Curriculum Structure & Syllabi

(As per National Education Policy 2020)

of

B. Tech.

in

Electrical Engineering

(w.e.f. 2024-25)

Vision

Mission

Program Educational Objectives

Program Outcomes

Program Specific Outcomes

Overall Credit Structure

Curriculum

Syllabus

Offered By

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

Department of Electrical Engineering

CURRICULA & SYLLABI

B. Tech. in Electrical Engineering

Vision:

To develop intellectual potentials with excellence in electrical engineering & technology for the global needs.

Mission:

1. Empowering students with state-of-art knowledge, technological skills & ethics.
2. Provide research environment for sustainable technical growth in power and energy.
3. Providing effective solutions for industries through research and consultancy.
4. Exposure to standard electrical safety measures and practices.
5. Encourage new and non-conventional energy technology for sustainable development and environmental stewardship.

Programme Educational Objectives (PEO)

PEO-1 To provide technical knowledge in electrical engineering to excel in electrical utility & services.

PEO-2 To nurture the students to become successful engineer with administrative acumen to ethically handle the critical situations timely.

PEO-3 To prepare and motivate the students for higher education, research, and continuous learning in multi-disciplinary areas with innovative ideas for sustainable development.

Programme Outcome (POs)

Students will demonstrate the ability to-

PO-1 Apply the knowledge of mathematics, science, and Engineering in all aspects of Electrical Engineering.

PO-2 To formulate the techniques of using appropriate tools to analyze and/or fabricate electrical systems.

PO-3 Design of different parts of electrical machines, drives &power system network.

PO-4 Align with and upgrade to higher learning and research activities.

PO-5 Model real life problems using different hardware and software platforms, both offline and in real-time.

PO-6 Cultivate awareness of professional, societal, environmental, and ethical dimensions in engineering practice, with emphasis on utilizing renewable and non-conventional energy sources to achieve sustainable development.

PO-7 Promote the good practices of electrical engineering with high ethical values.

PO-8 Work in a team and comprehend his/her scope of work, deliverables and issues in which help is needed by other members of the team.

PO-9 To communicate effectively and to prepare formal technical plans leading to solutions and detailed reports for electrical systems.

PO-10 To be familiar with project management problems and basic financial principles for a multi-disciplinary work such as biomedical instrumentation.

PO-11 A recognition of the need for identifying contemporary issues due to changing technical scenario and an ability to engage in life-long learning to update himself/herself.

Programme Specific Outcome (PSOs)

PSO-1 Apply the fundamentals of mathematics, science, and engineering knowledge to identify, formulate, design, and investigate complex engineering problems of electrical circuits, control systems, electrical machines, and power system.

PSO-2 Apply the appropriate techniques and modern engineering hardware and software tools in electrical engineering to engage in life-long learning and to successfully adapt in multi-disciplinary environments.

PSO-3 Aware of the impact of professional engineering solutions in societal, environmental context, professional ethics and be able to communicate effectively.

SYLLABUS AND CREDIT STRUCTURE FOR B. TECH. (ELECTRICAL ENGINEERING)
(SESSION 2024-2025 AND ONWARDS)
OVERALL CREDIT STRUCTURE FOR B.TECH. (ELECTRICAL ENGINEERING)

<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><td colspan="4">Minor Degree (MD) from any Department and Micro Specializations (MS) within the Department</td></tr>
<tr><td colspan="3">• The total number of credits for graduation will be kept to minimum 160 and additionally 18-20 credits required for Minor Degree Courses.
• Micro specializations will be run by the department to aligned to industry careers or higher studies</td><td>Offered as a Professional Electives (PE)</td></tr>
</table>

DEPARTMENT OF ELECTRICAL ENGINEERING
MADAN MOHAN MALAVIYA UNIVERSITY OF TECHNOLOGY (MMMUT)
GORAKHPUR-273 010, UP, INDIA
SEMESTER WISE CREDIT STRUCTURE FOR B. TECH. (ELECTRICAL ENGINEERING)

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	Environmental Science and Green Chemistry	3	0	2	4
3.	EF	BEE- 110 / BEE-160	Basic Electrical Engineering	3	0	2	4
4.	PS	BEE-108A	Electrical Wiring & Estimation	3	0	2	4
5.	HSS	BHS-102/152	Technical Writing and Professional Communication	2	1	2	4
			Total	**14**	**2**	**8**	**20**

6.	ECA-I		Induction Program	-	-	-	0

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

First Year, Semester II

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	BSM	BSM-160	Engineering Mathematics II	3	1	0	4
2.	BSM	BSM-181	Engineering Physics	3	0	2	4
3.	EF	BCS-110/160	Introduction to C Programming	3	0	2	4
4.	PS	BEE-159	Basics of Electrical Machines & Protective Equipments	2	0	4	4
5.	HSS	BHS- 151	Universal Human Values: Understanding Harmony	3	1	0	4
			Total	**14**	**2**	**8**	**20**
6.	VAC/AC	BEE-161	Design Thinking in Electrical Systems	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-211	Complex Variables and Integral Transforms	3	1	0	4
2.	EF	BEC-207	Digital Electronics	3	0	2	4
3.	PC	BEE-205	Analysis of Linear Systems	3	1	0	4
4.	PC	BEE-206	Fundamentals of DC Electrical Machines & Transformers	3	0	2	4
5.	PC	BEE-207	Electrical Measurement and Measuring Instruments	3	0	2	4
			Total	**15**	**2**	**6**	**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	BME-260	Fundamentals of Mechanical Engineering	3	0	2	4
2.	PC	BEE-256	Fundamentals of AC Electrical Machines	3	0	2	4
3.	PC	BEE-257	Microprocessor	3	0	2	4
4.	PC	BEE-258	Network Analysis & Synthesis	3	0	2	4
	Students may choose either PE-1 or PE-2 or Both PE-1 and PE-2						
5.	PE		PE-1	3	1/0	0/2	4
6.	PE		PE-2	3	1/0	0/2	4
			Total	**15-18**	**0-2**	**8-12**	**20-24**
7.	VAC/AC	AUC-101	Constitution of India	2	0	**0**	0
8.	ECA - IV			-	-	-	0

Third Year, Semester V

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	M	BMS-302/352	Engineering Economics and Financial Management	3	1	0	4
2.	PC	BEE-306	Power System-I	3	1	0	4
3.	PC	BEE-307	Control System Engineering	3	0	2	4
4.	PC	BEE-308	Power Electronics	3	0	2	4
	Student may choose maximum up to 04 courses from the list of PE category courses (PE-1 to PE-9)						
5.	PE		PE-1	3	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.	HSSE	BHS-303/353	Industrial/Organizational Psychology	3	1	0	4

2.	PC	BEE-356	Power System-II	3	0	2	4
3.	PC	BEE-357	Instrumentation Engineering	3	0	2	4
4.	PC	BEE-358	Switchgear & Protection	3	0	2	4
5.	P	BEE-381	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	BEE-481	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	IEE-410	Industrial Practice	0	0	20	10
			Without Industrial Practice (IP)				
2.	MP	IEE-411	Major Project	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.	PE1	EEE-101	Linear Programming for Optimization	3	0	2	4
		EEE-102	Fundamentals of Power Electronics	3	1	0	4
		EEE-103	Modelling and Simulation Techniques	3	0	2	4
		EEE-104	Power Electronics Systems and Grid Integration for Electric Vehicles	3	1	0	4
2.	PE2	EEE-201	Power Generation Engineering	3	1	0	4
		EEE-202	Fundamentals of Electric Vehicles	3	1	0	4
		EEE-203	Scientific and Engineering Computation	2	1	2	4
3.	PE3	EEE-301	Nonlinear Optimization	3	1	0	4
		EEE-302	Advanced Power Converter Design	3	1	0	4
		EEE-303	Linear Control System	3	1	0	4
		EEC-311	Embedded System for Automotive Applications	3	1	0	4
4.	PE4	EEE-401	Emerging Technologies in Renewable Energy Sources	3	0	2	4
		EEE-402	Energy Storage, Battery Management Systems, and Motor Drives for EVs	3	1	0	4
		EEE-403	Fuzzy Logic Control System & Applications	3	1	0	4
		EEE-411	Advanced Power Electronics	3	1	0	4
		EEE-412	Power Plant Engineering	3	1	0	4
		EEE-413	High Voltage Engineering	3	1	0	4
		EEE-414	Intelligent Instrumentation	3	1	0	4
		EEE-415	Solar Energy Systems	3	1	0	4

5.	PE5	EEE-501	AI & Machine Learning for Optimization	3	1	0	4
		EEE-502	Control and Modulation Techniques in Power Electronics	3	1	0	4
		EEE-503	Introduction To Robotic Control	3	0	2	4
		EME-511	Vehicle Dynamics and control	3	1	0	4
6.	PE6	EEE-601	Power Market- Planning and Operations	3	1	0	4
		EEE-602	EV Grid Integration and Smart Systems	3	1	0	4
		EEE-603	Modern Control System	3	1	0	4
		EEE-611	Digital Control System	3	0	2	4
		EEE-612	Nonlinear System Analysis	3	1	0	4
		EEE-613	Facts Controllers & Devices	3	1	0	4
		EEE-614	EHV AC & DC Transmission	3	1	0	4
		EEE-615	Power Electronics Controlled Electric DC-Drives	3	1	0	4
		EEE-616	Advanced Microprocessor and Micro Controllers	3	0	2	4
7.	PE7	EEE-701	Application of Optimization in Industry	3	1	0	4
		EEE-702	Applications of Power Electronics in Emerging Technologies	3	1	0	4
		EEE-703	Industrial Instrumentation and Process Control	3	1	0	4
		EME-711	Sustainable Energy and EVs	3	1	0	4
8.	PE8	EEE-801	Smart Grid and Resilient Power System	3	1	0	4
		EEE-802	EV - Vehicle Dynamics and Electric Motor Drives	3	1	0	4
		EEE-803	Nonlinear Control System	3	1	0	4
		EEE-811	Electric Drives	3	1	0	
		EEE-812	Power System Operation and Control	3	1	0	4
		EEE-813	Power Quality	3	1	0	4
		EEE-814	Optimal And Adaptive Control Systems	3	1	0	4
		EEE-815	Power Electronics Applications	3	1	0	4
		EEE-816	Energy Efficiency & Conservation	3	1	0	4
		EEE-817	Bio Instrumentation	3	1	0	4
9.	PE9	EEE-901	Computational Tools for Optimization	3	1	0	4

		EEE-902	Intelligent Grid Systems and Microgrid Integration	3	1	0	4
		EEE-903	Numerical Methods & Optimization Techniques	3	1	0	4
		EEE-904	Smart Grid: Basics to Advanced Technologies	3	1	0	4
		EEE -911	Non-Conventional Energy Resources	3	1	0	4
		EEE-912	Utilization and Traction	3	1	0	4
		EEE-913	SCADA & Energy Management System	3	1	0	4
		EEE-914	Introduction to Battery Technology and Management System	3	1	0	4
		EEE-915	Industrial Process Control	3	1	0	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

Note:** Detailed syllabus of **Audit Courses (AC)** is attached **as Annexure-01.

Note:** Detailed information about different **Minor Degree courses,** along with their detailed Course structure, is attached in **Annexure-02

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

List of Extra Curricular Activity (ECA) Courses

ECA-II						
S. No.	Branch	Category	Subject Name	Subject Code	Hours/ Week	Credit
1.	Open to all Branches	ECA	Skill Development-I	ECA-151	2	0
2.	Open to all Branches	ECA	Unity and Discipline (NCC)-I	ECA-171	2	0
3.	Open to all Branches	ECA	Unity and Discipline (NSS)-I	ECA-172	2	0
4.	Open to all Branches	ECA	Games & Sports-I	ECA-181	2	0
5.	Open to all Branches	ECA	Cultural, Art & Literary-I	ECA-182	2	0
ECA-III						
S. No.	Branch	Category	Subject Name	Subject Code	Hours/Week	Credit
1.	Open to all Branches	ECA	Skill Development-II	ECA-201	2	0
2.	Open to all Branches	ECA	Unity and Discipline (NCC)- II	ECA-221	2	0
3.	Open to all Branches	ECA	Unity and Discipline (NSS)-II	ECA-222	2	0
4.	Open to all Branches	ECA	Games & Sports-II	ECA-231	2	0
5.	Open to all Branches	ECA	Cultural, Art & Literary-II	ECA-232	2	0
ECA-IV						
S. No.	Branch	Category	Subject Name	Subject Code	Hours/Week	Credit

1.	Open to all Branches	ECA	Skill Development-III	ECA-251	2	0
2.	Open to all Branches	ECA	Unity and Discipline (NCC)- III	ECA-271	2	0
3.	Open to all Branches	ECA	Unity and Discipline (NSS)- III	ECA-272	2	0
4.	Open to all Branches	ECA	Games & Sports-III	ECA-281	2	0
5.	Open to all Branches	ECA	Cultural, Art & Literary-III	ECA-282	2	0

ECA-V

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

ECA-VI

S. No.	Branch	Category	Subject Name	Subject Code	Hours/ Week	Credit
1.	Open to all Branches	ECA	Skill Development-V	ECA-351	2	0
2.	Open to all Branches	ECA	Games & Sports-V	ECA-381	2	0
3.	Open to all Branches	ECA	Cultural, Art & Literary-V	ECA-382	2	0

ECA-VII

S. No.	Branch	Category	Subject Name	Subject Code	Hours/ Week	Credit
1.	Open to all Branches	ECA	Skill Development-VI	ECA-401	2	0
2.	Open to all Branches	ECA	Games & Sports-VI	ECA-431	2	0
3.	Open to all Branches	ECA	Cultural, Art & Literary-VI	ECA-432	2	0

*****Note: Detailed syllabus of Extra Curricular Activity (ECA) Courses is attached as Annexure-04***

SKILLS-ENHANCEMENT COURSES FOR EXIT (ELECTRICAL ENGINEERING):

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

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

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

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	Skill Enhancement	BEE-162	Electrical Installation, Testing & Maintenance	2	0	2	3
2.	Skill Enhancement	BEE-163	Mini Project	0	0	6	3

OR

Equivalent skills-enhancement courses from MOOC/SWAYAM.

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

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

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	Skill Enhancement	BEE-262	Integrated Electrical Systems	2	0	2	3
2.	Skill Enhancement	BEE-263	Mini Project	0	0	6	3

OR

Equivalent skills-enhancement courses from MOOC/SWAYAM.

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

The candidate should pass the following courses to qualify for **B.Voc (Engg.).**

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	Skill Enhancement	IEE-310	Industrial Training (6 to 8 weeks)	0	0	12	6
OR							
1.	Skill Enhancement	BEE-362	Integrated Power Systems and Industrial Automation	3	0	0	3

2.	Skill Enhancement	BEE-363	Mini Project	0	0	6	3

OR

Equivalent skills-enhancement courses from MOOC/SWAYAM.

SYLLABUS

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 One Minor tests and One Major Theory Examination
Course Objectives		The course is aimed to develop the mathematical understand about Complex variables and complex functions and to acquire the skill of evaluating contour integrals using Cauchy's integral formula and Cauchy's integral theorem.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Prove basic results in complex analysis.
2. Establish the capacity for mathematical reasoning through analyzing, proving, and explaining concepts from complex analysis.
3. Solve the problems using complex analysis techniques applied to different situations in engineering contexts.
4. Use of Laplace Transform to solve the differential equation.
5. Use of Fourier transforms, and Z transforms to solve the differential equation.
6. To inculcate the habit of mathematical thinking and lifelong learning.

Topics Covered

UNIT-I **(9hrs)**

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 **(9hrs)**

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 **(9hrs)**

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

UNIT-IV **(9hrs)**

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		**Environmental Science and Green Chemistry**
Course category	:	Basic Sciences & Maths (BSM)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and One Minor tests and One Major Theory Examination
Course Objectives		The course is aimed to develop the mathematical understand about Complex variables and complex functions and to acquire the skill of evaluating contour integrals using Cauchy's integral formula and Cauchy's integral theorem.
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.

Topics Covered

UNIT-I **(9hrs)**

Basic Chemical Concepts Periodic properties of elements, Ionization potential, electron affinity and electronegativity; mole concept, molarity and normality, Chemical Bonding – MO Theory, MO diagram of diatomic molecules, hydrogen bonding, electrophiles, nucleophiles, inductive effect and mesomeric effect. Reaction Mechanism. Acidity and basicity - Concept of pH.

UNIT-II **(9hrs)**

Atmospheric chemistry & Water Chemistry The atmosphere of Earth, layers of atmosphere and temperature inversion, Air pollution, Global warming, and Greenhouse effect. Acid rain and Ozone layer depletion. Chemical and photochemical Smog. Sources of water, conservation of water, impurities in water and their effects. WHO guideline and BIS guideline for drinking water. Hardness of water,

Softening of water by Zeolite process, Lime Soda process, Ion exchange process and Reverse osmosis.

UNIT-III **(9hrs)**

Spectroscopic analytical method Absorbance, Transmittance and Beer-lamberts Law. Basic principles of UV-Visible spectroscopy, Fluorescence spectroscopy, Infrared spectroscopy, NMR Spectroscopy. Use of these instrumental techniques for monitoring of environmental pollution. Environmental problems posed by the use of non-biodegradable polymers widely used in day-to-day life. Incineration as the key method for disposal of polymeric waste. Bio-degradable polymers.

UNIT-IV **(9hrs)**

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 asz 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.

BCS-110/160 **Introduction to C Programming**

Course category: Engineering Fundamental (EF)

Pre-requisite Subject: NIL

Contact hours/week: Lecture: 3, Tutorial: 0, Practical: 2

Number of Credits: 4

Course Assessment methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, Viva-voce, two tests and One Major Examination (T & P)

Course Objective: The course covers the basics of programming and demonstrates fundamental programming techniques, customs and terms including the most common library functions and the usage of the pre-processor. The salient features of course objectives are given below.

1. To develop C Programs using basic programming constructs
2. To develop C programs using arrays and strings
3. To develop applications in C using functions and structures

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

1. Basic terminology used in computer programming.
2. Programs development in C Language by writing, compiling, and debugging.
3. Design of programs involving simple statements, conditional statements, iterative statements, array, strings, functions, recursion, structure, and union.
4. Difference between call by value and call by reference.
5. Dynamic memory allocations and use of pointers.
6. Basic operations on a file.
7. Basics of dynamic memory.

UNIT-I **(9hrs)**

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

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

UNIT-II **(9hrs)**

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

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

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

UNIT-III **(9hrs)**

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

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

UNIT-IV **(9hrs)**
Dynamic Memory Allocation: malloc, calloc, realloc, free functions.
File Management: Defining and Opening a File, Closing a File, Input/ Output Operations in Files. The Pre-processor Directives, Macros. Command Line Arguments. Introduction to Graphics Programming.

EXPERIMENTS

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

Textbooks

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

Reference Books

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

BEE-108A		**Electrical Wiring & Estimation**
Course category	:	PS
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, Viva-voce, one test and One Major

Course Objectives : 1. To introduce the fundamentals of electrical components, wiring systems, tools, and safety.
2. To familiarize students with protection devices, metering, and power supply systems.
3. To introduce basic concepts of estimation and costing in household electrical installations.

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

1. Understand the properties of basic electrical components and identify various wiring systems and tools.
2. Apply electrical safety measures and estimate wiring requirements for simple layouts.
3. Operate and interpret readings from common electrical measuring instruments.
4. Design and estimate domestic wiring layouts including switchboards and sub-circuits.
5. Analyze electricity billing and understand UPS system components and connections.
6. Perform basic troubleshooting, preventive maintenance, and cost estimation for domestic electrical installations.

TOPICS COVERED

UNIT I: Basic Electrical Components and Wiring Practices ***(9hr)***

Electrical properties of Resistor, Capacitor, and Inductor; Familiarization with basic electrical tools and electrical symbols; Types of conductors, cables, and wiring systems; Star and Delta connections: concept and demonstration; Introduction to household wiring and simple circuit layouts.

UNIT II: Electrical Safety, Protection, and Estimation Fundamentals ***(9hr)***

Safety rules, PPE, and first aid in electrical work; Fuses, circuit breakers (MCB), relays, isolators: purpose and selection; Earthing, Grounding, and Isolation: importance and implementation; Introduction to estimation: Load calculation, wire sizing, and material identification; Simple cost estimation of wiring for one/two-room layout.

UNIT III: Measuring Instruments and Domestic Wiring Layouts ***(9hr)***

Working principle and usage: Voltmeter, Ammeter, Wattmeter, Energy Meter (AC/DC); Switchboard wiring, socket outlets, and lighting connections; Main switch, distribution board, sub-circuit arrangement; Estimation of switchboards, points, and fitting materials in a small house

UNIT IV: Electricity Billing, UPS Systems, and Appliance Maintenance ***(9hr)***

Electricity bill structure: energy units, tariff types, meter reading; Introduction to UPS systems: components and connection; Fault detection and minor repair in domestic appliances (iron, fan, lamp); Preventive maintenance practices; Cost estimation and checklist for wiring repair or small installations

List of Experiments

1. To identify and demonstrate electrical tools, materials, and standard symbols

2. To perform wiring for a single-way switch control circuit
3. To perform wiring for a two-way switch control circuit
4. To perform staircase wiring system for lighting control
5. To perform tube light wiring with choke and starter
6. To perform and demonstrate different types of cable joints
7. To design and test a basic earthing system
8. To repair a ceiling or table fan and identify motor winding terminals
9. To demonstrate the design of a single-phase motor winding
10. To prepare switchboard wiring with socket, indicator, and fuse
11. To estimate the electrical load and material requirement for a single-room wiring layout
12. To read an energy meter and calculate electricity billing based on connected load

TEXT BOOKS:

1. Electrical Design Estimating and Costing, K.B. Raina, S.K. Bhattacharya, New Age International Publisher.
2. Design of Electrical Installations, Dr. V.K. Jain, Dr. Amitabh Bajaj, University Science Press.
3. Electricity pricing Engineering Principles and Methodologies, Lawrence J. Vogt, P.E., CRC Press.

REFERENCE BOOKS:

1. Guide for Electrical Layout in residential buildings, Indian Standard Institution, IS: 4648-1968
2. Electrical Installation buildings Indian Standard Institution, IS: 2032.
3. Electrical Wiring Estimating and Costing by S. L. Uppal. Khanna Publishers.
4. Practical Handbook on Electric Motors, Starters and Controllers by M.P. Krishna Pillai, Standard Publishers Distributers.
5. Advanced Home Wiring by Black & Decker, 5th Edition, Editors of Cool Spring press

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 One test, teacher's assessment (quiz, tutorial, assignment, attendance), and One Major Theory Examination.
Course Objectives	: The objectives of this course are to: - The course aims- 1. To sensitize the students to understand the role and importance of communication for personal and professional success. 2. To enable the learners to enhance their writing skills in techno-cultural and professional echo-system. 3. To equip learners to differentiate technical writing from general writing. 4. To equip them with technical writing skills.

