIMO systems: SISO, SIMO, MISO, MIMO.

UNIT-IV 6

Microstrip antenna, wearable antenna, textile antenna, 3D printing antenna, role of materials, measurement of antenna parameters such as gain, radiation pattern and polarization.

Experiments

1. Introduction to Electromagnetic Simulation Environment Using ANSYS HFSS Software
2. Design and Simulation of Half-Wave Dipole Antenna and Analysis of Radiation Characteristics Using HFSS
3. Parametric Analysis and Optimization of Antenna Dimensions Using HFSS Software
4. Design and Performance Analysis of Monopole Antenna for IoT Frequency Band Using HFSS
5. Design and Simulation of Microstrip Patch Antenna for IoT Applications Using ANSYS HFSS
6. Return Loss (S11) and VSWR Analysis of Antenna Using ANSYS HFSS
7. Far-Field Radiation Pattern, Gain and Directivity Analysis of Antenna Using HFSS
8. Bandwidth Enhancement and Impedance Matching Techniques for Antennas Using HFSS

Books & References

1. T1: Kraus, John D. & Mashefka, Ronald J., "Antennas for All Applications", Tata McGraw Hill.
2. T2: Balanis, C. A., "Antenna Theory: Analysis and Design", TMH.

BEC-394		**Modern Industrial IoT**
Course category	:	Program Elective
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, quiz test, viva voce, One minor test and one major theory examination.

Course Objectives : This course focuses on the opportunities and challenges of the Industrial Internet of Things (IIoT), particularly in business expansion, system architecture, and cybersecurity. It equips students with practical knowledge to address these challenges and succeed in the evolving IIoT landscape.

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course (CO 1-6)

7. Understand basic IoT Concept, sensing, actuation, and IoT
8. Understand Industry 4.0 Principles and Cyber Physical System
9. Identify major IIOT applications and interpret simple industrial case studies
10. To understand the structure of Industrial IoT architectures, the role of IIOT layers, reference architectures, and industrial communication technologies such as MQTT, CoAP, OPC-UA, and industrial networking concepts
11. Analyze IIOT data acquisition and processing methods, compare cloud, edge, and fog computing models, and apply essential IIOT security principles including authentication, encryption, and secure communication
12. Evaluate cloud-enabled IoT applications and case studies and identify future trends such as digital twins and edge AI for real-world IoT solutions.

Topics Covered

UNIT-I **6**

Introduction of IIoT, IIoT vs Automation, Industrial sensing, and actuations: smart sensor, function of smart sensor, industrial sensor calibration, Industrial Processes: Industrial revolution, industry 4.0, features of industry 4.0, 5C architecture, smart factory of future, different sector of industry 4.0.

UNIT-II **6**

Business models and Reference Architecture for IIoT: Introduction of business model and its component, need of new business model, types of business model, business opportunities in IIoT, challenges of IIoT business model. Introduction of IIRA, Industrial Internet Consortium (IIC), IIRA-architecture patterns.

UNIT-III **6**

IIoT Analytics and Data Management: Introduction of IIoT analytics, IIoT analytics: application of Machine Learning and Deep Learning in IIoT, types of machine learning algorithms, integration of machine learning with IIoT, applications of IIoT with machine learning, Industry 4.0 requirements from IIoT. Fog computing for IIoT.

UNIT-IV **6**

Advanced Technologies and IIoT Applications: Software -Defined Networking (SDN), securities in IIoT, Factories and assembly line, food industry, Healthcare, IIoT healthcare architecture, drivers of IIoT in power plant, challenges of IIoT in power plant.

Books & References

6. Dr. Guillaume Girardin, Antoine Bonnabel, Dr. Eric Mounier, 'Technologies Sensors for the Internet of Things Businesses & Market Trends 2014 -2024', Yole Development Copyrights ,2014.

7. Industrial Internet of Things: Cyber manufacturing System, Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer Publication).
8. Sabina Jeschke, Christian Brecher, Tobias Meisen, Dennis Özdemir, Industrial Internet of Things: Cyber manufacturing Systems, Springer, 2017
9. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016

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 Outcomes:
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.

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:

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 : 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- 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.

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.

REFERNCE 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.

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

1) Discover India; Festival of India by Sonia Mehta

2) 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:

● Vedic mathematics methods are used in coding and VLSI implementation of encryption.
● Vedic mathematics method of division, exponentiation and multiplication are used in internet security and cryptographic algorithms for making these calculations faster than before.
● 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.
● 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.