5. To enable learners to exhibit knowledge, skills, attitude and judgment in and around human communication that facilitate their ability to work collaboratively with others in an interpersonal environment.

Course Outcomes : The students will be able to demonstrate the following knowledge, skills, and attitudes upon completion of the course: -

1. Overcome the problems she/he shall faces 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 **(6hrs)**

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 **(6hrs)**

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 (6hrs)

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 (6hrs)

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 Experiments:

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

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, Modern Language Association of America, NY, US.
7. Gurumani, N. (2010) Scientific Thesis Writing and Paper Presentation, MJP Publishers, Chennai.
8. Hamilton Richard. (2009) Managing Writers. Penguin, India.
9. Mc Graw S. J. (2008) Basic Managerial Skills for All. Ed. 08th, Prentice Hall of India, New Delhi.
10. Murphy & Hildebrandt. (2008) Effective Business Communication. Tata McGraw Hill New Delhi.
11. Pandey, S.P., Singh, S. N. & Kumar, Raman, (2023) Exploring Digital Humanities: Challenges & Opportunities, MacBrain Publishing House, New Delhi.

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 **(9hrs)**

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 **(9hrs)**

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 **(9hrs)**

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 **(9hrs)**

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 & Maths (BSM)
Pre-requisite Subject	:	Nil
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and Two Minor tests 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 attitudes 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 lasers in different fields of Engineering.
3. Know the knowledge of Optical Fibre 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: (9hrs)

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.**Laser:** Spontaneous and stimulated emission of radiation, Population inversion, Concept of 3 and 4 level Laser, Construction and working of Ruby, He-Ne lasers, and laser applications.

UNIT-II Quantum Mechanics and Fiber Optics: (9hrs)

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.

Fiber Optics: Fundamentals of optical fiber, Acceptance angle and cone, Numerical aperture, Single and Multi-Mode Fibers, Step index and graded index fiber, Propagation Mechanism in optical fibers.

UNIT-III Electrodynamics: (9hrs)

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: (9hrs)

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.

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 **(9hrs)**

D C Circuit Analysis and Network Theorems:

Circuit Concepts: Concepts of network, Active and passive elements, Voltage and current sources, Concept of linearity and linear network, Unilateral and bilateral elements, R, L and C as linear elements, Source transformation, Kirchhoff's laws, Loop and nodal methods of analysis, Star-delta transformation, Network theorems: Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem.

UNIT II **(9hrs)**

Introduction to AC Circuits:

AC fundamentals, Analysis of single phase series, parallel and series-parallel RLC Circuits, Resonance in series and Parallel circuit.

Three Phase AC Circuits: Three phase system-its necessity and advantages, Star and delta connections, Balanced supply and balanced load, Line and phase voltage/current relations, three-phase power, and its measurement.

UNIT III **(9hrs)**

Measuring Instruments:

Fundamentals of measurement & instrumentation, Units, Dimensions and Standards. Error Analysis, types of errors & its analysis. Measuring instruments, construction and working principles of PMMC, Moving Iron and Electro-dynamometer type voltmeters & ammeters, Use of shunts and multipliers.

UNIT IV **(9hrs)**

Magnetic Circuits and Transformers:

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

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

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

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 One test, 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.

Unit 1 **(9hrs)**

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 **(9hrs)**

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 **(9hrs)**

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 **(9hrs)**

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.

BEE- 159		**Basics of Electrical Machines & Protective Equipments**
Course category	:	PS
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 2, Tutorial: 0, Practical: 4
Number of Credits	:	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 Objective	:	**1.** To demonstrate and understand the basic principle of operation and construction of different types of electrical measuring instruments. **2.** To demonstrate and understand the applications of different types of protective schemes.

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 concepts of DC machines.
2. Acquire knowledge about characteristics and its applications.
3. Understand the basic concepts of AC (single-phase and three-phase) machines.
4. Classify and compare different types of AC machines.
5. Student gains knowledge on different Protective Equipments of Power Systems.
6. Different applications of the relays, circuit breakers, grounding and able to understand the Recovery and Restricting effects of power system.

Topic Covered

UNIT I **(6hrs)**

DC Machines:

Concept of electromechanical energy conversion DC machines: Types, EMF equation of generators and torque equation of motor, Characteristics, and applications of DC generators & motors.

UNIT II **(6hrs)**

AC Machines:

Three Phase Induction Motor: Types, Principle of operation, Torque-slip characteristics, and its applications.

Single Phase Induction motor: Principle of operation and introduction to methods of starting, applications.

UNIT III **(6hrs)**

Protective Relays:

Introduction to protection system and its elements, Functional Characteristics of protective relaying, Protective zones, Primary and Backup protection, desirable qualities of protective relaying, basic terminology sealing/auxiliary relay. Electromagnetic, attracted and induction type relays, thermal relay, gas actuated relay.

UNIT IV **(6hrs)**

Circuit Breakers:

Introduction to circuit breakers. Constructional features and operation of different types of circuit breakers like Air, Bulk Oil, Minimum Oil, Air Blast, SF_6, and Vacuum Circuit breakers, Ratings & Testing of Circuit Breakers

List of Experiments:

1. To draw the magnetization characteristics of separately excited dc motor.
2. To perform the external load characteristics of dc shunt motor.
3. To study running and speed reversal of a three-phase induction motor and record speed in both directions.
4. To study Impedance, MHO, and Reactance type distance relays.
5. To study the working and principle of operation of Buchholz relay.
6. To study the IDMT over current relay and determine the time current characteristics.
7. To study percentage differential relay.
8. To study Impedance, MHO and Reactance type distance relays.
9. To understand the protection scheme of substation through visit to local high voltage substation and to sketch labelled schematic diagram/single line diagram of it.

Textbooks:

1. Fundamentals of Electric Circuits, C.K. Alexander and M.N.O. Sadiku; TATA McGraw-Hill.
2. Electrical Technology, B. L. Thareja and A. K. Thareja; S. Chand.
3. S. S. Rao, "Switchgear and Protection", Khanna Publishers.
4. B. Ravindranath and M. Chander, Power system Protection and Switchgear, Wiley Eastern Ltd.
5. B.Bhalja, R.P. Maheshwari& N. G. Chothani, Protection & Switch Gear, Oxford University Press.
6. B. Ram and D. N. Vishwakarma, "Power System Protection and Switchgear", Tata Mc. Graw Hill

BEE - 161	**Design Thinking in Electrical Systems**
Course category:	VAC/AC
Pre-requisite Subject:	NIL
Contact hours/week:	Lecture: 0, Tutorial: 0, Practical: 2
Number of Credits:	0
Course Assessment methods:	Continuous assessment through attendance, practical work, record, Viva-voce

Course Objective:

The course is designed to give an in-depth understanding on various aspects of innovation, creativity, evolving electrical systems modules/products for various applications inculcate the knowledge, incubation and the entrepreneurship in any role you're in.

1. Continuously produce breakthrough ideas
2. Catalyze design thinking in your daily routine
3. Unlock the innovative capacity of your team
4. Build a lifelong practice of creative problem-solving

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

1. Explain the fundamentals of Design Thinking and innovation.
2. Analyse the model action plan.
3. Describe the principles of innovation and idea generation for product design.
4. Apply design thinking techniques for given tasks and in solving problems in various sectors.

UNIT-I

Design Thinking: Introduction to design, history & importance of design thinking, elements, components, and principles of fundamental design. Design Thinking Framework/Methods - Empathise –Define – Ideate

– Prototype – Test- System Module Development Methodology. Tools of design thinking - person, customer, journey map, brainstorming, product development.

UNIT-II

Innovation: Art of innovation, Difference between innovation and creativity, role of creativity and innovation in organizations. Teams for innovation, Measuring the impact and value of creativity, Innovation Management-Changing Management Paradigms-Design Thinking related Electrical Engineering Solutions for Industry and Society.

UNIT-III

Product Design: Problem formation, Introduction to product design (for eg. SMPS, UPS, Electrical Charger for various devices etc.), Product strategies, Product value, Product planning, Product specifications.

UNIT-IV

Design Case Studies: Study of electric bell, charger, UPS, SMPS, inverter, battery in various electric appliances, power supply and ideate, incubate for entrepreneurship.

Textbooks

1. Change by Design, Tim Brown, Harper Bollins (2009)
2. Design Thinking in the Classroom by David Lee, Ulysses Press
3. Electrical Wiring, Estimating and Costing by S. L. Uppal, Khanna Publication
4. Electrical Installation Estimating & Costing by J. B. Gupta, S. K. Kataria & Sons Publication

Reference Books

1. Design the Future, Shrutin N. Shetty, Notion Press
2. Universal Principles of Design- William Lidwell, Kritina Holden, Jill Butter, Rockport Publishers.
3. The Era of Open Innovation – Henry W. Chesbrough, MIT Sloan, Management Review.
4. Product Design and Manufacturing, A. K. Chitale and R.C. Gupta, Prentice Hall

Skill-Based Courses to Qualify for UG Certificate (Engg.) in Electrical Engineering

BEE-162		**Electrical Installation, Testing & Maintenance**
Course category	:	Skill Development
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 2, Tutorial: 0, Practical: 2
Number of Credits	:	3
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and One Minor tests and One Major Theory Examination
Course Objectives		To develop foundational knowledge and practical competencies in electrical installation techniques, wire, and cable selection, switching and control systems, and circuit protection devices.

• The course is designed to provide learners with the ability to select appropriate materials, tools, and safety practices while working on low-voltage electrical installations in residential, commercial, and light industrial settings.

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

1. Understand the construction, insulation types and applications of various wires and cables such as single core, multicore, and flexible types.
2. Demonstrate awareness of site selection, safety procedures, and the proper use of hand tools and electrical installation equipment.
3. Calculate cable sizes using load, cable run length and derating factors to ensure safe and efficient operation.
4. Differentiate between SWG and mm² standards and apply them to real-world installations.
5. Identify different types of switches and explain their domestic and industrial applications

Topics Covered

UNIT-I **(6hrs)**

Wires, Cables and Installation

Types of wires: Single core, multicore, flexible, twin and earth Cable insulation: PVC, XLPE, FRLS,Difference between wires and cables ,Site selection and safety precautions, Tools and equipment used for installation & fault detection methods.

UNIT-II **(6hrs)**

Cable Sizing and Wire Gauge Selection

SWG vs mm2standards ,Cable size selection criteria, Load (kW/KVA to amps.),Length of cable run (Voltage drop consideration), Derating factor and current carrying capacity, Common electrical hazards on-site ,Importance of earthing and types of earthing, Ambient temperature, cable grouping, laying condition.

UNIT-III **(6hrs)**

Switches and Control Devices

Types of switches SPST, SPDT, DPST, DPDT, TPST,TPDT,Modular switches vs. traditional, Push button, toggle, rotary switched, Application of each in domestic and industrial usage, Overview of switchgear classifications, Standard and symbol used in switched gear

UNIT-IV **(6hrs)**

Circuit Protection Devices

Fuses : Types (Rewirable, HRL cartridge), rating, advantages/disadvantages ,MCB, MCCB (Working principle) ,Single pole, double pole, triple pole MCBs ,Current rating, breaking capacity, Overview of Relaying system

Experiments

1. Demonstration of wiring MCB with load and neutral.
2. Identify and connect three types of switches in a demo board.
3. Select proper MCBs for a two room house with one Air Conditioning.
4. Wiring a miniature DB board setup for trainee.
5. Staircase wiring
6. Study of LT substation layout
7. Study of Pipe/Plate earthing

Books & References

1. Electrical Installation Estimating and Costing, J.B. Gupta, S.K. Kataria & Sons.
2. Testing, Commissioning, Operation and Maintenance of Electrical Equipment, S. Rao, Khanna Publishers.
3. Electrical Installation Work, Brian Scaddan, Routledge (UK).

SECOND YEAR

BSM-211/261		**Complex Variables and Integral Transforms**
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 mathematical understand about Complex variables and complex functions and to acquire the skill of evaluating contour integrals using Cauchy's integral formula and Cauchy's integral theorem.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Prove basic results in complex analysis.
2. Establish the capacity for mathematical reasoning through analyzing, proving, and explaining concepts from complex analysis.
3. Solve the problems using complex analysis techniques applied to different situations in engineering contexts.
4. Use of Laplace Transform to solve the differential equation.
5. Use of Fourier transforms, and Z transforms to solve the differential equation.
6. To inculcate the habit of mathematical thinking and lifelong learning.

Topics Covered

UNIT-I **(9hrs)**

Functions of Complex Variable I: Complex differentiability, Cauchy-Riemann equations, Analytic functions, Harmonic functions, Harmonic conjugates, Cauchy-Integral Theorem, Cauchy-Integral formula, Cauchy's integral formula for higher derivatives.

UNIT-II **(9hrs)**

Functions of Complex Variable II: Taylor's Series and Laurent Series, Zero's and Singularities of functions, Removable singularity, Poles and essential singularities, Residues, Cauchy's residue theorem., Residue theorem, Evaluation of the real integrals of the type $\int_0^{2\pi} f(\cos\theta, \sin\theta)d\theta$ *and* $\int_{-\infty}^{+\infty} f(x)dx$.

UNIT-III **(9hrs)**

Integral Transform I: Laplace Transform Laplace transform, Existence theorem, Laplace transforms of derivatives and integrals, Initial and final value theorems, Unit step function, Dirac- delta function. Laplace

transform of periodic function, Impulse function. Inverse Laplace transform, Convolution theorem, Application to solve simple linear and simultaneous differential equations.

UNIT-IV **(9hrs)**

Integral Transform II: Fourier integral, Complex Fourier transform, Inverse Transforms, Convolution Theorems, Fourier sine and cosine transform, Applications of Fourier transform to simple one-dimensional heat transfer equation, wave equation.

Z- transform and its application to solve difference equations

Books & References

1. B.S. Grewal: Higher Engineering Mathematics; Khanna Publishers.
2. Jain, Iyenger and Jain: Advanced Engineering Mathematics, Tata McGraw Hill Education Pvt. Ltd., New Delhi
3. James W. Brown & R. V. Churchill: Complex variables and applications, Mcgraw-Hill Asia
4. Debanth L. and Bhatta D., "Integral Transforms and Their Applications", 2nd edition, Taylor and Francis Group, 2007.
5. Sneddon I. N. Fourier Transforms, Dover Publication, 2010.

BEC-207 **Digital Electronics**

Course category	Engineering Fundamental
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 Objectives	The course aims to provide knowledge of digital electronics, combinational and sequential circuits, state machines, and digital system design.
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 **(9hrs)**

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 **(9hrs)**

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

UNIT-III **(9hrs)**

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 **(9hrs)**

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)

BEE-205	**:**	**Analysis of Linear Systems**
Course category	:	Professional 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 One Minor Test 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. Analyse as well as synthesize Continuous and discrete signals, classification & identification of different signals/ models. 2. Acquire the knowledge of analogous electrical systems of different non- electrical systems. 3. Application of Fourier-series and Fourier Transform for the analysis of periodic & aperiodic signals. 4. Application of Laplace Transform for the analysis of continuous-time systems. 5. Modelling and system analysis through State variable. 6. Application of Z-Transform for the analysis of discrete-time systems.

Topics Covered

UNIT-I **(9hrs)**

Introduction to continuous time signals and systems:

Basic continuous time signals, unit step, unit ramp, unit impulse and periodic signals with their mathematical representation and characteristics. Classification of continuous time signals, Signal analysis and synthesis, Classification of continuous time systems.

Introduction to discrete time signals and systems:

Basic discrete time signals with their mathematical representation and characteristics. Classification of discrete time signals, Discrete signal analysis and synthesis, Classification of discrete time systems

UNIT-II **(9hrs)**

Laplace Transform Analysis:

Laplace Transformation, some basic Theorems, Gate function, Laplace Transform of periodic functions, Waveform synthesis and Laplace Transform of complex waveforms, Initial and Final Value Theorems, Inverse Laplace Transform, Convolution Theorem, Impulse Response, Superposition Integral, Application of Laplace Transform to solution of systems and network problems,

UNIT-III **(9hrs)**

Z-Transform Analysis:

Concept of Z-Transform, Z-Transform of common functions, Properties of Z-Transform, Some basic Theorems, Inverse Z-Transform, Initial and Final Value theorems, Analysis of Linear Time Invariant systems in Z-domain, Pulse Transfer Function.

UNIT-IV **(9hrs)**

State Variable Analysis:

Introduction, State Space representation of linear systems, Transfer Function and state Variables, State Transition Matrix, Solution of state equations for homogeneous and non-homogeneous systems, Applications of State-Variable technique to the analysis of linear systems

Books & References

1. Choudhary D. Roy, "Network & Systems", Wiley Eastern Ltd.
2. Donald E. Scott, "Introduction to circuit Analysis" Mc. Graw Hill
3. B.P. Lathi, "Linear Systems & Signals" Oxford University Press, 2008.
4. I.J. Nagrath, S.N. Saran, R. Ranjan and S. Kumar, "Signals and Systems, "Tata Mc. Graw Hill, 2001.
5. Taan S. Elali & Mohd. A. Karim, "Continuous Signals and Systems with MATLAB" 2nd Edition, CRC Press.

BEE-206 : Fundamentals of DC Electrical Machines & Transformers

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, 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. Acquire knowledge about the fundamental principles and classification of electromagnetic machines.
2. Ability to understand electro-mechanical energy conversion process of rotating electrical machines in singly exited & doubly excited magnetic system.
3. Ability to learn basic concept of design, working & performances of DC Machines as Generator.
4. Ability to solve theoretical & numerical problems related with DC Machines as Generator.
5. Ability to learn basic concept of design, working & performances of DC Machines as Motors and solve theoretical & numerical problems.
6. Ability to know constructional details, working principle & Performances of single Phase & three phase transformer.

Topics Covered

UNIT-I **(9hrs)**

Principles of Electro-mechanical Energy Conversion Introduction, Flow of Energy in Electromechanical Devices, Energy & Co-energy in magnetic systems, Singly Excited and Doubly excited Magnetic field Systems; derivation of mechanical force, magnetic energy and torque in magnetic field system, generated EMF, and torque in rotating electrical machines

UNIT-II **(9hrs)**

D.C. Generator Construction of DC Generator, parts of dc generator, armature winding, types of dc generators, Emf and torque equation, Armature Reaction, Commutation process, Interpole and Compensating Windings, Performance Characteristics of D.C. generators under no load and loaded conditions.

UNIT-III **(9hrs)**

D.C. Motor DC motors, operating characteristics of D.C. motors, back EMF and torque equation, DC motor starters, Speed control of D.C. motors, losses, Efficiency, and various Testing on D.C motors. Concept of Brushless DC motor.

UNIT-IV **(9hrs)**

Transformer: Construction& working of single-phase transformer, types of transformers, equivalent circuit models, efficiency, voltage regulation, various testing methods, Single phase auto transformers, efficiency, merits & demerits, and applications of auto transformer. Construction, working and classifications of three phase transformers, phasor groups, Inrush current & harmonics in three phase transformers, three winding transformers, Parallel operation of transformers.

List of Experiments

1. To obtain magnetization characteristics of a d.c. shunt generator
2. To obtain load characteristics of a d.c. shunt generator.
3 To obtain efficiency of a dc shunt machine using Swinburn's test.
4. To perform Hopkinson's test and determine losses and efficiency of DC machine
5. To obtain speed-torque characteristics of a dc shunt motor and series motor.
6. To obtain speed control of dc shunt motor using (a) armature resistance control (b) field control
7. To obtain speed control of dc separately excited motor using Ward-Leonard.
8. To study polarity and ratio test of single phase and 3-phase transformers
9. To obtain equivalent circuit, efficiency and voltage regulation of a single transformer using open circuit and short Circuit test.
10. To obtain efficiency and voltage regulation of a single-phase transformer by Sumpner's test.
11. Study of 3-phase to 2-phase conversion by Scott connection.

Text Books:

1. I. J. Nagrath & D. P. Kothari," Electrical Machines", Tata McGraw Hill
2. Ashfaq Husain," Electrical Machines", Dhanpat Rai& Sons
3. U.A Bakshi and M.V Bakshi, "Electromechanical Energy Conversion-I", Technical Publication Pune,
4. B.R. Gupta &Vandana Singhal, "Fundamentals of Electrical Machines, New Age International Publication
5. Fitzerald, A.E., Kingsley and S. D. Umans "Electric Machinery", MC Graw Hill.

Books & References

1. Irving L. Kosow, "Electric Machine and Transformers," Prentice Hall of India.
2. M.G. Say, "The Performance and Design of AC machines", Pit man & Sons.
3. P. S. Bimbhra, "Electrical Machinery", Khanna Publisher

BEE-207	**:**	**Electrical Measurement & Measuring Instruments**
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 attendance, home assignments, practical work, record, viva voce and one minor test and One Major Theory & Practical Examination.
Course Outcomes	:	The student are expected to be able to demonstrate the following knowledge, skill and attitudes after completing this course 1. Basic concept of measurement, instrumentation, working & performances of different kind of measuring instruments 2. Ability to analyze performance characteristics of measuring instruments. 3. Ability to know, working principle & Performances of AC Bridges 4. Ability to understand construction, principle of operation, working and applications of waveform analyzers and spectrum analyzers. 5. Ability to understand construction, principle of operation, working and applications of harmonic distortion analyzers. 6. Ability to understand construction, principle of operation, working and measurements of Cathode Ray Oscilloscope (CRO).

Topics Covered

UNIT-I **(9hrs)**

Fundamentals of Measurement Systems

Philosophy of measurement, methods of measurements, classification of measurement system, functional elements of measurement, units, dimensions & standards, static performance characteristics, errors analysis, loading effect of instrument, uncertainty in compound quantity, histogram, deviation, dispersion, standard deviations, variance, Gaussian's distribution curve analysis.

UNIT-II **(9hrs)**

Analog Measurement of Electrical Quantities

Types of measuring instruments, secondary instruments, essentials components of instruments, design of sprigs, pivot & jewels, Ammeters & Voltmeters; moving coil, moving iron, electrodynamic, electrostatic, rectifier & thermocouple type, Measurement of power, wattmeter, Measurement of energy, induction type energy meter, errors & remedies in wattmeter and energy meter, frequency meters.

UNIT-III **(9hrs)**

Instrument Transformers & A.C. Bridges

Instrument Transformer (CT &PT) and their applications in the extension of instrument range, Different methods of measuring low, medium and high resistances**,** measurement of inductance & capacitance with the help of AC Bridges.

UNIT-IV **(9hrs)**

Magnetic Measurement & Digital Measurement of Electrical Quantities

Flux meter**,** determination of hysteresis loop, measurement of iron losses**.** Concept of digital measurement, block diagram study of digital voltmeters (DVM), Spectrum analyzers, Wave Analyzer and Harmonics distortion analyzer; Basic CRO circuit (Block Diagram), Cathode ray tube (CRT) & its components**,** application of CRO in measurement, Lissajous Pattern.

List of Experiments

(Note: Minimum 8 experiments are to be performed**)**

1. Calibration of ac voltmeter and ac ammeter.
2. Calibration of single of induction type energy meter with the help of wattmeter.

3. Extension of range instruments using CT & PT.
4. Determination of iron loss using Lloyd Fisher's square method.
5. Measurement of phase difference and frequency of a sinusoidal ac voltage using C.R.O.
6. Measurement of power and power factor of a load using three voltmeter methods.
7. Measurement of low resistance by Kelvin's double bridge.
8. Study of Maxwell's inductance bridge.
9. Study of Schering bridge.
10. Study of Hay's bridge.
11. Study of Anderson's bridge.
12. Study of Owen's bridge.

Textbooks:

1. E.W. Golding & F.C. Widdis, "Electrical Measurement &Measuring Instrument", A.W. Wheeler& Co. Pvt. Ltd. India.
2. A.K. Sawhney, "Electrical & Electronic Measurement & Instrument", Dhanpat Rai& Sons India.

Books & References

1. E.O. Decblin, "Measurement System – Application & design", McGraw Hill.
2. Forest K. Harries, "Electrical Measurement", Willey Eastern Pvt. Ltd. India.
3. M.B. Stout,"Basic Electrical Measurement" Prentice hall of India.
4. W. D. Cooper," Electronic Instrument & Measurement Technique "Prentice Hall International.
5. B.C. Nakra & K. Chaudhry, "Instrumentation, Measurement and Analysis", Tata McGraw Hill 2nd Edition.
6. J.B. Gupta, "Electrical Measurements and Measuring Instruments", S.K. Kataria & Sons

BME-260 Fundamentals of Mechanical Engineering

Course category	:	Engineering Fundamentals (EF)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and one Minor tests and One Major Theory & Practical Examination
Course Objectives	:	This course introduces fundamentals of mechanical engineering and their applications in solving engineering problems based on the concepts of thermodynamics, engine, measurement, engineering materials, mechanical properties and testing etc.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course: 1. The knowledge of basic laws of thermodynamics; steam generation and its properties; refrigeration cycles, properties, and machines; and reciprocating engine such as two/four strokes IC engines. 2. The knowledge of measuring instruments, types of transducers for measurement of different geometrical parameters.

3. The knowledge of various engineering materials and their applications.
4. The ability to understand different types of stresses, Hooke's law and its applications.
5. Understand the different mechanical properties and testing of engineering materials.
6. The knowledge of different types of beams, shear force and bending moment diagrams for statically determinate beams, stresses in simple bending of beams and torsion in circular shafts.

Topics Covered

UNIT-I **(9hrs)**

Thermodynamics

Thermodynamics laws, Enthalpy, Entropy, Steam properties, Steam processes at constant pressure, volume, enthalpy and entropy, Classification of steam boilers, boiler mounting and accessories, Refrigeration, Basics of Vapour compression and vapour absorption system, Coefficient of performance (COP), Refrigerants properties.

Reciprocating Machines

Carnot cycle, Otto and Diesel cycles, Working of two and four strokes petrol and diesel engines.

UNIT-II

(9hrs)

Measurement & Metrology

Introduction to measurement and measuring instruments, Types of sensors and transducers and their characteristics, measuring error uncertainty analysis, Temperature, pressure, velocity, flow, strain, force and torque introduction of dial gauges, slip gauges and sine bar

Engineering Materials

Classification of materials, Ferrous and nonferrous metals, Composition of cast iron, carbon steel, alloy steel and their applications, Non-ferrous metals such as Cu, Al, Zn, Cr, Ni etc. properties and its applications.

UNIT-III **(9hrs)**

Simple Stress and Strain

Introduction, Normal and shear stresses, Poisson's ratio, Elastic constants and their relationships, Hooke's law, Deflection of bars of uniform and varying cross-sections, Strain energy in due to static loading, Stress-strain diagrams for ductile and brittle materials

Mechanical Properties and Testing

Strength, Stiffness, Malleability, Ductility, Brittleness, Toughness, Hardness, Fracture, Fatigue & creep.

UNIT-IV **(9hrs)**

Beams

Introduction, Classification of beams, types of loading, Free body diagram, Shear force and bending moment, Analysis of beams, Shear force and bending moment diagrams for statically determinate beams, Simple bending theory, Stress of beams of different cross sections

Torsion of Circular shafts

Introduction, Torsion of circular shafts, Shear stress due to torsion, Polar modulus, Power transmission

List of Experiments:

(Note: Minimum 8 experiments are to be performed)

1. Tensile strength test on universal testing machine.
2. Compressive strength test on universal testing machine.
3. Impact test on Impact testing machine.

4. Hardness testing on Vicker/Brinell hardness testing machine.
5. Stiffness test on spring testing machine.
6. Study of two stroke engine model.
7. Study of four stroke engine model.
8. Deflection on bending of simple supported and cantilever beams.
9. Determination of COP of vapour absorption system.
10. Determination of COP of vapour compression refrigeration system.
11. Study of steam boilers model.
12. Study of domestic refrigerator

Textbooks and References:

1. Basic and Applied Thermodynamics-P. K. Nag (Tata McGraw Hill)
2. Basic Thermodynamics- Cengel(Tata McGraw Hill).
3. Applied Thermodynamics-Onkar Singh (New Age International)
4. Material Science-V. Raghvan (Prentice Hall India Limited)
5. Elements of Materials science and Engineering-Van Vlash (Jhon Wiley & Sons)
6. Mechanical Measurement-G. Beckwith Thomas (Narosa Publishing House)
7. Mechanical Measurement – Sirohi (New Age Publications)
8. Strength of Materials-S. Ramamurtham (Dhanpat rai Publishing Co.)
9. Strength of Materials-R. K. Rajput (S. Chand)

BEE-256 : Fundamentals of AC Electrical Machines

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, practical work, record, viva voce, 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. Ability to learn basic concept of design, working & performances of three phase Synchronous Generator.
2. Ability to solve theoretical & numerical problems related to three phase Synchronous Generator.
3. Ability to learn basic concept of design, working & performances of three phase Synchronous Machines as Motors.
4. Ability to solve analytically numerical problems related to three phase Synchronous Motors.
5. Ability to know constructional details, working principle & Performances of Single-Phase Electric Motors
6. Ability to understand working, operating characteristics & applications of Single-phase Electric Motors

Topics Covered

UNIT-I **(9hrs)**

Synchronous Generator

Constructional features, types of Synchronous Generator, EMF Equation, Armature reaction, O. C. & S. C. tests, Voltage Regulation and its calculations by different methods, Parallel Operation of synchronous generators, synchronization of Synchronous generators, synchronizing power and torque coefficients, concept of X_d, and X_q. Two Reaction Theory, Power flow equation of Synchronous Generators.

UNIT-II **(9hrs)**

Synchronous Motor Synchronous Motor**,** power flow and torque equation, Effect of varying field current at different loads, V- Curves, Hunting, damper windings, synchronous condenser, applications of synchronous motor. Power flow equations of Synchronous Motor. Concept of Permanent Magnet Synchronous Motor (PMSM)

UNIT-III **(9hrs)**

Three phase Induction Motor

Constructional features, rotating magnetic field, working principle, Phasor diagrams, equivalent circuits, torque and power equations, Torque- slip characteristics, no load & blocked rotor tests, losses, efficiency, starting methods, various speed control techniques, Deep bar and double cage Induction Motors, Cogging & Crawling effects, doubly fed Induction Motor.

UNIT-IV **(9hrs)**

Single phase Electric Motors

Single-phase Induction motors, construction & working, equivalent circuits, no load and blocked rotor tests, starting methods, Shaded pole motors, Repulsion motor, Reluctance motor, Hysteresis motor, A.C. series motor, Universal motor

EXPERIMENTS

1. To perform no load and blocked rotor tests on a three-phase squirrel cage induction motor and determine equivalent circuit.
2. To perform load test on a three-phase induction motor and draw: Torque -speed characteristics
3. To perform no load and blocked rotor tests on a single-phase induction motor and determine equivalent circuit parameters and efficiency.
4. To study speed control of three phase induction motor by (i) pole changing (ii) supply voltage and (iii) frequency control method
5. To study speed control of three phase slip ring induction motor by rotor emf injected method.
6. To perform open circuit and short circuit tests on a three-phase alternator and determine voltage regulation at full load and at unity, 0.8 lagging by (i) Synchronous Impedance method and (ii) MMF method.
7. To perform V-curves and inverted V-curves of a three-phase synchronous motor.
8. To determine X_d and X_q of a three-phase salient pole synchronous machine using the slip test and draw the power-angle characteristics.
9. To study synchronization of an alternator with the infinite bus by using
   (i) dark lamp method

(ii) two bright and one dark lamp method.

10. To study speed-torque characteristics of three phase slip ring induction motor and effects of additional resistance, or capacitance in the rotor circuit.
11. To study VSI based slip power recovery scheme of three phase induction motor
12. To study performances of three phase Induction Generator.

Text Books

1. D.P. Kothari & I.J. Nagrath, "Electric Machines", Tata McGraw Hill
2. Ashfaq Hussain "Electric Machines" Dhanpat Rai & Company, New Delhi
3. U.A Bakshi, M.V Bakshi, "Electromechanical Energy Conversion-II, Technical Publications Pune.

Books & References

1. P.S. Bimbhra, "Electrical Machinery", Khanna Publishers
2. P.S. Bimbhra, "Generalized Theory of Electrical Machines", Khanna Publishers
3. M.G. Say, "Alternating Current Machines", Pitman & Sons
4. Fitzerald, A.E., Kingsley and S.D. Umans "Electric Machinery", McGraw Hill.

BEE-257 Microprocessor

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, practical work, record, viva voce, one Minor test and one Major Theory & Practical Examination.

Course Objectives

The students should be able to use and apply:
1. The hardware knowledge of 8085 microprocessor
2. The programming skill on 8085 microprocessor-based applications along with peripheral interfaces
3. The knowledge on intel 8086 microprocessor architecture and operation.

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

1. Microcomputer systems and its associated hardware
2. Detailed architecture of the Intel 8085microprocessor.
3. Operation and control, instruction set and interrupts of the microprocessor
4. Assembly language programming with the 8085 microprocessors
5. Intel 8255 and 8254 peripheral interfaces
2. Architecture and operation of the intel 8086 microprocessor

Topics Covered

UNIT-I

Introduction to Microcomputer Systems and Hardware: History of Computers, Computer Languages, Large computers to Single-Chip-Microcomputers, Evolution of Microprocessors, Microprocessor Architecture and Its operations, memory, Input/Output, Interfacing Devices. **(9hrs)**

Intel 8085 Microprocessor: Pin configuration, internal architecture, control and status signals, interrupts, bus timings, de-multiplexing of address bus, generating control signals, ALU, Flag register.

UNIT-II **(9hrs)**

Operation and Control of Microprocessor: Decoding and executing an instruction, op-code fetch machine cycle, memory read/write machine cycles, I/O read/write machine cycles, interrupt acknowledge machine cycle, state-transition diagram.

Instruction Set: Addressing modes; Data transfer, arithmetic, logical, branch, stack and machine control groups of instruction set, macro-RTL and micro RTL flow chart of few typical instructions; unspecified flags and instructions.

Interrupts: Interrupt structure of 8085 microprocessor, processing of vectored and non-vectored interrupts, latency time and response time; handling multiple interrupts.

UNIT-III **(9hrs)**

Assembly Language Programming for 8085 microprocessor Assembler directives, simple examples; Subroutines, parameter passing to subroutines, programming techniques with looping, counting and indexing, counter and timing delays.

Programmable Peripheral Interface: Intel 8255, pin configuration, internal structure of a port bit, modes of operation, bit SET/RESET feature.

Programmable Interval Timer: Intel 8253/8254, pin configuration, internal block diagram of counter and modes of operation, counter read methods.

UNIT-IV **(9hrs)**

16-bit Microprocessor: Architecture of Intel 8086 (Bus Interface Unit, Execution Unit), register organization, memory addressing, memory segmentation, operating modes, addressing modes, instruction set, hardware and software interrupts, responses and types

Experiments

Perform at least any ten experiments from the following:

1. To become familiar with 8085 microprocessor training kit/Software Simulator and execute following programs.
   - Add two 8 bit numbers stored in register B & C store result in register D.
   - Subtract 8 bit data stored at memory location 4021h from data stored at memory location 4020h. Store result at memory location 4022h.
   - To perform OR operation between accumulator and register B. Store result in register C.
2. To become familiar with 8085 microprocessor simulator and simulate following programs using simulator
   - Write a program to interchange content of register B and C
   - Subtract content of register E from register B.
   - Complement content of accumulator and display result on output port PORT2.
   - Perform logical OR operation between register B and C, logical AND operation between accumulator and register B.
3. Write a program to transfer set of data from memory location 2050-205Fh to 2060-206Fh
4. Write a program to find smallest number from given set of data stored at location 2040h to 205Fh
5. Write a program to find negative numbers in given set of data stored at the location 2050h to 205Fh
6. Write program to arrange an array of data in ascending order
7. Write a program to multiply two 8 bit numbers stored at the location 2100 and 2101. Store result at memory location 2102h

8. Write program to divide 16 bit number stored at memory location 2100h and 2101h by 8 bit number stored at memory location 2102h. Store the quotient in memory locations 2110h and 2111h, remainder at memory location 2112h.
9. Write a program to convert hexadecimal number into equivalent BCD number
10. Write a program to check parity of data stored at memory location 2100. Move content EEh to register B, if parity is even and 00h if parity is Odd.
11. To interface Programmable peripheral interface (PPI) IC-8255 with 8085 Microprocessor in Mode 0.
12. To generate square wave on port pin PC7 of 8255 in BSR mode.

Text Books:

1. Gaonkar, Ramesh S, "Microprocessor Architecture, programming and applications with the 8085" Pen ram International Publishing 5th Ed.
2. Uffenbeck, John, "Microcomputers and Microprocessors" PHI/ 3rd Edition.
3. Ray, A.K. &Burchandi, K.M., "Advanced Microprocessors and Peripherals: Architecture, Programaming and Interfacing" Tata Mc. Graw Hill.
4. Krishna Kant, "Microprocessors and Microcontrollers" PHI Learning.

Reference Books:

1. Brey, Barry B. "INTEL Microprocessors" Prentice Hall (India)
2. Aditya P. Mathur, "Introduction to Microprocessor" Tata McGraw Hill
3. M. Rafiquzzaman, "Microprocessors- Theory and applications" PHI
4. B. Ram, "Advanced Microprocessor & Interfacing" Tata McGraw Hill
5. Renu Singh &B.P.Singh, "Microprocessor and Interfacing and applications" New Age International
6. Hall D.V., "Microprocessors Interfacing" Tata McGraw Hill
7. Liu and Gibson G.A., "Microcomputer Systems: The 8086/8088 Family" Prentice Hall (India)

BEE-258 Network Analysis and Synthesis

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, assignments, practical work, record, and viva-voce, and two minor tests and one major theory examination, and one major practical examination
Course Outcomes	:	After completing this course, the students are expected to be able to demonstrate the knowledge, skills and attitudes as following 1. Able to apply the network theorems for D.C. and A.C. networks. 2. Able to analyse two-port networks. 3. Able to understand the concept of graph theory and its applications. 4. Able to understand the concept of network functions and their characteristics. 5. Able to synthesize two-elements (L-C, R-C, and R-L) networks. 6. Able to understand the basic concepts of filters and their applications.

Topics Covered

UNIT-I **(9hrs)**

Network Theorems:

Fundamentals to network analysis, Thevenin's theorem, Norton's theorem, Superposition theorem, Maximum Power Transfer theorem, Reciprocity theorem, Compensation theorem,

Substitution theorem, Millman's theorem, and Tellegen's theorem. Problems with ac and dependent sources.

UNIT-II **(9hrs)**

Two Port Networks:

Characterization of LTI two port networks, two port network parameters, Z, Y, ABCD, A'B'C'D', h and g parameters, reciprocity and symmetry. Inter-relationships between the network parameters, inter-connections of two port networks, ladder and lattice networks, T & Π representation of networks.

UNIT-III **(9hrs)**

Introduction to Graph Theory:

Introduction to graph theory and applications; network graph, definitions, tree, co-tree, link, basic loop and basic cut set, incidence matrix, tie set matrix, and cut set matrix; duality, mesh and nodal analysis using network graph.

Network Functions:

Concept of complex frequency, transform impedances, network functions of one-port and two-port networks, concept of poles and zeros, properties of driving point and transfer functions, basics of time response and stability from pole zero plot.

UNIT-IV **(9hrs)**

Network Synthesis:

Fundamentals to network synthesis; Positive real function, definition and properties; properties of LC, RC and RL driving point functions; Foster first and second forms, and Cauer first and second forms of network realizations; synthesis of LC, RC and RL driving point immittance functions.

Introduction to Filters:

Introduction to filters, basic concepts, types, and applications.

List of Experiments:

(Note: Minimum 8 experiments are to be performed**)**

1. Verification of Thevenin's Theorem.
2. Verification of Norton's Theorem.
3. Verification of Superposition Theorem.
4. Verification of Maximum Power Transfer Theorem.
5. Verification of Reciprocity Theorem.
6. Verification of Tellegen's Theorem.
7. To determine Z and Y parameters of a T two-port network.
8. To determine ABCD parameters of a π two-port network.
9. To measure input impedance and output impedance of a two-port network.
10. Verification of network parameters properties for a cascade connected two-port networks.
11. To perform T-π, and Star-Delta Transformations.
12. To plot frequency response of a series resonant circuit using MATLAB.
13. To plot frequency response of a parallel resonant circuit using MATLAB.
14. To synthesize a RC network for a given driving point function.

Textbooks:

1. M.E. Van Valkenburg, "Network Analysis", Prentice Hall of India.
2. D. Roy Choudhary, "Networks and Systems", Wiley Eastern Ltd.
3. C.L. Wadhwa, "Network Analysis and Synthesis", New Age International Publishers, 2007.
4. A. Chakrabarti, "Circuit Theory", Dhanpat Rai & Co.

Books & References

3. Donald E. Scott: "An Introduction to Circuit analysis: A System Approach", McGraw Hill Pub.
4. M.E. Van Valkenburg, "An Introduction to Modern Network Synthesis", Wiley Eastern Ltd.
5. N.C. Jagan and C. Lakshminarayana, "Network Analysis" B.S. Publications, 2008.
6. K.S. Suresh Kumar, "Electric Circuits and Networks" Pearson Education, 2009.
7. A. Ramakalyan, "Linear Circuits: Analysis and Synthesis" Oxford University Press, 2005.

EEE-101	**Linear Programming for Optimization**
Course Category	**:** Professional Elective (PE)
Pre-requisites	**:** NIL
Contact Hours/Week	**:** Lecture: 3, Tutorial: 0, Practical: 2
Credits	**:** 4
Course Assessment Methods	• Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test • Final Evaluation: One Major Theory Examination, Lab/Practical Examination
Course Outcomes (COs)	: The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Understand fundamental concepts of Matrix algebra, matrices, determinants, and linear transformations**.**
2. Apply matrix operations, eigenvalues, eigenvectors to solve systems of linear equations and Formulating LP Problems.
3. Formulate real-world optimization problems using linear programming (LP) techniques.
4. Solve LP problems using graphical and simplex methods and its application in industry/electrical system
5. Analyse the effect of changes in system parameters using duality and sensitivity analysis in linear programming problems.
6. Apply linear programming techniques to solve practical industrial and electrical engineering problems such as production planning, transportation, and power flow optimization.

Topics Covered

UNIT-I Matrix Algebra for Optimization (9hrs)

Vectors, Matrices, and Matrix Operations, Rank, Determinants, and Inverse Matrices, Eigenvalues/Eigenvectors & Positive Definite Matrices, Solving Linear Systems (Gauss Elimination, LU Decomposition)

UNIT-II Introduction to Linear Programming (LP) (9hrs)

Formulating LP Problems (Objective Functions, Constraints), Graphical Method for 2-Variable LP, Standard & Canonical Forms of LP, Duality & Economic, Interpretation of Dual Variables

UNIT-III Simplex Method & Sensitivity Analysis (9hrs)

Simplex Algorithm (Tableau, Pivoting, Optimality Conditions), Big-M & Two-Phase Simplex Methods, Sensitivity Analysis (Shadow Prices, Range of Optimality), Degeneracy & Unbounded Solutions

UNIT-IV Applications of LP in Industry/Electrical Systems (9hrs)

Production Planning & Resource Allocation, Transportation & Assignment Problems, Optimal Power Flow (DC Approximation), Network Flow Optimization (Shortest Path, Max Flow)

List of Experiments (Minimum 8 experiments are to be performed)

1. To Find the rank of a given matrix.
2. To Compute determinant and inverse of a square matrix.
3. To Find eigenvalues and eigenvectors of a matrix.
4. To Check whether a matrix is positive definite.
5. To Perform LU decomposition of a matrix.
6. To find Matrix Operations and Solving Linear Equations
7. To find Graphical Solution of a 2-Variable Linear Programming Problem
8. To Solve a Linear Programming Problem
9. To perform Simple Sensitivity Test – Change RHS Value and Compare
10. To find Simple Resource Allocation Problem

Books & References

1. B V. Ramana: Numerical Methods for Engineers and Scientists; (McGraw Hill)
2. J. K. Sharma: Operations Research: Theory and Applications; (Macmillan)
3. K. B. Datta : Matrix Algebra for Engineers – (PHI Learning)
4. Qingkai Kong, Timmy Siauw, Alexandre Bayen: Practical Optimization with Python (Cambridge University Press)
5. Dimitris Bertsimas and John N. Tsitsiklis: Introduction to Linear Optimization – (Athena Scientific)

EEE-102	**Fundamentals of Power Electronics**
Course Category	**:** Professional Elective (PE)
Pre-requisites	**:** NIL
Contact Hours/Week	**:** Lecture: 3, Tutorial: 1, Practical: 0
Credits	**:** 4
Course Assessment Methods	• Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test • Final Evaluation: One Major Theory Examination
Course Outcomes (COs)	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1) Explain the characteristics, ratings, and applications of **power semiconductor devices**
2) Analyze and explain the operation and performance of uncontrolled AC–DC converters.
3) Analyze and explain the operation and performance of controlled AC–DC converters.
4) Analyze and explain the **controlled DC–DC converters** in continuous and discontinuous modes.
5) Explain the operation and performance of **DC–AC inverters** using PWM techniques.
6) Apply **harmonic reduction and protection techniques** in inverter systems.