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.
6. Bharatiya Mathematicians, Sharda Sanskrit Sansthan, Varanasi.

ASTRONOMY

Course Code: : **AUC 106** **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

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. Bradley W.Carroll and Dale A. Ostlie, "An Introduction to Modern Astrophysics" Addison Wesley Publishing Company,1996
5. 'Stellar Astronomy' by K. D Abhayankar.
6. 'Solar Physics' by K. D Abhayankar.

ARTS OF INDIA

Course Code: : AUC 107 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- 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.

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.
5. 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.

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

- Textbook of Intellectual Property Rights, N.K. Acharya. Asia Law House, ed. 2021.
- Intellectual property right, Deborah. E. Bouchoux, Cengage learning.
- Intellectual Property Rights–Pandey Neeraj, Dharni Khushdeep. PHI.
- 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.

3) Intellectual Property Rights – Heritage, Science, & Society under international treaties – A. Subbian, - Deep & Deep Publications – New Delhi.

HUMAN RIGHTS

Course Code:	**:**	**AUC 109** **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:

On completion of the course, students will be able to:

1. Simply put, human rights education is all learning that develops the knowledge, skills, and values of human rights.
2. Strengthen the respect for human rights and fundamental freedoms.
3. Enable all persons to participate effectively in a free society.
4. Learn about human rights principles, such as the universality, indivisibility, and interdependence of human rights.

UNIT-I

The Basic Concepts: Individual, Group, Civil Society, State, Equality, Justice, Human Values: Humanity, Virtues, Compassion.

UNIT-II **Human Rights and Human Duties:**

i) Philosophical and historical foundation of human rights and duties
ii) Theories of rights
iii) Concept and classifications of human rights and duties
iv) Human rights and duties

1. Correlation of rights and duties/responsibilities
2. 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.
2. Nirmal, C.J., Human Rights in India: Historical, Social and Political Perspectives (Law in India), Oxford India.

LOGICAL RESEARCH

Course Code: : AUC 110 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: 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.

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
4. Marketing Research- G C Beri
5. Logical reasoning- R S Agarwal

PROFESSIONAL ETHICS

Course Code: : AUC 111 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

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.

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

- Mike W Martin, Roland Schinzinger, " Ethics in Engineering", Tata McGraw –Hill.
- 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

- Aarne Vesblind, Alastair S Gunn, "Engineering Ethics and the Enviornment".
- 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 Co., Lucknow. Reprinted 2008.

ENVIRONMENTAL LAWS

Course Code: : AUC 112 Credits (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:

1) 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.
2) Students will develop a thorough understanding of practice and procedure followed by various environmental law enforcing agencies/bodies.
3) 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.
4) Students will be able to assist industries and projects in obtaining environmental clearance and compliances with other environmental laws.

UNIT-I

Development of Environmental Laws and Policies in India:

I. Concept of 'environment' and understanding scope of environmental law.
II. Two approaches towards environmental protection- 'Eco-centric approach' and 'Anthropocentric' approach.
III. Impact of IEL on environmental law in India.
IV. Significance of Environmental Protection in Five Year Plans.
V. Development of the 'Right to Environment' as a Fundamental Right and challenges.

UNIT-II **Judicial remedies and the role of National Green Tribunal:**

I. Civil Remedies i.e. Tortious remedy and Class Action
II. Criminal Law Remedies under relevant provisions of Indian Penal Code, 1860 and Criminal Procedure Code, 1973
III. Constitutional Law Remedies i.e. Writ Jurisdiction & Public Interest Litigation
IV. 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:

I. 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]

II. The Air (Prevention and Control of Pollution) Act 1981 [Framework of the Act, Criminal Liability and Judicial relief under the Act, Noise Pollution]
III. Environment (Protection) Act, 1986 [Framework of the Act, Enforcement mechanisms and Role of Pollution Control Boards, Environment Impact Assessment, Coastal zone regulations Notifications]
IV. Law on Waste Management and Handling
V. 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:

II. 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]
III. 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)
6) Philippe Sands, Principles of International Environmental Law (2nd ed, Cambridge University Press, 2003)

HEALTH LAW

Course Code:	**:**	**AUC 113**	**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: 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.

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.

REFERENCES:

1)Jonathan Herring- Medical Law and Ethics
2)Mason and Mc Call Smith- Law and Medical Ethics
3)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 Outcomes: 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.

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 SYSTEM: CONCEPTS AND APPLICATIONS IN 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.

INDIAN KNOWLEDGE SYSTEM

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