Topics Covered

Unit I: Introduction to Power Semiconductor Devices (9hrs)

Introduction of power electronics converter, power semiconductor devices, control characteristics of power devices, characteristics and specification of switches, Characteristics of SCR, MOSFET, IGBT, GTO, device ratings and switching characteristics, Turn-on and turn-off methods for SCR. Gate drive and snubber circuits, Heat sinking and thermal design of devices, Comparison of device types and switching speed

Unit II: (9hrs)

Un-Controlled DC supply: Diode circuit with DC Source, Single phase diode rectifier (half and full operation), operating principle for R, R-L load and Freewheeling diode for half and full conversion operation, performance parameters for Un-Controlled DC supply, Applications of Un-Controlled DC supply.

Unit III: (9hrs)

Controlled AC-DC supply: Introduction of Controlled AC-DC supply, types of Controlled AC-DC supply, Single-phase half and full controlled DC supply, Performance parameters: power factor, and THD, Controlled converter waveforms and analysis, three phase controlled DC supply, Applications of Controlled Rectifier,

Controlled DC-DC supply: Introduction of Controlled DC-DC supply, Types of Controlled DC-DC supply, and operation of Step-down Controlled DC-DC supply, Step-up Controlled DC-DC supply**,** Continuous and discontinuous modes of operation, Efficiency analysis and performance comparison, Applications of Controlled DC-DC supply.

Unit IV: DC-AC Supply (9hrs)

DC-AC Inverters: Introduction and types of Controlled DC-AC supply, Single-phase and three-phase bridge inverters, PWM Controlling techniques, Harmonic reduction methods, Current source inverters (CSI), Overmodulation and inverter protection, Applications of single-phase and three-phase inverters.

Books & References

1. **M. H. Rashid**, *Power Electronics: Circuits, Devices and Applications*, Pearson Education
2. **Ned Mohan, Tore M. Undeland, William P. Robbins**, *Power Electronics: Converters, Applications, and Design*, Wiley
3. **P. S. Bimbhra**, *Power Electronics*, Khanna Publishers

EEE-103		**Modelling And Simulation Techniques**
Course Category	:	Professional Elective (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial:0, Practical: 2
No of Credits	:	4
Course Assessment Methods	:	Continuous assessment will be carried out through tutorials, practical work, attendance, home assignments, quizzes, one minor test, one major theory examination, and a practical examination.
Course Objectives	:	Study of system behavior using mathematical models and computer simulations to analyze, predict, and optimize real-world dynamic processes.
Course Outcome	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

1. Understand basic concepts and classification of modelling and simulation.
2. Apply simulation steps, estimation, and validation techniques.
3. Analyze dynamic response of first- and second-order systems.

4. Develop system models using transfer function and state-space methods.
5. Simulate systems using MATLAB and Simulink tools.
6. Apply parameter estimation and system identification techniques

Topics Covered

Unit I: Introduction to modelling and simulation (9hrs)

Modelling: Model classification, Mathematical, physical, and analog models, Basic of Estimation, Experimental nature of simulation, steps involved in simulation studies, computer simulation of continuous & discrete systems.

Unit II: Dynamic Response (9hrs)

Dynamic response of 1st order system and 2nd order system, performance measures for 2nd order system, system transfer function, transfer function of 1st and 2nd order system Block diagram algebra, signal flow diagram, state variable formulation, frequency & time domain analysis and bode plots.

Unit III: Simulation Techniques (9hrs)

MATLAB & Simulink, Modelling and Simulation of electrical systems, Selected tool boxes for electrical systems, verification, and validation of simulation model.

Unit IV: Parameter Estimation & system Identification (9hrs)

Introduction to System Identification and Parameter Estimation, Time Domain Functions, Open and Closed Loop Systems, SISO systems, Multivariable systems, Linear and nonlinear Models, Estimation of Model Parameters, least squares method, Recursive least squares method, Kalman filter.

List of Experiments: (Minimum 8 experiments are to be performed)

1. To study about arithmetic, algorithm, exponential & trigonometric function & operation.
2. To study about algebraic, relational, logical function & operation using variables and arrays.
3. To study matrix formation and its manipulation.
4. To study about two dimensional Plots, multiple plots and subplots.
5. To plot a circle, impulse, unit step, ramp, functions.
6. To generate the continuous and discrete time signal.
7. To study the dynamic response of a first-order system to unit-step, ramp, impulse and sinusoidal inputs.
8. To study and analyze the dynamic (time-domain) response of a second-order system for a unit-step input.
9. To study and analyze the dynamic (time-domain) response of a second-order system for a unit-step input.
10. To convert the transfer function of a system into state space form and vice-versa.
11. To draw a Bode diagram of the transfer function.
12. To study the transient analysis of RLC, RL and RC circuits for sinusoidal and step inputs.

Textbooks:

1. Programming with MATLAB for Scientists: A Beginner's Introduction, E. Mikhailov Eugeniy, CRC Press; 1st edition, February 2, 2018.
2. MATLAB an Introduction with Applications, Rao V. Dukkipati, New Age International Publisher.
3. MATLAB for Engineers, Holly Moore, Pearson, 5th Edition, 2018
4. MATLAB: A Practical Introduction to Programming and Problem Solving, Stormy Attaway, Butterworth-Heinemann, 4th Edition, 2018
5. Essential MATLAB for Engineers and Scientists, Brian Hahn and Daniel T. Valentine, Academic Press, 6th Edition, 2016

EEE-104	**Power Electronics Systems and Grid Integration for Electric Vehicles**
Course Category	Professional Elective (PE)
Pre-requisites	NIL
Contact Hours/Week	Lecture: 3, Tutorial: 1, Practical: 0
Credits	4
Course Assessment Methods	• Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test • Final Evaluation: 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:

CO1: Select and analyze semiconductor devices for EV systems.

CO2: Design and analyze AC–DC and DC–DC converters, including isolated and non-isolated topologies.

CO3: Implement and tune control algorithms in both analog and digital domains.

CO4: Integrate power electronics into EVs, renewable systems, and smart grid infrastructure.

CO5: Design, simulate and evaluate single-phase and three-phase inverter systems.

CO6: Integrate power electronic converters and control techniques into electric vehicles, renewable energy systems

Topics Covered

Unit I: (9hrs)

Power Semiconductor Devices and Converters: Characteristics and operation of SCR, MOSFET, IGBT, GTO, Turn-on/turn-off techniques, device ratings, and switching characteristics, Gate drive circuits and snubber design, Single-phase and three-phase controlled rectifiers, Buck, Boost, Buck-Boost, and Cuk DC-DC converters, Isolated topologies: Flyback and Forward converters

Unit II: (9hrs)

Inverters and Advanced Power Converter Topologies: Single-phase and three-phase DC-AC bridge inverters, PWM techniques: Sinusoidal PWM and Space Vector PWM, Harmonic reduction and current source inverters (CSI), Multilevel inverter topologies: Diode-clamped, Flying capacitor, CHB, Resonant converters: Series, Parallel, LLC and soft-switching (ZVS, ZCS), Matrix and Modular Multilevel Converters (MMC): Principles and applications

Unit III: (9hrs)

Control and Modulation in Power Converters: Classical control techniques: PI, PID, PR controllers, Voltage and current loop design with stability analysis, Digital control: PWM generation, ADC sampling, DSP/microcontroller implementation, Dead-time and delay compensation, Modulation strategies: Carrier-based PWM, SVM, multicarrier PWM, Control of resonant, bidirectional, and isolated converters; PFC techniques

Unit IV: (9hrs)

Applications in EVs, Renewables, and Smart Technologies: Power electronics in electric vehicle drive-trains and converter design, Battery charging systems and regenerative braking in EVs, Renewable energy

interface: Grid-connected PV, wind, MPPT algorithms, VFDs, soft starters, and servo drive applications in industrial automation, Power electronics in smart grids, distributed generation, and SSTs, IoT-enabled converters, cloud-based monitoring, and EV-grid integration

Books & References

1. Muhammad H. Rashid, "Power Electronics: Circuits, Devices and Applications, 4th Edition, Pearson Education, ISBN: 978-9332542603 (Indian Edition).
2. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
3. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.
4. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
5. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.

EEE-201	**: Power Generation Engineering**
Course Category	**:** Professional Elective (PE)
Pre-requisites	**:** NIL
Contact Hours/Week	**:** Lecture: 3, Tutorial: 1, Practical: 0
Credits	**:** 4
Course Assessment Methods	• Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test • Final Evaluation: One Major Theory Examination
Course Outcomes (COs)	: The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Compare generation systems using load curves, capacity factor, and plant location criteria.
2. Analyze thermal/nuclear plant performance, reactor types, and waste disposal metrics.
3. Evaluate hydro/diesel plants using turbine efficiency, fuel consumption rates, and emission levels.
4. Design hybrid systems with storage applications, peak shaving, and LCOE (Levelized Cost).
5. Analyze the environmental and economic impacts of different power generation technologies, including emissions, efficiency, and sustainability aspects
6. Apply power generation concepts to real-world case studies involving microgrids, hybrid systems, and net-zero energy initiatives.

UNIT-I Introduction to Power Generation Systems (9hrs)

Generation systems, Overview of electric power generation – Centralized Vs. Distributed generation system, Classification of power plants: Thermal, Hydro, Nuclear, Factors affecting power plant location and selection, Load curves, Base load and Peak load, Load factor, Capacity factor, Diversity factor ,Structure of power Generation, Transmission and Distribution.

UNIT-II Thermal and Nuclear Power Plants (9hrs)

Thermal power plants: Working Principle, Boiler types, Turbines, Condensers, Cooling towers, Fuel handling and ash disposal systems, nuclear power plants, Nuclear Fission, Reactor types, Waste disposal, Advantages, and limitations Comparison with Thermal and Hydro Plants.

UNIT-III Hydro and Diesel Power Plants (9hrs)

Hydroelectric power plants, Classification: Run-of-River, Pumped storage, Reservoir-based, Turbines, Efficiency considerations, Environmental and social impact, Diesel power plants, Fuel System, Standby and Remote Power Supply and its Limitations

UNIT-IV Emerging Trends & Hybrid Systems **(9hrs)**

Hybrid power systems, Concept, and advantages of hybrid Power Systems (Solar, Wind, Battery), Design principles, Case studies of Microgrids and Hybrid Systems in remote area, Load Balancing, Peak Shaving aspects and working, Future trends of Power Generation, Carbon Capture and Storage (CCS), Net-Zero Initiatives

Books & References

1. Power Plant Engineering – P.K. Nag– Nagrath & Kothari (McGraw Hill)
2. Non-Conventional Energy Sources – G.D. Rai (Khanna Publishers)
3. Electric Power Generation, Transmission and Distribution – Leonard L. Grigsby (Oxford University Press)
4. Energy Storage for Power Systems – A.G. Ter-Gazarian(IET)
5. Renewable Energy: Power for a Sustainable Future – Stephen Peake & Ellie Highwood (Oxford University Press)

EEE-202	**: Fundamentals of Electric Vehicles**
Course Category	**:** Professional Elective (PE)
Pre-requisites	**:** NIL
Contact Hours/Week	**:** Lecture: 3, Tutorial: 1, Practical: 0
Credits	**:** 4
Course Assessment Methods	• Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test • Final Evaluation: One Major Theory Examination
Course Outcomes (COs)	: The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Understand the basic architecture, components, and advantages of electric vehicles.
2. Analyse vehicle dynamics and performance estimation methods.
3. Compare various EV and hybrid configurations.
4. Interpret Indian and international EV policies and standards.
5. Explain the basic concepts, evolution, and significance of electric and hybrid vehicles in the context of sustainable transportation.
6. Interpret thermal management techniques, safety considerations related to electric vehicle systems.

Topics Covered

Unit I: **(9hrs)**

Basics of E-Mobility: Introduction to Electric and Hybrid Vehicles, significance and need of sustainable transportation, Historical evolution and classifications, Working Principle, interconnections, and operational characteristics of EV components: motor, controller, battery, charger, Advantages, and limitations of EVs

Unit II: **(9hrs)**

Vehicle Dynamics: Basic understanding of vehicle dynamics, Newton's laws of motion for ground vehicles, importance of traction, stability, and response during motion. Principles of vehicle dynamics, different resistive forces: Aerodynamic, rolling, and gradient resistance. Tractive effort and power requirement, Driving cycles and range estimation

Unit III: (9hrs)

EV Architectures: Series, parallel, and series-parallel hybrid configurations, Plug-in Hybrid EVs (PHEVs), Electric drivetrain design considerations, Energy flow and efficiency

Unit IV: (9hrs)

Thermal Management and Safety in EVs: Importance of thermal management in EVs, Battery and power electronics cooling techniques, Safety issues in EV design, Standards for thermal and electrical safety in EV systems

Books & References

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.

EEE-203		**Scientific And Engineering Computation**
Course Category	:	Professional Elective (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 2, Tutorial:1, Practical: 2
No of Credits	:	4
Course Assessment Methods	:	Continuous assessment will be carried out through tutorials, practical work, attendance, home assignments, quizzes, one minor test, one major theory examination, and a practical examination.
Course Objectives	:	This course provides the knowledge and understanding to handle research projects using numerical techniques and to solve differential equations through computational methods.
Course Outcome	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

1. Understand the need for simulation and implementation for the verification of mathematical functions.
2. Gain familiarity with the features of a numerical computing environment to support higher-level learning.
3. Implement simple mathematical functions and equations using computational tools.
4. Interpret and visualize mathematical functions and operations through graphical plots and displays.
5. Analyze programs for correctness, estimate or predict outputs, and verify them in a simulation environment.
6. Solve ordinary differential equations using appropriate numerical methods.

Topics Covered

Unit I (6hrs)

Introduction to numerical computing, error estimation, root-finding methods, and the order of convergence of various techniques.

Unit II (6hrs)

Solving System of Linear Algebraic equations, Continuing Solving System of Linear Algebraic equations, Curve fitting and Interpolation.

Unit III (6hrs)

Continuing Curve fitting and Interpolation, Continuing Curve fitting and Interpolation, Numerical differentiation.

Unit IV **(6hrs)**

Numerical Integration, Numerical solution to ordinary differential equations (ODE's), Continuing with numerical solution to ODE's.

List of Experiments:

1. Study the usefulness of numerical computing toolboxes.
2. Perform mathematical operations using computational software.
3. Perform logical operations using computational software.
4. Explore the application of simulation models.
5. Study optimization toolboxes and their applications.
6. Determine the roots of a polynomial.
7. Determine polynomial coefficients using the method of least squares curve fitting.
8. Analyze polynomial fitting, residuals, exponential fitting, and error bounds from given data.
9. Solve differential equations using the 4th order Runge-Kutta method.
10. Solve differential equations using the revised Euler method.
11. Develop simulation models to analyze electrical networks.
12. Demonstrate feedback control systems using simulation models.

Textbooks:

1. Programming with MATLAB for Scientists: A Beginner's Introduction, E. Mikhailov Eugeniy, CRC Press; 1st edition, February 2, 2018.
2. MATLAB An Introduction with Applications, Rao V. Dukkipati, New Age International Publisher.
3. MATLAB for Engineers, Holly Moore, Pearson, 5th Edition, 2018
4. MATLAB: A Practical Introduction to Programming and Problem Solving, Stormy Attaway, Butterworth-Heinemann, 4th Edition, 2018
5. Essential MATLAB for Engineers and Scientists, Brian Hahn and Daniel T. Valentine, Academic Press, 6th Edition, 2016

Skill-Based Courses to Qualify for UG Diploma (Engg.) in Electrical Engineering

BEE-262 **Integrated Electrical Systems**

Course Category	:	Skill Development
Mode	:	Theory +Practical
Contact hours/week	:	Lecture: 2, Tutorial:0, Practical: 2
No of Credits	:	3
Course Assessment Methods	:	Continuous assessment will be carried out through tutorials, practical work, attendance, home assignments, quizzes, one minor test, one major theory examination, and a practical examination.
Course Objectives	:	• To provide foundational knowledge in power electronics, power systems, control systems, and electrical measurements. • To familiarize students with the essential components and functioning of integrated electrical systems in practical environments. •

To develop basic analytical and troubleshooting skills across different electrical subsystems.

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

- Understand the principles and applications of power electronic devices.
- Describe the basic structure and operation of electric power systems.
- Understand basic control theory and its applications in electrical systems.
- Operate and interpret readings from standard electrical measuring instrument

Topics Covered

Unit I **(6hrs)**

Basics of Power Electronics

Introduction to Power Electronics and its applications, Overview of Semiconductor Devices: Diodes, SCR, TRIAC, MOSFET, IGBT, Rectifiers (Half wave, Full wave, Bridge) – working and waveforms, Basics of Inverters and Converters.

Unit II **(6hrs)**

Basics of Power System

Introduction to Electrical Power Generation (Thermal, Hydro, Nuclear, Solar),Transmission & Distribution – basic structure and components, Single Line Diagram of Power System, Types of Substations.

Unit III **(6hrs)**

Basics of Control System Introduction to Control Systems – Open Loop & Closed Loop.

Block Diagram Representation of Control Systems, Transfer Function and Feedback, Application of Control Systems in Electrical Engineering.

Unit IV **(6hrs)**

Smart Energy Meter & Transducers

Basics of Energy Metering • Concept of energy metering (kW, kWh, units),Single-phase vs. three-phase energy meter, Smart Energy Meters , Features of smart meters, Advantages over traditional meters ,Electrical Transducers(Definition, classification and applications), Difference between sensor, transducer and pick-ups,Special Transducers

List of Experiments:

1. Study and Characteristics of Power Semiconductor Devices
2. Single Phase Full-Wave Bridge Rectifier using SCRs at various firing angles.
3. Study of Various Protection Devices. 52
4. Circuit Breaker, Fuse, Isolator (Demonstration or simulation-based).
5. Study of Open Loop and Closed Loop Systems.
6. Working of overcurrent /Undervoltage relay 7. Measurement of non-electrical parameters using transducers

Textbooks:

1. Power Electronics – P.S. Bhimbra / M.H. Rashid
2. Power System Engineering – I.J. Nagrath & D.P. Kothari
3. Control Systems Engineering – Nagrath & Gopal / Benjamin C. Kuo
4. A Course in Electrical and Electronic Measurements and Instrumentation – A.K. Sawhney
5. Basic Electrical Engineering – V.K. Mehta & Rohit Mehta

Third Year

BMS-302/352	**:**	**Engineering Economics and Financial 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 TheoryExamination
Course Objective		Enable students to understand the fundamental economic concepts applicable to engineering.
Course Outcomes (COs)	:	1. Students should be able to acquire foundational knowledge of Engineering Economics and Financial Management and understand their relevance to engineering decision-making. 2. Students should be able to develop theoretical and empirical skills to analyze economic and financial data for managerial decisions. 3. Students should be able to demonstrate a basic understanding of microeconomics. 4. Students should be able to analyze demand and elasticity in engineering projects 5. Students should be able to compare market structures and infer pricing/output strategies. 6. Students should be able to apply time value of money, assess risk-return, and evaluate investments using capital budgeting technique including risk adjustments..

Topic Covered

Unit-1

Introduction to Engineering Economics: Nature and Scope of Engineering Economics, its integration with other streams.

Demand Analysis: Concept of Demand & its determinants. Price, Income, Substitution Effect, Elasticity of demand: Meaning, types, measurement and significance of engineering economics in managerial decisions..

Unit-2 **(9hrs)**

Cost: Various Cost Concept and Classification, Cost Output Relationship in short and Long run cost Curves, Economies and diseconomies of Scale.

Pricing: Nature of market, Types of markets and their characteristics, pricing under different market structures-Perfect, Monopoly, Oligopoly, and Monopolistic Competition in engineering industry.

Unit-3 **(9hrs)**

Introduction to Financial Management: Nature, scope and objectives of financial management related to engineering projects, Time value of money, Risk and Return, Profitability vs shareholders Wealth Maximization, Capitalization Concept.

Unit-4 **(9hrs)**

Capital Budgeting: The Capital Budgeting Process, Cash Flow Estimation for Engineering projects, Payback Period Method, Discounted Payback Period Method, Accounting Rate of Return, Net Present

Value, Net Terminal Value, Internal Rate of Return, Profitability Index.

Books & References

1. D. N Dwivedi, Managerial Economics, Vikas Publication.
2. H L Ahuja, Managerial Economics, S Chand & Co. New Delhi
3. I. M. Pandey, Financial Management, Vikas Publication & Pearson
4. R. P. Rustagi, Financial Management, Taxmann's
5. M Y Khan & P K Jain, Financial Management, McGraw Hill
6. Prof. D.N. Kakkar, Managerial Economics for Engineering, PHI publication, New Delhi

BEE-306	**: POWER SYSTEM-I**
Course Category	**:** Professional Core (PC)
Pre-requisites	**:** Electrical Circuits and Analysis
Contact Hours/Week	**:** Lecture: 3, Tutorial: 1, Practical: 0
Credits	**:** 4
Course Assessment Methods	• Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test • Final Evaluation: One Major Theory Examination
Course Outcomes (COs)	**:** The student is expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Comprehensive understanding of the structural framework and components of an electrical power system.
2. Understanding of the structure and operation of electrical supply systems.
3. Analysis of overhead transmission line performance and parameters.
4. Understanding of EHVAC & HVDC transmission lines.
5. Understanding of corona effects, insulation coordination, neutral grounding, and mechanical design of transmission lines.
6. Enhances understanding of mechanical and electrical transmission line design, along with neutral grounding principles, to ensure safe and reliable power system operation.

Topic Covered

UNIT I

Power System Components: (9hrs)

Single line Diagram of Power system, Brief description of power system Elements: synchronous machine, transformer, transmission line, bus bar, circuit breaker and isolator **Supply System:**

Different kinds of supply system and their comparison, choice of transmission voltage.

Transmission Lines:

Configurations, types of conductors, resistance of line, Kelvin‟s law, skin effect, Proximity effect.

UNIT II

Over Head Transmission Lines: (9hrs)

Calculation of inductance and capacitance of single phase, three phase, single circuit and double circuit transmission lines, Representation and performance of short, medium and long transmission lines, Ferranti effect, Surge impedance loading.

EHV AC and HVDC Transmission:
Introduction to EHV AC and HVDC transmission and their comparison, Use of bundle conductors, Kinds of DC links, and incorporation of HVDC into AC system.

UNITIII

Corona and Interference: (9hrs)
Phenomenon of corona, corona formation, calculation of potential gradient, corona loss, factors affecting corona, methods of reducing corona and interference. Electrostatic and electromagnetic interference with communication lines.

Overhead line Insulators:
Type of insulators and their applications, Potential distribution over a string of insulators, methods of equalizing the potential, String efficiency.

Insulated cables:
Type of cables and their construction, Dielectric stress, Grading of cables, Insulation resistance, Capacitance of single phase and three phase cables, Dielectric loss, Heating of cables.

UNITIV

Mechanical Design of transmission line: (9hrs)
Catenary curve, Calculation of sag & tension, Effects of wind and ice loading, Sag template, Vibration, Dampers.

Electrical Design of Transmission Line:
Design consideration of EHV transmission lines, Choice of voltage, Number of circuits, Conductor configuration, Insulation design, Selection of ground wires.

Neutral grounding:
Necessity of neutral grounding, Various methods of neutral grounding, Earthing transformer, Grounding practices.

Text Books

1. C.L. Wadhwa, "Electrical Power Systems", New Age International, 6th Edition, 2011.
2. S. N. Singh, "Electric Power Generation, Transmission and Distribution" PHI, Learning Pvt Ltd, 2009.
3. Ashfaq Hussain, "'Electrical Power Systems", CBS Publishers and Distributors, 5th Edition, 2023.

Reference Books

1. Soni, Gupta &Bhatnagar, "A Course in Electrical Power", Dhanpat Rai & Sons, 9th Edition, 1989.
2. S. L. Uppal & S.S. Rao, "Electric Power Systems", Khanna Publishers, 13th Edition, 1988.
3. B. R. Gupta, "Power System Analysis and Design" Third Edition, S. Chand & Co., 2005.
4. W.D. Stevenson, Jr. "Elements of Power System Analysis", McGraw Hill, 4th Edition, 1982.

BEE-307 : Control System Engineering
Course category : Professional Core (PC)
Pre- requisites : Nil
Contact hours/week : Lecture : 3, Tutorial :0, Practical :2
Number of Credits : 4
Course Assessment Methods : Continuous assessment through tutorials, assignments, attendance, quizzes, practical work, record, viva voce, One minor test, One Major Theory & Practical Examination.
Course Outcomes (COs) : The student are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course
The student will be able to demonstrate:

1. Apply the basic control systems engineering principles of modelling, analysis, and design to simple control systems.
2. Identify the various control system components and their representations.
3. Apply the concepts of various system stability criterions.
4. Analyze the various time domain parameters.
5. Apply the concepts of various system stability criterions.
6. Able to design compensators.

Topic Covered

UNIT I

Control System Introduction and Mathematical Modelling: (9hrs)

Open loop & closed control; servomechanism; Mathematical modelling of physical systems; Transfer functions, Block diagram algebra, Signal flow graph, Mason's gain formula, Reduction of parameter variation and effects of disturbance by using negative feedback.

UNIT II

Control System Components: (9hrs)

Constructional and working principles of AC & DC servomotors, stepper motor, and synchros, error detectors. Basic control actions: proportional (P), integral (I), derivative (D), and PID controllers.

Concept of Stability: Stability concepts, algebraic criteria, and necessary conditions, Routh-Hurwitz criteria, and limitations.

UNITIII

Time Response analysis: (9hrs)

Standard test signals, time response of first and second order systems, time response specifications, steady state errors and error constants.

Design specifications of second order systems: Derivative error, derivative output, integral error and PID compensations, design considerations for higher order systems, performance indices. Root Locus Technique: The root locus concepts, construction of root loci.

UNIT-IV

Frequency response Analysis: (9hrs)

Frequency response, correlation between time and frequency responses, polar and inverse polar plots, Bode plots.

Stability in Frequency Domain: Nyquist stability criterion, assessment of relative stability, gain margin and phase margin, constant M&N circles

List of Experiments

(Note: Minimum 8 experiments are to be performed**)**

1. Study Metaldyne cross-field generator. Determine its transfer function.
2. Determine transfer function of dc generator. Study behavior of dc generator in open loop and closed loop conditions at various loads.
3. Determine transfer function of dc motor. Study behavior of dc motor in open loop and closed loop conditions at various loads.
4. Study DC position control system and determine speed-torque characteristics of ac servomotor.
5. Study AC position control system and determine speed-torque characteristics of ac servomotor.
6. Study PID control using linear simulator unit and determine step input response of first order and second order systems.
7. Study synchros. Determine synchros-transmitter characteristics. Configure synchro-transmitter and synchro-control transformer unit as error detector and obtain output vs input characteristics.
8. Study stepper motor from its characteristics and applications point of view.

References:

1. I. J. Nagrath and M. Gopal, "Control System Engineering", 4th Edition, New age International.
2. M. Gopal, "Control Systems: Principles and Design", Tata McGraw-Hill Education, 2002.

3. K. Ogata, "Modern Control Engineering", Pearson Education, 4th Indian reprint.
4. B.C. Kuo and Farid Golnaraghi, "Automatic Control System" Wiley India Ltd, 2008.
5. D.Roy Choudhary, "Modern Control Engineering", Prentice Hall of India.
6. Ajit K. Mandal, "Introduction to Control Engineering" New Age International, 2006.

BEE-308 : **Power Electronics**

Course category : Professional Core (PC)
Pre- requisites : Nil
Contact hours/week : Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits : 4
Course Assessment : Continuous assessment through tutorials, assignments, Methods attendance, quizzes, practical work, record, viva voce ,One minor test ,One Major Theory & Practical Examination.

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

1.The working principle of various Power semiconductor devices.
2.The concept of phase-controlled converters.
3.The analysis of inverters in various configuration and elimination of harmonics.
4.The concepts of DC choppers, for various applications.
5.The concepts of AC voltage controllers for various applications.
6.The concepts of Cyclo converters for various applications

Topics Covered

Unit-I **(9hrs)**

Concept of Power Electronics and its devices:

Concept of Power Electronics Systems, Power Semiconductor Devices, their symbols, rating, Operation of Power Diode, Characteristics of Power diodes, Diode Recovery Characteristics, Thyristor's operation, Static I-V characteristics of Thyristor's, Thyristor's turn-on method, Switching characteristics of Thyristor during Turn-on and Turn-Off, Two transistor model of Thyristor, Thyristor's Protection, Design of Snubber circuits, Series operation of thyristors.

Unit-II **(9hrs)**

Modelling of DC-DC supply:

Principle of Chopper operation, Control Strategies: time ratio control, Current-limit control, And Step-down chopper, Step up chopper, Steady State Time domain analysis of chopper, Steady State Ripple, Types of chopper circuits: Type A chopper, Type B chopper, Type C chopper Type D chopper and Type E chopper, Multiple phase chopper.

Modelling of AC-AC Voltage Controllers:

Principle of on-off and phase control, Operation of single-phase AC Voltage Controller for Resistive load and Resistive with inductive loads.

Unit-III **(9hrs)**

Modelling of DC supply:

Principle of Phase control, Single Phase Half Wave Circuit With RL load, Single Phase Half Wave circuit With RL load with Freewheeling Diode, Single Phase Half Wave circuit With RLE load, Single Phase Full-Wave Controlled Converter: Mid-Point full Wave converter, Full wave bridge converter, Single phase Symmetrical and Asymmetrical Semi-converter, Effect of source impedance on the performance of single phase Full converter, Single phase Dual converters. Three phase fully controlled bridge converters.

Unit-IV **(9hrs)**

Modelling of AC supply:

Operating principle of Single-phase half and full Bridge Voltage Source inverters, Steady state analysis of single phase inverter, Fourier Analysis of Single-phase inverter output voltage, Voltage control in single phase inverter: External control of AC output voltage, External control of DC Input voltage, Internal control

of Inverter, Pulse width modulated inverters: Single pulse Modulation, Multiple pulse Modulation, and Sinusoidal pulse modulation, Reduction of Harmonics in the inverter output voltage: Harmonic Reduction by PWM, reduction by transformer connection, Operation of Three Phase Bridge 120- and 180-degree mode operation, Principle operation of single phase cyclo-converter, Types, and configuration of cyclo-converters.

Experiments:

(Note: Minimum 8 experiments are to be performed)

1. To study V-I characteristics of SCR and measure latching and holding currents.
   a. To study UJT trigger circuit for half wave and full wave control.
   b. To study single phase half wave-controlled rectifier with (i) resistive load, (ii) inductive load with and without freewheeling diode.
2. To study single phase (i) fully controlled (ii) half-controlled bridge rectifiers with resistive and inductive loads
3. To study three phases fully/half-controlled bridge rectifier with resistive and inductive loads.
4. To study single phase ac voltage regulator with resistive and inductive loads.
5. To study single phase cyclo converter
6. To study triggering of (i) IGBT, (ii) MOSFET, & (iii) Power transistor
7. To study operation of IGBT/MOSFET chopper circuit.
8. To study MOSFET/IGBT based single phase series resonant inverter
9. To study MOSFET/IGBT-based single-phase bridge inverter.

BOOKS & REFERENCES

1. M. H. Rashid, "Power Electronics Circuits, Devices & Application" Prentice Hall of India Ltd. 4th Edition 2018.
2. M.D. Singh and K.B. Khanchandani, "Power Electronics" Tata McGraw Hill,2005
3. V.R. Moorthy "Power Electronic Devices circuits and Industrial Applications" Oxford University Press, 2007
4. P.S. Bimbhra "Power Electronics" Khanna Publisher, New Delhi, 2010.
5. Chakrabarti & Rai "Fundamental of Power Electronics & Drives" Dhanpat Rai & sons.

EEE-301	**: Nonlinear Optimization**
Course Category	**:** Professional Elective (PE)
Pre-requisites	**:** NIL
Contact Hours/Week	**:** Lecture: 3, Tutorial: 1, Practical: 0
Credits	**:** 4
Course Assessment Methods	• Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test • Final Evaluation: One Major Theory Examination
Course Outcomes (COs)	**:** The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understand the basics of nonlinear optimization problems and their real-world applications.
2. Formulate mixed-integer programming (MIP) models for optimization problems.
3. Apply gradient-based methods (like Newton's method) to solve nonlinear optimization problems.
4. Use branch-and-bound methods to solve mixed-integer problems.
5. Understand the basic ideas of computational complexity in optimization problems, including the difference between P and NP problems.

6. Solve practical optimization problems from industry and electrical engineering applications using software tools such as Python.

Topics Covered

UNIT-I

Integer Programming Fundamentals (9hrs)

Binary/Integer Variables in Optimization, Relaxation and Branch & Bound, Cutting Plane Methods (Gomory Cuts), Complexity Analysis (P vs. NP)

UNIT-II

Mixed-Integer Linear Programming (MILP) (9hrs)

Formulating MILP Models and Problem Structures, Applications: Production Scheduling (Job Shop Problems) Facility Location Selection, Power Unit Commitment

UNIT-III

Fundamentals of Nonlinear Optimization (9hrs)

Basics of LP and NLP problems, Differences between LP and NLP, Convex vs. Nonconvex Functions, Unconstrained Optimization (Gradient Descent), Optimality Conditions (KKT Conditions, Lagrange Multipliers), Penalty and Barrier Methods

UNIT-IV

Applications of LP in Industry / Electrical Systems (9hrs)

Electric Vehicle Charging Station Deployment, Process Optimization in Chemical/Petroleum Industries, Robotics Path Planning, Tools for MILP: Python: PuLP, Pyomo, CVXPY

Books & References

1. K. Deb: Engineering Optimization; PHI Learning
2. S.S. Rao: Optimization Techniques; McGraw Hill
3. Hamdy A Taha: Operations Research: An Introduction; Pearson India

EEE-302	**Advanced Power Converter Design**
Course Category	**:** Professional Elective (PE)
Pre-requisites	**:** NIL
Contact Hours/Week	**:** Lecture: 3, Tutorial: 1, Practical: 0
Credits	**:** 4
Course Assessment Methods	• Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test • Final Evaluation: One Major Theory Examination
Course Outcomes (COs)	: The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Explain EV architecture, components, and key performance metrics.
2. Model and simulate vehicle dynamics under different driving conditions.
3. Analyze and control DC, induction, and PMSM motor drives for EVs.
4. Apply power electronic converters and modulation techniques in EV systems.
5. Analyze multilevel, modular, matrix, and resonant converter topologies.
6. Evaluate efficiency, thermal management, and EMI/EMC aspects in converters.

Topics Covered

Unit I: (9hrs)

Multilevel Inverter Topologies: Diode-clamped, Flying capacitor, Cascaded H-bridge • Control strategies for multilevel inverters. Applications in drives and renewable energy systems, Fault diagnosis in multilevel inverters, Neutral point balancing techniques

Unit II: **(9hrs)**

Resonant and Soft Switching Converters: Resonant converter classifications: series, parallel, LLC, Zero Voltage Switching (ZVS) and Zero Current Switching (ZCS), Design of resonant tank and control strategies, Steady-state analysis and waveform shaping, Load-independent behaviour and gain characteristics, Use in wireless and medical power supplies

Unit III: **(9hrs)**

Matrix and Modular Multilevel Converters: Introduction and Operating Principles Applications in FACTS and HVDC, Control methods and modulation schemes, Modular redundancy, and fault-tolerant design, MMC sizing and energy balancing

Unit IV: **(9hrs)**

Thermal and EMI Design Considerations: Heat sinks, cooling systems, thermal modelling • EMI/EMC compliance, Parasitic elements and PCB layout considerations, Common-mode noise and filtering techniques, Standards for electromagnetic compatibility

Books & References

1. **Bin Wu**, *High-Power Converters and AC Drives*, Wiley-IEEE Press
2. **Robert W. Erickson and Dragan Maksimović**, *Fundamentals of Power Electronics*, Springer
3. **Narayan G. Hingorani and Laszlo Gyugyi**, *Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems*, IEEE Press
4. **Adrian Ioinovici**, *Power Electronics and Energy Conversion Systems, Volume 2: Advanced and Intelligent Systems*, Wiley

EEE-303	**:**	**Linear Control System**
Course Category	:	Professional Elective (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial:1, Practical: 0
No of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, one minor test, and one major theory examination.
Course Objectives	:	To impart foundational knowledge of control systems, including modeling, time and frequency response analysis, and design of controllers for stable and efficient system performance.
Course Outcomes (COs)	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

1. Understand the basics of linear control, its open loop and closed loop types & applications.
2. Able to understand and do the mathematical modelling of linear systems.
3. Able to evaluate the linear systems stability using Routh-Hurwitz and other algebraic criterions.
4. Analyze the system dynamics using the time-domain response specifications.
5. Analyze the system dynamics using the frequency-domain response specifications.
6. Able to design and apply the basic linear controllers.

Topics Covered

Unit I: Introduction of Control System **(9hrs)**

Open loop & closed control; servomechanism; Mathematical modelling of physical systems; Transfer functions, Block diagram algebra, Signal flow graph, Mason's gain formula.

Unit II: Control System Components **(9hrs)**

Constructional and working principles of AC & DC servomotors, stepper motor, and synchro, error detectors. Basic control actions: proportional (P), integral (I), derivative (D), and PID controllers.

Unit III: Time Response analysis & Stability **(9hrs)**

Standard test signals, time response of first and second order systems, time response specifications, steady state errors and error constants. Stability concepts, algebraic criteria, and necessary conditions, Routh-Hurwitz criteria and limitations, root locus concept.

Unit IV: Frequency response Analysis **(9hrs)**

Frequency response, correlation between time and frequency responses, polar and inverse polar plots, Bode plots. Stability in frequency domain.

Text Books

1. I. J. Nagrath and M. Gopal, "Control System Engineering", 4th Edition, New age International.
2. K. Ogata, "Modern Control Engineering", Pearson Education, 4th Indian reprint.
3. D. Roy Choudhary, "Modern Control Engineering", Prentice Hall of India.
4. Ajit K. Mandal, "Introduction to Control Engineering" New Age International, 2006.

EEC-311	**: Embedded Systems for Automotive Applications**
Course Category	**:** Professional Elective (PE)
Pre-requisites	**:** NIL
Contact Hours/Week	**:** Lecture: 3, Tutorial: 1, Practical: 0
Credits	**:** 4
Course Assessment Methods	• Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test • Final Evaluation: One Major Theory Examination
Course Outcomes (COs)	: The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Select and analyze semiconductor devices for EV systems.
2. Design and simulate converters and inverters used in EVs.
3. Implement and tune control algorithms in both analog and digital domains.
4. Integrate power electronics into EVs, renewable systems, and smart grid infrastructure.

Topics Covered

Unit I: **(9hrs)**

Introduction to Embedded Systems in Automotive Applications: Overview of embedded systems and their role in automotive engineering; Fundamentals of microcontrollers and microprocessors used in automotive applications; Introduction to real-time operating systems (RTOS) and their importance in automotive embedded systems.

Automotive Communication Protocols: Overview of automotive communication protocols (CAN bus, LIN bus, FlexRay, etc.); Applications of embedded systems in electric vehicles and hybrid electric vehicles.

Unit II: **(9hrs)**

Embedded Systems for Vehicle Diagnostics and Maintenance: Introduction to onboard diagnostics (OBD) systems and standards (OBD-II, ISO 15765, etc.); Embedded systems for monitoring vehicle performance, emissions, and fault diagnosis; Implementation of diagnostic trouble code (DTC) retrieval

and interpretation algorithms; Remote diagnostics and over-the-air (OTA) software updates in modern vehicles; Development of embedded diagnostic tools and maintenance systems for electric vehicles.

Unit III: (9hrs)

Automotive Infotainment and Human-Machine Interface (HMI): Introduction to automotive infotainment systems and HMI design principles, Designing and prototyping automotive infotainment systems using embedded platforms.

Unit IV: (9hrs)

Embedded Systems for Vehicle Safety and Driver Assistance: Overview of advanced driver assistance systems (ADAS) and their components; Embedded systems for collision avoidance, lane departure warning, and adaptive cruise control; Case studies on real-world applications of embedded systems in vehicle safety and driver assistance.

Books & References

1. Kathiresh, M., & Neelaveni, R., Automotive Embedded Systems. Springer International Publishing (2021).
2. Zurawski, R., Embedded Systems Handbook: Embedded systems design and verification. CRC press (2018).
3. Real-time embedded systems. John Wiley & Sons (2017).
4. Subhashini, N., Mohanaprasad, K., & Murugan, M., Intelligent embedded systems. D. Thalmann (Ed.). Springer (2018).
5. Nicolescu, G., & Mosterman, P. J., Model-based design for embedded systems. Crc Press. (2018).

EEE-401	**: Emerging Technologies in Renewable Energy Sources**
Course Category	**:** Professional Elective (PE)
Pre-requisites	**:** NIL
Contact Hours/Week	**:** Lecture: 3, Tutorial: 0, Practical: 2
Credits	**:** 4
Course Assessment Methods	• Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test, Practical/Lab Examination • Final Evaluation: One Major Theory Examination
Course Outcomes (COs)	: The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Evaluate the working principles, applications, and global trends of solar, wind, biomass, and emerging renewable energy technologies.
2. Evaluate wind energy fundamentals (turbine components, power calculations, Weibull distribution) and turbine efficiency.
3. Demonstrate the working principles of fuel cells and hydrogen production/storage methods
4. Conduct energy audits using instruments (power analysers, flow meters) and strategies.
5. Concept of hybrid renewable energy resources planning.
6. Analysis and Applications in Current Scenario.

UNIT-I Fundamentals of Renewable Energy Sources & Solar Technologies (9hrs)

Energy sources Overview Indian & global energy scenario, Classification of energy sources (conventional vs. non-conventional), Emerging technologies in Renewables, Solar energy principles. Photovoltaic (PV) cells: Working and applications, Energy storage systems (Batteries, Hydro Storage), Applications of Solar energy (Residential/Industrial).

UNIT-II Wind, Biomass, and Alternative Renewable Systems (9hrs)

Wind energy fundamentals: Wind types, Wind characteristics and power calculations, Weibull Distribution, Biomass Energy Conversion, Technologies, Biofuels and Fermentation Processes, Other Renewable Sources Ocean Thermal, Geothermal and Tidal energy.

UNIT-III Advanced Energy Systems & Fuel Cells (9hrs)

Fuel cell technology, Principles and types of fuel cells, Hydrogen production methods (electrolysis, reforming), Hydrogen storage challenges, Integration of fuel cells, Hybrid Systems (renewables + fuel cells), Applications in thermal systems and Hybrid Vehicles

UNIT-IV Energy Efficiency & Audit (9hrs)

Energy Audit Fundamentals, Objectives and strategies, Audit instruments (power analyzers, flow meters), Performance Evaluation, Motor efficiency and performance factors, Quality control via energy audits, Case Studies Industrial/commercial audit

List of Experiments:

1. To Analyze I-V characteristics of solar
2. To Analyze P-V characteristics of solar
3. Evaluate performance under varying irradiation and temperature solar
4. Understand temperature coefficient and its effect on PV power
5. Study effect of partial shading on module output of solar
6. Study effect of partial shading on module output
7. To Analyze Torque vs Speed and Power vs Speed characteristics for wind
8. To analyse different Wind Turbine Models for diverse operating conditions

Books & References

1. Rai, G. D., & Rai, C. D. Non-conventional energy sources. Khanna.
2. Sukhatme, S. P. Text Book of Solar Energy Engineering. Mc GeawHill,
3. Tiwari, G. N., & Tiwari, A. Handbook of solar energy (Vol. 498). Springer.
4. Maczulak, A. E. Renewable energy: sources and methods. Infobase Publishing.
5. Márquez, F. P. G., Karyotakis, A., & Papaelias, M. (Eds.). (2018). Renewable energies: Business outlook 2050. Springer

EEE-402	**: Energy Storage, Battery Management Systems, and Motor Drives for EVs**
Course Category	**:** Professional Elective (PE)
Pre-requisites	**:** NIL
Contact Hours/Week	**:** Lecture: 3, Tutorial: 1, Practical: 0
Credits	**:** 4
Course Assessment Methods	• Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test • Final Evaluation: One Major Theory Examination

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

1. Understand battery types, characteristics, and modeling.
2. Design and evaluate battery pack configurations.
3. Implement BMS functions and protection.
4. Analyze EV charging infrastructure and grid interaction.
5. Compare and select suitable electric motors for electric vehicles.
6. Apply modern control techniques using digital control methods for EV propulsion systems.

Topics Covered

Unit I: (9hrs)

Battery Fundamentals and Battery Pack Design: Battery types: Lead-acid, Li-ion, NiMH, Modeling and characteristics, Charging/discharging cycles, DoD, Thermal behavior and efficiency, Series-parallel configurations, Sizing and management, Cooling techniques, SOC and SOH estimation

Unit II: (9hrs)

Battery Management System (BMS) and Charging Infrastructure: Functions of BMS, Protection and balancing, Communication and integration, Safety protocols, Slow, fast, ultra-fast, wireless methods, Grid integration and load management, Smart charging methods

Unit III: (9hrs)

Electric Motors for EVs: DC, BLDC, PMSM, IM, SRM motors, Motor control and selection, Torque-speed characteristics

Unit IV: (9hrs)

Control Techniques: PWM and SVPWM, Closed-loop speed and torque control, Regenerative braking, Digital implementation

Books & References

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
4. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.

: Fuzzy Logic Control System & Applications

EEE-403

Course Category	:	Professional Elective (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial:1, Practical: 0
No of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, one minor test, and one major theory examination.
Course Objectives	:	The course is designed to give a solid grounding in the fundamental concepts of fuzzy logic and its applications. The level of the course is chosen to be such that all students aspiring to be a part of computational intelligence directly or indirectly soon.

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

1. Understand the basic concepts, operations, and properties of fuzzy sets.
2. Learn how to combine fuzzy set theory with probability to address both random and non-random uncertainty in decision-making.
3. Understand the key features of membership functions, as well as the processes of fuzzification and defuzzification.
4. Analyze and demonstrate the differences between crisp set theory and fuzzy set theory.
5. Recognize and interpret fuzzy logic membership functions.
6. Apply fuzzy logic membership functions and fuzzy inference systems in practical scenarios.

Topics Covered

Unit I: Introduction to Fuzzy Sets **(9hrs)**

Fuzzy Sets, Logic and Systems & Applications, Fuzzy Sets, Logic and Systems & Applications, Real Life Applications of Fuzzy Systems, Fuzzy Sets and Fuzzy Logic Toolbox in MATLAB, Membership Functions, Nomenclatures used in Fuzzy Set Theory, Set Theoretic Operations on Fuzzy Sets.

Unit II: Properties of Fuzzy Sets **(9hrs)**

Introduction, Properties of Fuzzy Sets, Distance between Fuzzy Sets, Arithmetic Operations on Fuzzy Numbers, Complement of Fuzzy Sets, T-norm & S-norm Operators, Parameterized T-Norm & S-norm Operators

Unit III: Fuzzy Relation **(9hrs)**

Introduction to Fuzzy Relation, Operations on Crisp and Fuzzy Relations, Projection of Fuzzy Relation Set, Cylindrical Extension of Fuzzy Set, Properties of Fuzzy Relation, Extension Principle, Composition of Fuzzy Relations, Properties of Composition of Fuzzy Relations, Fuzzy Tolerance and Equivalence Relations, Linguistic Hedges and Negation/ Complement and Connectives, Concentration and Dilation & Composite Linguistic Term, Dilation and Composite Linguistic Term, Contrast Intensification of Fuzzy Sets, Orthogonality of Fuzzy Sets.

Unit IV: Fuzzy Rules and Fuzzy Reasoning **(9hrs)**

Introduction to Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference System, Mamdani Fuzzy Model, Larsen Fuzzy Model, Tsukamoto Fuzzy Model.

Textbooks:

1. Ross, T. J. (2005), "Fuzzy logic with engineering applications," John Wiley & Sons.
2. J.-S. R. Jang, C.-T. Sun, and E. Mizutani, "Neuro-Fuzzy and Soft Computing" Prentice Hall.
3. Klir, George J. and Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall, 1995.
4. Zimmermann, H.-J., Fuzzy Set Theory—and Its Applications, 4th Edition, Springer, 2001. Comprehensive coverage of fuzzy sets, systems, and control.
5. Dubois, Didier and Prade, Henri, Fuzzy Sets and Systems: Theory and Applications, Academic Press, 1980

EEE-411 : Advanced Power Electronics

Course Category	:	Professional Elective (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial:1, Practical: 0
No of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, one minor test, and one major theory examination.

Course Objectives : To learn & apply energy engineering management skills in practical problems for efficient energy management.

Course Outcomes(COs) : Upon completing this course, students are expected to demonstrate the following knowledge, skills, and attitudes.

CO1 - Describe modern power semiconductor devices and their applications.
CO2 - Select suitable protection circuits for power electronic devices..
CO3 - Analyse advanced DC–DC converter topologies for practical applications.
CO4 - Evaluate the performance of multilevel inverters and PWM techniques.
CO5- Analyse electric drives and VFDs used in industrial and renewable energy systems.
CO6- Apply power electronic converters in EV, PV, and wind energy applications.

Unit 1: (9hrs)

Modern Power Devices and Protection Circuits:

SIT, MCT, and FCT Power devices: Symbol, construction, working, V-I characteristics, and Applications, di/dt protection circuit and snubber circuit, dv/dt protection circuit and snubber circuit, Thermal Protection of SCR: Need, thermal resistance and heat sinks specification

Unit 2: (9hrs)

Advanced DC–DC Converter Topologies:

Resonant converters (SRC, LLC), soft-switched converters (ZVS/ZCS), isolated and bidirectional converters, high-gain and interleaved DC–DC converters, and intelligent and AI controlled of DC–DC converters (ANN-based controlled converters, Fuzzy logic controlled DC–DC converters and ANFIS-based DC–DC converters).

Unit 3: (9hrs)

Unit - III Multi-level Inverters:

Inverter-Concept, types-Voltage Source Inverter(VSI) and Current Source Inverter(CSI), Single phase CSI - Working with ideal switches and waveforms (R load), Three phase bridge voltage source inverter: 180° mode 120° mode -Working with ideal switches and waveforms (R load), Pulse width modulation: need, types: Sinusoidal Pulse Width Modulation (SPWM), Multiple Pulse Width Modulation(MPWM) SPWM: concept, working principle and waveforms, Space Vector Modulation.

UNIT 4: (9hrs)

Electric Drives and Industrial Applications:

Variable frequency drives (VFD): Need, Block diagram, working principle, Advantages, disadvantages and its applications, Charge controller: Concept, types, applications in Photovoltaics (PV) system with block diagram with focus on inverter, AC to AC converter using DC link: Concept, applications in Wind Power Generation and with focus on VFD, Electrical traction system: Introduction, function of each block with focus on Drive mechanism and applications, Electrical vehicle(EV)- Plug-in Electrical vehicle (PEV) and Plug in Hybrid electric Vehicle(PHEV): Block diagram, function of each block with focus on Drive mechanism and application

References

1. Muhammad H. Rashid, Power Electronics: Devices, Circuits, and Applications, 4e, Pearson Education, ISBN-13 978 8120345317
2. M D Singh, K B Khanchandani, Power Electronics McGraw Hill Education, ISBN-13 978-0070583894
3. P.S.Bimbhra, Power Electronics, Khanna Publisher, New Delhi, SBN-13 ?978-8195123124
4. B.R.Gupta and V.Singhal Power Electronics S.K.Kataria and Sons, ISBN-13 978-8185749532
5. Madhukar Waware, D.S.More, Vijay Mohale, Abhay Wagh Power Electronics and Its Applications, Khanna Book Publishing, ISBN 13 978-9355380425

EEE-412 : Power Plant Engineering

Course category : Professional Elective (PE)
Pre-requisite Subject : Nil
Contact hours/week : Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits : 4
Course Assessment : Continuous assessment through tutorials, assignments, Methods attendance, quizzes, one minor test and One Major Theory Examination.

Course Outcomes(COs) **:** The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

1. Explain the global and Indian energy landscape, energy resources, and fundamentals of power generation.
2. Analyze the working principles, layouts, and performance characteristics of modern steam and combined cycle power plants.
3. Evaluate hydro-electric and pumped storage power plants with respect to grid support and renewable energy integration.
4. Assess the operation and applications of diesel power plants in emergency, remote, and hybrid systems.
5. Analyze environmental impacts, emission control techniques, and sustainability aspects of power plants.
6. Explain the role of digitalization, automation, and smart technologies in modern power plants.

Topic Covered

UNIT–I

Energy Landscape & Power Plant Fundamentals (9hrs)

Power and energy concepts, Global and Indian energy scenario, Conventional and non-conventional energy sources, Fuels and fuel characteristics, Load estimation and load curves (conceptual), Selection of power plant units, Basic power plant economics and tariffs, Sustainable and green power generation

UNIT–II

Advanced Steam & Combined Cycle Power Plants (9hrs)

Classification of steam power plants, Subcritical, supercritical, and ultra-supercritical power plants, General layout of modern steam power plants, Boilers, steam turbines, condensers, and auxiliary systems (overview), Reheating and regenerative cycles, Combined Cycle Power Plants (CCPP), Operation, maintenance, and site selection, Case study of an Indian supercritical power plant

UNIT–III

Hydro & Pumped Storage Power Plants (9hrs)

Layout and classification of hydro-electric power plants, Hydraulic turbines and performance characteristics, Governing and control of hydro plants, Pumped storage power plants, Role of hydro plants in renewable-rich grids, Safety, maintenance, and hydro power development in India

UNIT–IV

Diesel, Hybrid & Digital Power Plants

(9hrs) Diesel power plant layout and major components, Performance characteristics of diesel power plants, Applications in emergency, remote, and islanded systems, Hybrid power plants (diesel–solar, thermal–solar), Environmental impact and emission control systems, Digital power plants: SCADA, automation, and condition monitoring

Text Books

1. P. K. Nag, *Power Plant Engineering*, Tata McGraw-Hill.
2. R. K. Rajput, *Power System Engineering*, Laxmi Publications.
3. F. T. Morse, *Power Plant Engineering*, East-West Press.
4. Mahesh Verma, *Power Plant Engineering*, Metropolitan Book Company.

5. A. J. Wood & B. Wollenberg, *Power Generation, Operation and Control*, Wiley.

EEE-413 : High Voltage Engineering
Course Category : Professional Elective (PE)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial:1, Practical: 0
No of Credits : 4
Course Assessment Methods : Continuous assessment will be carried out through tutorials, practical work, attendance, home assignments, quizzes, one minor test, and one major theory examination.
Course Outcomes(COs) : The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

1. The concepts of break down in gases, solids & liquids with numerical calculation
2. The concept of generation & measurement of high voltages & currents.
3. Understand the generation and measurement of high voltages.
4. Understand electric fields and field stress control around high voltage systems.
5. The concept of various high voltage testing.
6. Understand the phenomena involved in non-destructive insulation and testing as well as over voltages in power systems.

Topics Covered

Unit I: (9hrs)

Break Down In Gases: Ionization processes, Townsend's criterion, breakdown in electronegative gases, time lags for breakdown, streamer theory, Paschen's law, break down in non-uniform field, breakdown in vacuum.

Break Down In Solid & Liquid Dielectrics:

Classification of liquid dielectric, characteristic of liquid dielectric, breakdown in pure liquid and commercial liquid. electromechanical breakdown, breakdown of solid, breakdown in composite dielectrics.

Unit II: Generation of High Voltages and Currents: (9hrs)

Generation of high direct current voltages, generation of high alternating voltages, generation of impulse voltages, generation of impulse currents, tripping, and control of impulse generators.

Unit III: Measurement of High Voltages and Currents: (9hrs)

Measurement of high direct current voltages, measurement of high alternating and impulse voltages, measurement of high direct, alternating, and impulse currents, Cathode Ray Oscillographs for impulse voltage and current measurements.

Unit IV: (9hrs)

Non-Destructive Testing:

Measurement of direct current resistively, measurement of dielectric constant and loss factor, partial discharge measurements.

High Voltage Testing:

Testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, testing of transformers, testing of surge arresters, radio interference measurements.

Textbooks:

1. M. S. Naidu and V. Kamaraju, "High Voltage Engineering, Tata Mc-Graw Hill.

Reference Books:

2. E. Kuffel and W. S. Zacngal, High Voltage Engineering", Pergamon Press.
3. M. P. Chaurasia , "High Voltage Engineering", Khanna Publishers

4. R. S. Jha, "High Voltage Engineering", Dhanpat Rai& sons
5. C. L. Wadhwa, "High Voltage Engineering", Wiley Eastern Ltd.
6. M. Khalifa,' High Voltage Engineering Theory and Practice,' Marcel Dekker.
7. Subir Ray,' An Introduction to High Voltage Engineering' Prentice Hall of India.

EEE-414 : Intelligent Instrumentation

Course category : Professional Elective (PE)
Pre- requisites : Nil
Contact hours/week : Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits : 4
Course Assessment Methods : Continuous assessment through tutorials, assignments, attendance, quizzes, one minor test and One Major Theory Examination.

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

1. The concepts of intelligent instrumentation system.
2. The concept of signal processing, manipulation & transmission.
3. Analyze and design OP-AMP based signal processing and signal transmission circuits.
4. The concept of Smart Sensors, Interfacing Instruments & Computers.
5. Analyze sensor non-idealities and apply suitable compensation techniques.
6. Recent trends in sensor technology.

Topic Covered

UNIT I

Introduction: (9hrs)

Intelligence features characterizing intelligence, intelligent instrumentation system; features of intelligent instrumentation; components of intelligent instrumentation system; Block diagram of an intelligent instrumentation system.

UNIT II

Signal Processing, Manipulation and Transmission: (9hrs)

Signal filtering: Low-pass, High-pass, Band-pass and Band-stop (OP-AMP based); **Signal processing:** Signal amplification & attenuation (OP-AMP based); Instrumentation Amplifier (circuit diagram, high CMRR & other features); Differential amplification, Signal Linearization (OP-AMP based); Bias Removal, OP-AMP based Voltage-to-current converter, Current-to-voltage conversion, Signal integration, Voltage follower (pre-amplifier), voltage comparator, Signal addition, Signal multiplication; **Signal transmission**: Electrical transmission, Pneumatic transmission and Fibre-optic transmission.

UNIT III

Smart Sensors, Interfacing Instruments & Computers: (9hrs)

Smart Sensor: Introduction; **Sensor non-idealities and their compensation**: Nonlinearity (Look up table method, polygon interpolation, and polynomial interpolation, Approximation & regression), Noise & interference, Response time, Drift, Cross-sensitivity; **Interfacing:** Address decoding; Data transfer Control; Sample & hold circuit, A/D converter, D/A converter.

UNIT IV

Recent Trends in Sensor Technologies: (9hrs)

Introduction; Film sensors (Thick film sensors, thin film sensors); Semiconductor IC technology-standard methods; Microelectro-mechanical systems (Micro-machining, some application examples); Nano-sensors.

Textbook:

1. Barney, G.C. Intelligent Instruments. Hemel Hempstead: Prentice Hall, 1985.

2. Alan S. Morris, Principles of Measurement& instrumentation. N. Delhi; PHI Pvt. Ltd., 1999.

Reference Book:

1. D. Patranabis, Sensors & Transducers, PHI Learning Pvt. Ltd., 2013.
2. Roman Kuo, Introduction to Digital Signal Processing. N. York: McGraw-Hill Pub, Co.

EEE-415	**:**	**Solar Energy Systems**
Course Category	:	Professional Elective (PE)
Pre-requisite Subject	:	Power System-I
Contact hours/week	:	Lecture: 3, Tutorial:1, Practical: 0
No of Credits	:	04
Course Assessment Methods	:	Continuous assessment through tutorials/assignments, attendance, quizzes/record, one minor test and one major theory examination.
Course Objectives	:	To provide students with a comprehensive understanding of solar energy resources and environmental relevance, and to develop the ability to analyze, design, and evaluate solar PV and solar thermal power systems along with modern applications and pricing considerations.
Course Outcomes(COs)	:	The student is expected to be able to demonstrate the following knowledge and skills after completing this course:

1. Explain Assess energy scenario, impacts, and India's solar potential
2. Explain solar cells, PV systems, and MPPT basics.
3. Describe solar-thermal technologies, cycles, and hybridization.
4. Evaluate key applications: off-grid, PCM, floating PV, innovations.
5. Compare PV vs. solar-thermal for suitability and performance
6. Select and justify an appropriate solar solution for a given need.

Topic Covered

Unit I: Introduction To Solar Energy (9hrs)

World energy resources, Indian energy scenario, Environmental aspects of energy utilization, Growth of solar energy: Indian and global scenario, Solar potential in India, Merit and demerit of solar energy.

Unit II: Solar PV Generation (9hrs)

Principles and operation of solar cells, Types of Solar cell, Solar cell energy conversion efficiency, I-V characteristics, Historic development of solar PV system, Fundamental of solar PV system and their component, Classification of solar PV systems, Maximum power point tracking of solar PV system.

Unit III: Solar Thermal Power Generation (9hrs)

Layout of solar thermal power plant, Classification of solar thermal energy technology: Concentrating and non-concentrating solar thermal technology, Parabolic dish collector, Power generation cycle, Hybridization of concentrated solar power.

Unit IV: Solar Energy Application and Pricing (9hrs)

Off-Grid solar lighting testing and reliability, Phase change material (PCM), Floating solar PV system, Innovative application of solar energy.

Textbooks:

1. Chetan Singh Solanki — Solar Photovoltaics: Fundamentals, Technologies and Applications, PHI Learning, 2nd/3rd ed.
2. S. P. Sukhatme & J. K. Nayak — Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw-Hill / TMH.

3. G. D. Rai — Non-Conventional Energy Sources, Khanna Publishers.
4. B. H. Khan — Non-Conventional Energy Resources, McGraw-Hill Education.
5. Handbook of Solar Energy: Theory, Analysis and Applications, by G N Tiwari, Arvind Tiwari and Shyam, Energy Systems in Electrical Engineering, Springer Nature Singapore, Pte Ltd, Publisher, 2018.

BHS-303/353 :Industrial/Organizational Psychology

Course Category : HSSE
Prerequisite subject : None
Number of Credits : 4
Contact Hours/Week : Lectures: 3, Tutorial: 1, Practical: 0
Course Assessment Methods : Continuous assessment through One test, teacher's assessment (quiz, tutorial, assignment, attendance), and One Major Theory Examination.
Course Objectives : The objectives of this course are to: -

1. Provide students with a foundational understanding of the principles, theories, and research methods in the field of I/O psychology.
2. To help students to understand the process of personnel management (selection, training, performance appraisal, development) while also introducing the psychological assessment methods crucial for effective personnel selection, job analysis, and employee evaluation.
3. To help students to analyze the multifaceted influences on workplace behavior (motivation, job satisfaction, leadership dynamics, organizational culture) and to explore organizational dynamics (structure, communication patterns, decision-making processes), and strategies for effective change management.
4. To provide opportunities for students to apply I/O psychology principles to real-world scenarios.

Course Outcomes : The students will be able to demonstrate the following knowledge, skills, and attitudes upon completion of the course: -

1. Demonstrate a clear understanding of key concepts and theories in the field of Industrial psychology, including their historical development and contemporary relevance.
2. Identify and propose solutions to workplace problems using evidence-based approaches grounded in I/O psychology principles.
3. Apply knowledge and skills acquired in the course to real-world situations, such as improving employee performance, enhancing team effectiveness, and promoting organizational change.
4. Demonstrate awareness of ethical issues and professional standards, and apply ethical principles to decision-making in the workplace.

Unit 1 **(9hrs)**

Introduction to Industrial Psychology: Definition, scope, brief history, various sub divisions; Research in Industrial Psychology; Scientific Management Theory; Human Relations School; Managerial Roles, Functions & Skills; Effective vs Successful managers; Job Analysis and Evaluation; Employee Selection:

Recruitment, Realistic Job Previews, Effective Employee Selection Techniques, Job Search Skills; Employee Selection: References and Testing.

Unit 2 **(9hrs)**

Evaluating Employee Performance; Designing & Evaluating Training Systems; Performance Management; Employee Retention, Engagement, and Careers; Organizational Development and Change Management; Employee Relations: Ethics and Employee Rights, Labor Relations and Collective Bargaining, Managing Global Human Resources, Managing Human Resources in Small and Entrepreneurial Firms.

Unit 3 **(9hrs)**

Motivation: Concept, theories and application; Emotions at workplace; Attitudes and Job Satisfaction; Perception: Components, process, factors that influence it, person perception, individual decision making; Personality: Determinants, theories and measurement; Stress: Sources, consequences and management.

Unit 4 **(9hrs)**

Foundations of Group Behavior: Types of groups, properties, decision making in groups; Understanding work teams: Types, creating effective teams; Communication: Functions, process, modes and organizational communication; Leadership: Concept, theories, finding and creating effective leaders; Power & Politics; Conflict & Negotiation.

Text & Reference Books:

1. Aamodt, M. G. (2010). *Industrial/Organizational Psychology: An Applied Approach*. Wadsworth Cengage Learning.
2. Aswathappa, K. (2008). *Human Resource Management*. Tata McGraw Hill.
3. Chitale, A. K., Mohanty, R. P., & Dubey, N. R. (2019). *Organizational Behavior: Text and Cases*. Prentice Hall India.
4. Dessler, G., & Varrkey, B. (2020). *Human Resource Management*. Pearson.
5. Luthans, F. (2010). *Organizational Behavior*. McGraw Hill.
6. McShane, S. L., Glinow, M. A. V., & Rai, H. (2022). *Organizational Behavior*. McGraw Hill.
7. Muchinsky, P. M. (2006). *Psychology applied to work: An introduction to industrial and organizational psychology*. Hypergraphic Press.
8. Pareek, U. (2004). *Understanding Organisational Behaviour*. Oxford University Press.
9. Robbins, S. P., Judge, T.A., & Vohra, N. (2019). *Organizational Behavior*. Pearson.
10. Spector, P. E. (2016). *Industrial and Organizational Psychology: Research and Practice*. Wiley.

BEE-356	**: Power System-II**
Course Category	**:** Professional Core (PC)
Pre-requisites	**:** Power System- I
Contact Hours/Week	**:** Lecture: 3, Tutorial: 0, Practical: 2
Credits	**:** 4
Course Assessment Methods	• Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test , Lab/Practical Examination • Final Evaluation: One Major Theory Examination
Course Outcomes (COs)	**:** The student is expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understanding and representation of power system components using one-line, impedance, reactance, and per-unit diagrams for effective system analysis.

2. Analysis of power systems using symmetrical components, sequence networks, and transient behavior for fault and machine performance evaluation
3. Understanding of power system behavior in both symmetrical and asymmetrical fault conditions.
4. Analysis of power system load flows using bus classification and numerical solution methods.
5. Understanding of power system stability and its impact on reliable system operation.
6. The traveling wave theory and derive expressions for reflection and refraction coefficients with various terminations of the lines.

Topic Covered

UNIT-I

Representation of Power System Components: **(9hrs)**

Synchronous machines, Transformers, Transmission lines, One line diagram, Impedance and reactance diagram, Per unit System.

Symmetrical components, Symmetrical & Unsymmetrical faults:

Symmetrical Components of unbalanced phasors, Power in terms of symmetrical components, Sequence impedances and sequence networks. Transient in R-L series circuit, Calculation of 3-phase short circuit current and reactance of synchronous machine, Internal voltage of loaded machines under transient conditions.

Analysis of single line to ground fault, line-to-line fault and Double Line to ground fault on an unloaded generators and power system network with and without fault impedance. Formation of Zbus using singular transformation and algorithm, Computer method for short circuit calculations.

Unit-II

Load Flows: **(9hrs)**

Introduction, Bus classifications, Nodal admittance matrix (BUS Y), Development of load flow equations, Load flow solution using Gauss Siedel and Newton-Raphson method, Approximation to N-R method, Line flow equations and fast decoupled method.

Unit-III

Power System Stability: **(9hrs)**

Stability and Stability limit, Steady state stability study, Derivation of Swing equation, Transient stability studies by equal area criterion and step-by-step method. Factors affecting steady state and transient stability and methods of improvement

Unit-IV

Traveling Waves: **(9hrs)**

Wave equation for uniform Transmission lines, Velocity of propagation, Surge impedance, reflection, and transmission of traveling waves under different line loadings. Bewlay's lattice diagram, Protection of equipment's and line against traveling waves.

Text Books:

1. W.D. Stevenson, Jr. "Elements of Power System Analysis", McGraw Hill, 4th 1982.
2. C.L. Wadhwa, "Electrical Power System", New Age International, 6th Edition, 2011.
3. S. N. Singh, "Electric Power Generation, Transmission and Distribution" PHI, Learning Pvt Ltd, 2009.
4. T.K Nagsarkar& M.S. Sukhija,"Power System Analysis" Oxford University Press, 2007.

Reference Books:

5. L. P. Singh; "Advanced Power System Analysis & Dynamics", New Age International
6. Hadi Sadat; "Power System Analysis", Tata McGraw Hill.
7. P.S.R. Murthy "Power System Analysis" B.S. Publications, 2007.

8. Stagg and El-Abiad, "Computer Methods in Power System Analysis" Tata McGraw Hill
9. Kothari &Nagrath, "Modern Power System Analysis" Tata Mc. Graw Hill.

POWER SYSTEM II LAB

List of Experiments (A): Hardware Based Experiments

1. To determine fault current for different types of faults at the terminals of an alternator.
2. To determine fault current for different types of faults in transmission line.
3. To study Ferranti effect and voltage distribution in H.V. long transmission line.
4. To determine transmission line parameters of short and medium transmission line.
5. Plot the voltage profile of a long transmission line under different load conditions.
6. Obtain the string efficiency of a Pin type/String type insulators.
7. Determine the capacitance of a three-core cable.
8. Determine dielectric strength of cable insulation.
9. Plot the receiving end power circle diagram of a medium length transmission line.
10. To Determine the proximity and skin effect in transmission line conductor/UG cable.
11. To Determine the corona loss in transmission line.
12. Determine voltage regulation and efficiency of the transmission line under different load conditions.

List of Experiments (B): Simulation Based Experiments using (MATLAB/eTap/ Power World /CYM Software) Simulator or any other software

1. To determine transmission line performance.
2. To obtain formation of Y-bus and perform load flow analysis.
3. To perform symmetrical fault analysis in a power system
4. To perform unsymmetrical fault analysis in a power system
5. Load flow analysis using the GS/NR/DLF/FDLF methods.
6. Steady State & Transient stability analysis.
7. V-I characteristics of static VAR compensator (SVC).

BEE-357 : Instrumentation Engineering
Course category : Professional Core (PC)
Pre- requisites : Nil
Contact hours/week : Lecture : 3, Tutorial :0 , Practical :2
Number of Credits : 4
Course Assessment Methods : Continuous assessment through tutorials, assignments, quizzes, attendance, One minor test, Practical Examination and One Major Theory Examination.

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

1. Basic concept of instrumentation and its industrial application and working & performances of different kind of measuring instruments.
2. Ability to analyze performance characteristics of measuring instruments.
3. Ability to know, working principle & Performances of different electrical transducers.
4. Ability to understand construction, principle of operation, working and applications of waveform analyzers and spectrum analyzers, CRO and other display devices.
5. Ability to understand principle of operation of telemetry system and data acquisition system.
6. Ability to understand principle of operation of different display device and Introduction of Bio-electric signals (ECG, EEG, EMG, EOG, ERG etc.)

UNIT I

Fundamentals of Instrumentation Engineering (9hrs)

Fundamentals of instrumentation engineering, Performance characteristics of instruments, Static Performance Characteristics, Dynamic Performance Characteristics & Environmental Performance Characteristics, generalized input-output configuration of instrumentation, order of systems, Response of zero, first, seconds order systems, Transfer functions,

UNIT II

Transducers for Measurement of Non-Electrical Quantities (9hrs)

Advantages of electrical transducers, definition, description, classification, characteristics, factors affecting the choice of transducers, Sensors & pick-ups. Introduction to resistive, inductive & capacitive transducers. Transducers for measurement of displacement, velocity, acceleration, force, pressure, temperature, humidity, moisture, flow and liquid level monitoring & control. Piezoelectric, Piezo-resistive, Photo voltaic, Hall effect, and fiber optics.

UNIT III

Telemetry, Data Acquisition System and Recorders (9hrs)

General telemetry system, land line & radio frequency telemetering system, transmission channels and media, receiver & transmitter, TDM &, FDM. Analog data acquisition system, Digital data acquisition system, Modern digital data acquisition system. Display devices, LED, LCD, seven segment Display, Nixie Display devices, CRT Display, Digital storage oscilloscope (DSO), Strip chart & X-Y recorders, magnetic tape & digital tape recorders.

UNIT IV

Bio Medical Instrumentation (9hrs)

Introduction to Bio- Meical Engineering and its developments, Basic anatomy & Physiology ,Problem encountered while dealing with living systems, Invivo & Invitro method , Bio Potential Electrode , Different Types of Electrode , Resting and Action Potential, Introduction of ECG, EEG, EMG, EOG, ERG and its relevance in bio medical engineering, Role of microprocessors and computer in instrumentation engineering.

EXPERIMENTS

(Note: Minimum 8 experiments are to be performed**)**

1. Measurement of displacement using LVDT.
2. Measurement of displacement using strain gauge-based displacement transducer.
3. Measurement of displacement using LDR.
4. Measurement of speed of motor using magnetic pickup & photoelectric pickup.
5. Measurement of speed of motor using stroboscope.
6. Measurement of load using strain gauge-based load cell.
7. Measurement of temperature by RTD.
8. Measurement of temperature by thermocouple.
9. Measurement of weight of unknown sample using inductive transducers.
10. Study of ECG Data Acquisition System.
11. Recording of 12 lead ECG signals.
12. Study of storage oscilloscope and determination of transient response of RLC circuit.
13. Study of signal conditioning circuit for any transducer
14. Study of data acquisition system using "**Lab View**" software and test all signal points
15. Measurement of sine, triangular, square wave signal of function generator and verify its frequency at 100 Hz tap point using "**Lab View**" software.

Textbooks:

1. A.K.Sawhney, "Advanced Measurements & Instrumentation", Dhanpat Rai& Sons
2. B.C. Nakra & K.Chaudhry, "Instrumentation, Measurement and Analysis", Tata McGraw Hill 2nd Edition.
3. Cromwell & Weibell, "Bio Medical Instrumentation and Measurement", Prentice Hall

Reference Books:

4. E.O. Decblin, “Measurement System – Application & design”, McGraw Hill.
5. W.D. Cooper and A.P. Beltried, “Electronics Instrumentation and Measurement Techniques” Prentice Hall International
6. Rajendra Prasad, Electronic Measurement and Instrumentation Khanna Publisher
7. M.M.S. Anand, “Electronic Instruments and Instrumentation Technology” PHI Learning.

BEE-358 : Switchgear & Protection

Course category :Professional Core (PC)

Pre- requisites :Power System

Contact hours/week :Lecture: 3, Tutorial: 0, Practical: 2

Number of Credits :04

Course Assessment Methods :Continuous assessment through tutorials/assignments, attendance, practical work, quizzes/record, viva voce, One minor test and one major theory & practical examination.

Course Outcomes (COs) : The student are expected to be able to demonstrate the following knowledge and skills after completing this course

1. Understand basics of protection system, zones, primary/backup, and relay types.
2. Identify and compare overcurrent, directional, distance, differential and static relays.
3. Explain protection of lines, busbar, transformers, generators, and motors with schemes.
4. Understand arc theories and select/describe different circuit breakers with ratings/testing.
5. Apply coordination principles to design a reliable protection scheme.
6. Perform lab/field studies and interpret results for protection performance.

Topic Covered

UNIT-I

Protective Relaying Fundamentals & Relays (9hrs)

Introduction to protection system and its elements, Functional Characteristics of protective relaying, Protective zones, Primary and Backup protection, desirable qualities of protective relaying, basic terminology sealing/auxiliary relay. Electromagnetic, attracted and induction type relays, thermal relay, gas actuated relay.

UNIT-II

Relay Applications/Characteristics & Static Relays: (9hrs)

Over current relays, directional relays, distance relays, differential relay. Amplitude and phase comparators. Comparison between electromagnetic & static relays, classification, and description of static relays.

UNIT-III (9hrs)

Protection of Transmission Line & Power Apparatus

Over current protection, distance protection, pilot wire protection, carrier current protection, protection of bus bar, auto re-closing. Protection scheme for power transformers, generators, and motors.

UNIT-IV **(9hrs)**

Circuit Breaking Theories & Circuit Breakers:

Properties of arc, arc extinction theories, re-striking voltage transient, current chopping, resistance switching, capacitive current interruption, operating modes, selection of circuit breakers. Constructional features and operation of Air, Bulk Oil, Minimum Oil, Air Blast, SF6, and Vacuum Circuit breakers, Ratings & Testing of Circuit Breakers.

List of Experiments

(Note: Minimum 8 experiments are to be performed)

1. To study the IDMT over current relay and determine the time current characteristics.
2. To study percentage differential relay.
3. To study Impedance, MHO and Reactance type distance relays.
4. To study the working and principle of operation of Buchholz relay.
5. To understand the protection scheme of transformer through visit to local high voltage substation and to sketch labelled schematic diagram of various type of protection of transformer.
6. To understand the protection scheme using static relaying of nearby high voltage substation through visit and to sketch labelled schematic diagram.
7. To understand the protection scheme of alternator and to sketch labelled schematic diagram of various type of protection of alternator.
8. To understand various type of neutral earthling and specifications of earthling at different substations/locations and new trends in earthling schemes (information search).
9. To identify the components of different type of circuit breakers with their specifications (through/video/manuals)
10. To study operation of oil testing set and find out the break down strength of given oil sample.

Textbooks/Reference Books::

1. S. S. Rao, "Switchgear Protection and Power Systems", Khanna Publishers.
2. B. Ravindranath and M. Chander, Power system Protection and Switchgear, New Age International Publisher.
3. B.Bhalja, R.P. Maheshwari& N. G. Chothani, Protection & Switchgear, Oxford University Press.
4. B. Ram and D. N. Vishwakarma, "Power System Protection and Switchgear", Tata Mc. Graw Hill
5. Y. G. Paithankar and S R Bhide, "Fundamentals of Power System Protection", Prentice Hall of India.
6. T.S.M Rao,"Power System Protection: Static Relays with Microprocessor Applications" Tata Macgraw Hill".
7. A.R. Van C. Warringtaon , " Protective Relays- Their Theory and Practice, Vol. I & II" Jhon Willey & Sons.

EEE-501	**: AI & Machine Learning for Optimization**
Course Category	**:** Professional Elective (PE)
Pre-requisites	**:** NIL
Contact Hours/Week	**:** Lecture: 3, Tutorial: 1, Practical: 0
Credits	**:** 4
Course Assessment Methods	• Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test

- Final Evaluation: One Major Theory Examination

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

1. Understand basic concepts of AI, ML, and optimization techniques.
2. Apply machine learning algorithms (like regression, classification) to solve optimization problems.
3. Implement optimization techniques (e.g., Genetic Algorithms, Particle Swarm Optimization) using Python/MATLAB.
4. Analyse real-world problems (like supply chain, scheduling) using AI/ML for optimization.
5. Evaluate the performance and limitations of AI and machine learning models used for optimization in electrical engineering applications.
6. Apply AI-based optimization techniques to smart grid applications such as demand forecasting, and equipment health monitoring.

Topics Covered

UNIT-I Introduction to AI in Optimization (9hrs)

Review of Optimization Problems LP vs. NLP (convex/non-convex), AI based optimization vs. Traditional Optimization, Limitations of classical methods (LP, NLP), Supervised Learning for Optimization, Regression Techniques, Reinforcement Learning (RL) Basics, Application of AI in optimization

UNIT-II Neural Networks for Optimization (9hrs)

Neural Networks (NN), Feedforward NNs (input → hidden layers → output), AI for Electrical Systems, Practical Deep Learning, Limitations of AI

UNIT-III Reinforcement Learning (RL) Application in Industries (9hrs)

What is RL, RL with Real-World Analogies, Industrial Applications, Q-Learning for Supply Chain & Logistics, RL for traffic light optimization, Safety and Real-World Challenges

UNIT-IV Applications of AI in Smart Grids (9hrs)

AI for demand forecasting, Predictive Maintenance, Vibrational analysis of motors using ML, Low-Code AI Tools, Using AWS Lookout for Equipment, Bias in AI models

Books & References

1. K. P. Soman: AI for Engineers; PHI Learning
2. S. N. Sivanandam: Deep Learning for Beginners:Springer India
3. Anand Deshpande: Artificial Intelligence and Machine Learning:McGraw Hill India
4. P. Raja, S. P. Rajagopalan: Industry 4.0 with AI: CRC Press India

EEE-502 **:Control and Modulation Techniques in Power Electronics**

Course Category **:** Professional Elective (PE)

Pre-requisites **:** Nil

Contact Hours/Week **:** Lecture: 3, Tutorial: 1, Practical: 0

Credits **:** 4

Course Assessment Methods

- Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test
- Final Evaluation: One Major Theory Examination

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

1. Explain basic and advanced power electronic converters.
2. Analyse modulation techniques for AC supply.
3. Analyse modelling and design of switching mode regulators.
4. Analyse modelling and control of DC–DC converters.
5. Evaluate control strategies for DC–DC converters.
6. Apply control strategies inverters, including voltage-mode and current-mode control, and design feedback control schemes for stable operation.

Topics Covered

Unit I: (9hrs)

Overview of Basic and Power electronic converters: Principle of basic DC and AC supply converter and advanced Power electronic converters, isolated and non-isolated converter circuits, types of power converter models, basics of utility power conversion.

Unit II: (9hrs)

Modulation Strategies of AC supply: Principle operation of Inverter, performance parameters for inverter, Single and Multiple pulse PWM, Sinusoidal Pulse –Width Modulation, Modified Sinusoidal Pulse –Width Modulation, Phase displacement control, advanced modulation techniques: Trapezoidal modulation, staircase modulation, stepped modulation, harmonic injection modulation, Delta modulation technique, Modulation technique for three phase inverter: SPWM, 60 degree PWM, Third harmonic PWM, Space vector Modulation technique, Comparison of PWM technique

Unit III: (9hrs)

Modelling of switching mode regulators: Steady state converter analysis, Steady state modelling of the converters, Modelling of Buck regulator, condition for continuous inductor current and capacitor voltage, Finding the values of LC filter for the Buck regulator, Modelling of Boost regulator, condition for continuous inductor current and capacitor voltage, Finding the current and voltage in the boost regulator, Modelling of Buck-boost regulator, condition for continuous inductor current and capacitor voltage, Finding the current and voltage in the buck-boost regulator

Unit IV: (9hrs)

Modelling and control strategies of DC-DC converter: Principle of DC-DC converter operation, Finding the performance of DC-DC converter, Generation of Duty cycle, operation of step down converter for R-L load, finding the current of DC converter with an RL load, finding the load inductance to limit the load ripple current, control strategies for DC-DC converter, closed loop voltage and current controller.

Controlling of Inverter: Feedback control design, voltage mode and current mode control, control of inverters.

Books & References

1. **Sergio Franco** *Design with Operational Amplifiers and Analog Integrated Circuits*, McGraw-Hill.
2. **Vithayathil**, *Power Electronics: Principles and Applications*, McGraw-Hill
3. **Mohan, Undeland, Robbins**, *Power Electronics: Converters, Applications, and Design*, Wiley

4. **Bimal K. Bose,** Modern Power Electronics and AC Drives, *Pearson Education*

EEE-503	**:**	**Introduction To Robotic Control**
Course Category	:	Professional Elective (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial:0, Practical: 2
No of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, minor test, Practical Examination and one major theory examination.
Course Objectives	:	To provide students with a fundamental understanding of robotic systems, including their kinematics, dynamics, sensors, and actuators, along with control techniques for effective robot operation and automation. The course aims to equip students with practical skills in modeling, simulation, and control of robotic mechanisms.
Course Outcomes(COs)	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

1. Understand the basic structure, terminology, and classifications of robotic systems with emphasis on control-related features.
2. Analyze various robotic drive systems and actuators, and evaluate their suitability for specific control applications.
3. Apply knowledge of sensors and vision systems to develop feedback mechanisms for robotic control.
4. Interpret and utilize spatial transformation techniques for modeling and controlling robot motion.
5. Design and analyze simple robotic control systems using appropriate actuators, sensors, and control algorithms.
6. Demonstrate the ability to integrate drive systems, sensors, and control logic in robotic applications for industrial and automation tasks.

Topics Covered

Unit I **(9hrs)**

Introduction to Robotic Systems

Basics of robotics with relevance to control systems. Robot anatomy, degrees of freedom, accuracy, and repeatability as control parameters. Overview of robot classifications and selection criteria from a control perspective. Key industrial applications with brief insights into future trends.

Unit II **(9hrs)**

Actuators and End-Effectors for Robotic Systems

Overview of drive systems—hydraulic, pneumatic, electric—and their control characteristics. Key features of DC/AC servo and stepper motors used in control applications. Introduction to end-effectors and basic control principles for mechanical and pneumatic grippers.

Unit III **(9hrs)**

Sensors and Vision

Role and types of sensors in feedback control systems. Basic sensor selection criteria. Introduction to robot vision systems (RVS), its components, and control applications. Comparison with human vision for robotic decision-making.

Unit IV: **(9hrs)**

Transformations and Kinematics of Robotics

Spatial descriptions and transformations essential for motion control. Homogeneous transformations and their application in trajectory planning. Introduction to Euler angles and basic transformation

arithmetic in robotic control systems.

List of Experiments:

1. Model and visualize a 2-DOF or 3-DOF robot arm using Denavit-Hartenberg conventions.
2. Write MATLAB code to compute the position and orientation of the end-effector.
3. Solve for joint angles using numerical or analytical methods in MATLAB.
4. Generate and plot joint-space and Cartesian-space trajectories.
5. Implement a DC motor model in MATLAB and analyze its response.
6. Design and simulate a PID controller for motor speed and position control.
7. Create a dynamic model of a simple robot using Simulink and control it with feedback.
8. Implement stepper motor pulse sequence control and analyze motion.
9. Simulate a basic obstacle avoidance and path planning scenario.
10. Simulate noisy sensor readings and apply Kalman/ Low-pass filtering techniques.
11. Model a plant and design an adaptive controller using MATLAB functions.
12. Simulate a line-following robot using MATLAB image processing techniques.

Textbooks:

1. S. K. Saha, Introduction to Robotics 2e, TATA McGraw-Hill Education (2014).
2. John J. Craig, *Introduction to Robotics: Mechanics and Control*, 4th Edition, Pearson (2018).
3. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, *Robot Modeling and Control*, Wiley (2005).
4. Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, and Giuseppe Oriolo, *Robotics: Modelling, Planning and Control*, Springer (2009).
5. Ken Goldberg, *Introduction to Robotics: Mechanics and Control*, Addison-Wesley (2000).
6. Frank L. Lewis, Darren M. Dawson, and Chaouki T. Abdallah, *Robot Manipulator Control: Theory and Practice*, CRC Press (2004).
7. Peter Corke, *Robotics, Vision and Control: Fundamental Algorithms in MATLAB*, Springer (2017).
8. R.K. Jain, *Fundamentals of Robotics*, Wiley Eastern Limited (1998).

EME-511	**: Vehicle Dynamics and Control**
Course Category	**:** Professional Elective (PE)
Pre-requisites	**:** NIL
Contact Hours/Week	**:** Lecture: 3, Tutorial: 1, Practical: 0
Credits	**:** 4
Course Assessment Methods	• **:** Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test • Final Evaluation: One Major Theory Examination
Course Outcomes (COs)	: The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Understanding of importance of vehicle control and its dynamics.
2. The knowledge of driving assistance systems, ride quality and handling of traffic.
3. The knowledge of different vehicle dynamics systems used in the vehicles.
4. Able to understand the fundamentals lateral and longitudinal dynamic systems.

5. The knowledge of different types force generation, braking systems, tire models and its calculations.
6. The knowledge of different longitudinal control systems such as adaptive cruise control, collision avoidance, and automated highway systems etc.

Topics Covered

Unit I: **(9hrs)**

Introduction to Vehicle Dynamics: Vehicle dynamics, importance, drive assistance systems, active stability control systems, ride quality and technologies for addressing traffic congestion. **Longitudinal Dynamics:** Vehicle Load Distribution – Acceleration and Braking - Brake Force Distribution, Braking Efficiency and Braking Distance - Longitudinal dynamics of a Tractor-Semi Trailer.

Unit II: **(9hrs)**

Classification Tire Mechanics – An Introduction: Mechanical Properties of Rubber - Slip, Grip and Rolling Resistance - Tire Construction and Force Development - Contact Patch and Contact Pressure Distribution. **A Simple Tire Model:** Lateral Force Generation - Ply Steer and Conicity -Tire Models – Magic Formula - Classification of Tire Models and Combined Slip.

Unit III: **(9hrs)**

Lateral Dynamics: Lateral Systems Under Commercial Development, Lane departure waring, lane keeping system and yaw stability control system. Bicycle Model - Stability and Steering Conditions Understeer Gradient and State space Approach, Parameters affecting vehicle handling characteristics.

Unit IV: **(9hrs)**

Introduction to Longitudinal Control: Adaptive cruise control, Collision avoidance, Automated highway systems, Benefits of Longitudinal Automation, Anti-Lock Brake Systems, ABS functions, functioning of a stability control system.

Books & References

1. Hans. Tire and vehicle dynamics. Pacejka, Hans. Elsevier (2005).
2. Theory of ground vehicles. Wong, Jo Yung. John Wiley & Sons. (2001).
3. "The friction of pneumatic tyres". Moore, Desmond F (1975).
4. Vehicle dynamics: theory and application. Jazar, Reza N. Springer (2008).
5. Fundamentals of vehicle dynamics, Gillespie, Thomas D. (1992).
6. Vehicle dynamics and Control. Rajesh Rajamani, Springer (2012)

EEE-601	**: Power Market- Planning and Operations**
Course Category	**:** Professional Elective (PE)
Pre-requisites	**:** NIL
Contact Hours/Week	**:** Lecture: 3, Tutorial: 1, Practical: 0
Credits	**:** 4
Course Assessment Methods	• Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test • Final Evaluation: One Major Theory Examination
Course Outcomes (COs)	: The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Explain the evolution of power systems from regulated utilities to competitive electricity markets.

2. Distinguish between different electricity market structures and participant roles.
3. Distinguish between different electricity market structures and participant roles.
4. Evaluate transmission pricing, congestion management, and financial transmission rights.
5. Apply planning concepts for generation and transmission in a deregulated market environment
6. Assess advanced power market issues with emphasis on renewable integration and the Indian power market framework.

Topics Covered

UNIT 1: Introduction to Power Markets (9hrs)

Evolution of power systems: From vertically integrated utilities to competitive markets**;** Types of electricity markets: Pool, bilateral, hybrid, and multilateral markets**;** Market participants and their roles: Generators, DisComs, traders, system operators**;** Market architecture and design: Day-ahead, real-time, ancillary services**;** Price-based unit commitment and economic dispatch**.**

UNIT 2: Market Operations and Mechanisms (9hrs)

Transmission pricing and congestion management**;** Market clearing and settlement procedures**;** Auction mechanisms: Uniform pricing, pay-as-bid, Vickrey auctions**;** Role of Independent System Operator (ISO) and Regulatory Commissions**;** Financial Transmission Rights (FTRs) and congestion revenue rights

UNIT 3: Power System Planning in Market Environment (9hrs)

Generation expansion planning under deregulation**;** Transmission planning with economic and reliability considerations**;** Long-term power purchase agreements (PPAs) and risk assessment**;** Demand forecasting and demand-side bidding**;** Integrated resource planning (IRP)**.**

UNIT 4: Advanced Topics and Case Studies (9hrs)

Renewable integration and challenges in power markets**;** Demand response programs and dynamic pricing**;** Smart grid applications in market operation**;** Cross-border electricity trading and regional markets**;** Indian power market structure: Indian Energy Exchange (IEX) and Power Exchange India Limited (PXIL), and regulations by CERC

Books and References

1. Daniel S. Kirschen and Goran Strbac, *Fundamentals of Power System Economics*, 2nd Edition, Wiley, 2018.
2. Steven Stoft, *Power System Economics: Designing Markets for Electricity*, 1st Edition, IEEE Press & Wiley-Interscience, 2002.
3. Shmuel S. Oren and Stephen A. Smith (Editors), *Electricity Market Reform: An International Perspective*, 1st Edition, Cambridge University Press, 2007.
4. Mohammad Shahidehpour and Muwaffaq Alomoush, *Restructured Electrical Power Systems: Operation, Trading, and Volatility*, 1st Edition, CRC Press, 2001.
5. S.R. Narasimhan, *Electricity Markets: Theories and Applications*, 1st Edition, PHI Learning, 2011

EEE-602	**: EV Grid Integration and Smart Systems**
Course Category	**:** Professional Elective (PE)
Pre-requisites	**:** Power Systems
Contact Hours/Week	**:** Lecture: 3, Tutorial: 1, Practical: 0
Credits	**:** 4
Course Assessment Methods	• Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test • Final Evaluation: One Major Theory Examination

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

1. Analyze the impact of EV charging loads on power system operation.
2. Evaluate voltage, frequency, and power quality issues due to EV penetration.
3. Explain V2G architecture, standards, and grid support services.
4. Explain V2G architecture, standards, and grid support services.
5. Apply smart charging strategies using communication protocols and demand response
6. Assess energy management strategies for BEV and HEV applications

Topics Covered

Unit I: (9hrs)

Grid Fundamentals and Load Impact: Overview of power grid architecture (generation, transmission, distribution), Components of smart grid systems, Types of EV loads and demand variability Load flow analysis in presence of EV charging stations, Surge Impedance Loading (SIL) and transmission line capacity, Impact of EV loads on grid voltage and frequency stability, Power quality issues due to EV penetration (harmonics, flicker), Load forecasting techniques for EV integration

Unit II: (9hrs)

Vehicle-to-Grid (V2G): Concept and importance of bidirectional power flow, V2G communication protocols and standards (ISO 15118, OCPP), Power electronics interfaces for V2G systems, Aggregation of EVs for grid support, Frequency regulation and voltage support through V2G, Case studies of V2G implementation (India and abroad)

Unit III: (9hrs)

Renewable Integration: Solar-powered EV charging station design, Role of microgrids in EV and renewable integration, Distributed Energy Resources (DERs) and EV synergy, Types, and configurations of energy storage systems (ESS), Control strategies for renewables with EV charging, Optimization algorithms for solar-EV energy management, Environmental and economic impacts of renewable-powered EV systems

Unit IV: (9hrs)

Smart Charging and Communication, Energy Management strategies: Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, and implementation issues of energy management strategies. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).Demand response, Charging algorithms,

Books & References

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
4. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.

EEE-603 : Modern Control System

Course Category : Professional Elective (PE)

Pre-requisite Subject : NIL

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

No of Credits : 4

Course Assessment Methods : Continuous assessment through tutorials, attendance, home assignments, quizzes, One minor test, and one major theory examination.

Course Objectives : The course aims to provide foundational and advanced knowledge in classical, state-space, adaptive, and optimal control techniques. It enables students to model, analyze, and design control systems using various methods, ensuring stability and performance under varying system conditions.

Course Outcomes (COs) : The students are expected to demonstrate the following knowledge, skills, and attitudes after the completion of this course:

1. Understand and apply conventional control design techniques, including time and frequency response analyses, and design compensators using root locus and frequency response methods.
2. Model dynamic systems using state-space representation and convert between state space and transfer function models while analyzing system controllability and observability.
3. Design state feedback controllers and observers using pole-placement and Ackerman's formula to achieve the desired system performance and stability.
4. Analyze the stability of continuous-time and discrete-time systems using Lyapunov's stability theorems and other classical methods.
5. Explain adaptive control concepts and schemes, including Self-Tuning Regulators (STR) and Model Reference Adaptive Control (MRAC), to handle system uncertainties and parameter variations.
6. Formulate optimal control problems and evaluate performance criteria, understanding transient response, tracking, disturbance rejection, and cost functions in feedback control systems.

Topics Covered

Unit I: Introduction to Control Design: **(9hrs)**

Introduction, review of conventional control design techniques, continuous-time and discrete-time system modelling, time response analysis, and frequency response analysis; control design problem and preliminary considerations; lead, lag and lead-lag networks, compensator design using root locus plots and frequency response plots.

Unit II: State Space Analysis: **(9hrs)**

State variable representation, state variable model, conversion of state variable models to transfer function and vice-versa, solution of state equations, state transition matrix, controllability, and observability.

Unit III: State Space Control Design: **(9hrs)**

Design of state observer and controller. Pole-placement technique, Ackerman formula, observer-Controller design.

Stability Analysis: Continuous-time and discrete-time systems stability analysis, Lyapunov's stability theorems.

Unit IV: Introduction to Adaptive & Optimal Control **(9hrs)**

Linear feedback, effects of process variations, adaptive schemes, and the adaptive control problem, Self-tuning Regulators (STR), Model Reference Adaptive Control (MRAC).

Statement of optimal control problem, Problem formulation and types of optimal control, Selection of performance measures, General Model of feedback control systems, Transient performance analysis, Tracking performance analysis, Disturbance rejection analysis, Cost functions and norms.

Textbooks:

1. I. J. Nagrath and M. Gopal, "Control System Engineering", 4th Edition, New age International.
2. K. Ogata, "Modern Control Engineering", Pearson Education, 4th Indian reprint.
3. D. Roy Choudhary, "Modern Control Engineering", Prentice Hall of India.
4. Ajit K. Mandal, "Introduction to Control Engineering" New Age International, 2006.
5. Karl J Astrom and Bjorn Wittenmark, "Adaptive Control", Pearson education Inc., New Delhi, Second Edition, 2008.
6. D S Naidu "Optimal Control Systems", CRC Press 2002

EEE-611 : Digital Control System

Course category: : Professional Elective(PE)
Pre- requisites: : Control System Engineering
Contact hours/week : Lecture: 3, Tutorial :0 , Practical :2
Number of Credits **:** 4
Course Assessment Methods : Continuous assessment through assignments, attendance, quizzes, practical work, record, viva voce , One minor test,One Major Theory & Practical Examination.

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

1. Representation and solution of discrete time systems in z-domain.
2. Analyze transient response, and steady state behaviour of linear discrete-time systems, analytically and numerically using tools such as MATLAB and Simulink.
3. Analysis and Design of digital control systems using state-space methods.
4. Describe and test controllability and observability of linear systems.
5. Design of controller through state feedback
6. Stability analysis of discrete time systems

Topic Covered

UNIT-I

Signal Processing in Digital Control: (9hrs)

Basic digital control system, advantages of digital control and implementation problems, basic discrete time signals, z-transform and inverse z-transform, modelling of sample-hold circuit, pulse transfer function, solution of difference equation by z-transform method.

UNIT-II

Time Domain and Frequency Domain Analysis: (9hrs)

Time domain performance analysis of discrete time systems, Steady state accuracy, transient response and frequency response specifications, digital compensator design using frequency response plots and root locus plots.

UNIT-III

State Space Analysis and Design: (9hrs)

State space representation of digital control system, conversion of state variable models to transfer functions and vice-versa, solution of state difference equations, controllability and observability, design of digital control system with state feedback.

UNIT-IV

Stability of Discrete System: (9hrs)

Stability on the z-plane and Jury stability criterion, bilinear transformation, Routh stability criterion on r^{th} plane.

List of Experiments

(Note: Minimum 8 experiments are to be performed**)**

1. Determination of Z – transform, inverse Z - transform and Pole-zero map of discrete-time system.
2. To obtain the s-domain transfer function of a given RLC circuit and convert it into z-domain pulse transfer function.
3. To study the effects in transient response and frequency response of different methods and sampling time used in z- Transfer function.
4. To test the stability of closed –loop discrete-time system in z-plane.
5. Digital control of DC servo motor using MATLAB.
6. Computer simulation of Digital control systems through Simulink and to obtain its response.
7. To obtain the Root Locus plot of a Digital control system and comment on its stability.
8. To test the controllability and observability of a discrete time system using MATLAB.
9. To obtain the different canonical forms of a given state space models.
10. To design of digital control system with state feedback.
11. To obtain the reduced order model of a given discrete-time system.

References:

1. K. Ogata, "Discrete-Time Control System", Pearson Education.
2. B.C. Kuo, "Digital Control System", Saunders College Publishing.
3. M. Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill.
4. S. K. Nagar and S. K. Bhardwaj, "Modern Control Systems with Advanced Topics" New age international publishers.

EEE-612	**:**	**Nonlinear System Analysis**
Course Category	:	Professional Elective (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial:1, Practical: 0
No of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, One minor test, and one major theory examination.
Course Objectives	:	This course deals with the analysis of nonlinear systems. The need for special tools to analyze nonlinear systems arises from the fact that the principle of superposition on which linear analysis is based, fails in the nonlinear case. The course exposes the students to various tools to analyze the behavior of nonlinear systems, culminating in the stability analysis, which is of paramount importance in control systems.

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

1. A thorough knowledge of theory and methods for nonlinear dynamical systems.
2. Ability to analyze nonlinear systems using Phase Plane, Describing functions; Lyapunov's direct stability method
3. Design and implement systems to improve nonlinear system performance in the presence of constraints.
4. Analyse the stability of nonlinear systems using various approaches.
5. Ability to apply nonlinear control design tools to derive feedback control of nonlinear dynamical systems.
6. Able to improve the learning capacity independently through the design of nonlinear control and able to use MATLAB/Simulink in designing of nonlinear control system.

Topics Covered

Unit I **(9hrs)**

Why nonlinear systems? - Non-linear Models of Physical Systems, Mathematical Preliminaries: Finite dimensional normed spaces, Euclidean space and its topology, Infinite dimensional Banach spaces - Contraction mapping theorem.

Unit II **(9hrs)**

Existence and Uniqueness results for solutions to nonlinear, ODEs as vector fields - One dimensional systems - Phase portrait of second order linear systems - Equilibrium points, linearization and their classification, Examples: Simple pendulum, Bead on a hoop, for predation and competition, biological transcriptional system, van der Pol oscillator and conservative systems, nonlinear circuits - Limit cycles.

Unit III **(9hrs)**

Bifurcations of two-dimensional flows: Saddle-node, pitchfork, transcritical and Hopf - their normal forms, Notions of stability - Lyapunov and LaSalle's theorems, Finding Lyapunov functions: Linear systems, variable gradient method - Center Manifold Theorem.

Unit IV: **(9hrs)**

Physical Non-linearities - Interconnections and feedback - Aizermann's conjecture – Passivity, PR systems - Dissipation equality - Passive filters, KYP Lemma - Popov and circle criterion

Textbooks:

1. P. Ioannou and J. Sun, Robust Adaptive Control, Upper Saddle River, NJ: Prentice Hall 1996
2. Miroslav Krstic, Ioannis Kanellakopoulos, Petar V. Kokotovic Nonlinear and Adaptive Control Design, Wiley Series, July 1995
3. S. Sastry and M. Bodson, Adaptive Control: Stability, Convergence and Robustness, Upper Saddle River, NJ: Prentice Hall 1989
4. K. S. Narendra and A. M. Annaswamy, Stable Adaptive Systems, Dover Publications, 2005
5. H. K. Khalil, Nonlinear Systems, Pearson Publications, Third Edition, 2002
6. M. Vidyasagar, Nonlinear Systems Analysis, Second Edition, SIAM, 2002

EEE-613 : Facts Controllers & Devices
Course Category : Professional Elective (PE)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial:1, Practical: 0
No of Credits : 4

Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, One minor test, and one major theory examination.
Course Objectives	:	To learn & apply FACTS Controller Devices as per requirement of AC Power Transmission in Simulation Models.
Course Outcomes(COs)	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

1. Fundamentals of ac power transmission, transmission problems.
2. Able to analyze the needs, emergence of FACTS-FACTS controls considerations, FACTS controllers.
3. Principles, types & characteristics of shunt compensation FACTS devices.
4. Principles, types & characteristics of static series compensation FACTS devices.
5. Principles of operation and characteristics of UPFC.
6. Generalized Unified Power Flow Controller (GUPFC), unified power flow conditioners.

Topic Covered

Unit I **(9hrs)**

Fundamentals of ac power transmission, transmission problems and needs, emergence of FACTS, FACTS control considerations, Type of FACTS controllers and applications.

Unit II **(9hrs)**

Principles of shunt compensation – Variable Impedance type & switching converter type- Static Synchronous Compensator (STATCOM) configuration, characteristics and control.

Unit III **(9hrs)**

Principles of static series compensation, TCSC and TSSC, applications, Static Synchronous Series Compensator (SSSC), Interline power flow controller (IPFC), Custom Power Devices and its applications.

Unit IV **(9hrs)**

UPFC -Principles of operation and characteristics, independent active and reactive power flow control, comparison of UPFC with the controlled series compensators and phase shifters

Generalized Unified Power Flow Controller (GUPFC), unified power flow conditioners.

Textbooks:

1. "FACTS: Controller in Power Transmission and Distribution," K. R. Padiyar, Anshan Publication, 2009.
2. "Understanding FACTS: Concept and Technology of FACTS," N. G. Hingorani and L. Gyuayi, Wiley, 2000.

EEE-614 : EHV AC & DC Transmission

Course category	**:**	Professional Elective(PE)
Pre- requisites	**:**	Nil
Contact hours/week	**:**	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	**:**	4
Course Assessment Methods	**:**	Continuous assessment through tutorials, assignments, quizzes, attendance, One minor test and One Major Theory Examination.

Course Outcomes (COs) : The student are expected to be able to demonstrate the Following knowledge, skills, and attitudes after completing this course

1. Understand the concept and performance of EHV transmission line.
2. Acquire the knowledge about the properties of bundled conductors.
3. The concept of Extra High Voltage Generation, Measurement and Testing.
4. Understand the concept of HVDC Transmission and about the various scheme of converter station.
5. Understand the concept of how to control the HVDC link.
6. Understand the comparison between AC and DC transmissions Applications of HVDC transmission.

Topic covered

UNIT I

Introduction: (9hrs)

Need of EHV transmission, standard transmission voltage, comparison of EHV ac & dc transmission systems and their applications & limitations, mechanical design considerations of transmission lines, modern trends in EHV AC and DC transmission systems

UNIT II

EHV AC Transmission: (9hrs)

Corona effects, Corona loss formulas, audible noise – generation and characteristics, corona Pulses, generation and properties, radio interference, over voltages in EHV system caused by switching operations, Concept of travelling waves and standing waves

UNIT III

Extra High Voltage Generation, Measurement and Testing: (9hrs)

Characteristics and generation of impulse voltage, Impulse current, generation of high AC and DC voltages, measurement of high voltages, general lay out of EHV Labs, Standard testing methods, EHV line insulation testing characteristics, protection of EHV lines.

UNIT IV

HVDC Transmission: (9hrs)

Types of dc links, converter station, choice of converter configuration and pulse number, effect of source inductance on operation of converters. Principle of dc link control, converter controls characteristics, firing angle control, excitation angle control, Converter faults, generation of harmonics, ac and dc filters, Multi Terminal DC systems (MTDC): Types, control, protection and applications.

Textbooks:

1. R. D. Begamudre, "Extra High Voltage AC Transmission Engineering" Wiley Eastern.
2. K. R. Padiyar, "HVDC Power Transmission Systems: Technology and System Reactions" New Age International.
3. J. Arrillaga, "High Voltage Direct Current Transmission" IFFE Power Engineering Series 6, Peter Peregrinus Ltd, London.
4. M. S. Naidu & V. Kamaraju, "High Voltage Engineering" Tata McGraw Hill.

Reference Books:

5. M. H. Rashid, "Power Electronics: Circuits, Devices and Applications" Prentice Hall of India.
6. S. Rao, "EHV AC and HVDC Transmission Engineering and Practice" Khanna Publisher.
7. "EPRI, Transmission Line Reference Book, 345 KV and above" Electric Power Research Institute. Palo Alto, California, 1982.

EEE-615 Power-Electronic-Controlled DC Drives

Course Category	:	Professional Elective (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial:1, Practical: 0

No of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, One minor test, and one major theory examination.
Course Objectives	:	To learn & apply energy engineering management skills in practical problems for efficient energy management.
Course Outcomes(COs)	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

CO1: Analyse and design power-electronic-controlled DC drive systems.
CO2: Analyse the operation and performance of chopper-controlled DC drives.
CO3: Analyse rectifier-controlled DC drives under different operating conditions.
CO4: Explain the operation of closed-loop control schemes for DC drives.
CO5: Analyse microcontroller-based DC drive control systems.
CO6: Apply DC drive systems in industrial applications.

Unit 1: **(9hrs)**

Introduction:

Concept of Electric Drive, Advantage of Electric drives, Parts of electric Drive, Choice of electric Drives, Basic performance Equation of different type of DC motors, Modeling of electrical machines, Selection of motors for different applications, speed-torque characteristics, different control schemes like constant torque control, constant power control, Requirements of electric drives, Speed Torque convention and Multi Quadrant Operation,

Unit 2: **(9hrs)**

Chopper Controlled DC-Drives:

Basic principles of chopper drives, Power control or motoring control, regenerative braking control, Two Quadrant chopper drive, circuit diagram and application, Four Quadrant chopper drive, circuit diagram and application, closed loop speed and position control schemes, advantages, and disadvantages of Chopper Controlled Motor Drives.

Unit 3: **(9hrs)**

Rectifier Controlled DC Drives:

Phase controlled converter fed DC drives: Single phase half wave-controlled drives, Single phase Symmetrical and asymmetrical Semi controlled drives, Single phase full wave-controlled drives, active front end converters, Single phase Dual converter-controlled drives, three phase half and full wave-controlled drives, advantages, and disadvantages of Rectifier Controlled Motor Drives.

UNIT 4: **(9hrs)**

Closed Loop Control of DC Drives:

Various type of speed and current sensors, closed loop control of separately excited DC motor, Microcontroller based DC drive, application of DC drive for industrial application.

References:

1. Paul C Krause, Oleg Wasynczuk, Scott D Sudhoff, Analysis of Electric Machinery and Drive System, Wiley Inter-science.
2. Leonhard W., Control of Electrical Drives, Springer-Verlag, 1985.
3. Mohan, Undeland and Robbins, Power Electronics: Converters, Application and Design, John Wiley and Sons, 1989.
4. Krishnan, R., Electric Motor drives: Modelling, Analysis and Control, Prentice Hall, March 2001.

EEE-616 : Advanced Microprocessor And Micro Controllers

Course category	**:**	Professional Elective (PE)
Pre- requisites	**:**	Nil
Contact hours/week	:	Lecture : 3, Tutorial :0 , Practical :2

Number of Credits : 4
Course Assessment Methods **:** Continuous assessment through assignments, attendance, quizzes, practical work, record, viva voce, One minor tests, one Major Theory & Practical Examination.

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

1. Analyze the architecture and instruction set of microprocessors and develop assembly language programs.
2. Apply efficient register usage and addressing modes in microprocessor programming..
3. Design and implement the interfacing of memory and peripheral devices with microprocessors.
4. Analyse the architecture and operation of the 8087 coprocessor and its interfacing with the 8086.
5. Explain the architecture, programming, and interfacing of microcontrollers.
6. Describe the features and applications of high-end processors.

Topic covered

UNIT I

Introduction to Architecture of Microprocessors: (9hrs)

General definitions of minicomputers, microprocessors, microcontrollers, and digital signal processors. Overview of the 8085 microprocessors. Overview of the 8086 microprocessors. Signals and pins of the 8086 microprocessor.

Assembly language of 8086: Description of Instructions. Assembly directives. Assemble software programs with algorithms.

UNIT II

Interfacing with 8086: (9hrs)

Interfacing with RAMs, ROMs, along with the explanation of timing diagrams. Interfacing with peripheral ICs like 8255, 8254, 8279, 8259, 8259, etc. Interfacing with keyboards, LEDs, LCDs, ADCs, and DACs, etc.

Coprocessor 8087: Architecture of 8087, interfacing with 8086. Data types, instructions, and programming

UNIT III

Introduction to Microcontrollers: (9hrs)

Overview of the architecture of the 8051 microcontrollers. Overview of the architecture of 8096, a 16-bit microcontroller.

Assembly language of 8051: Description of Instructions. Assembly directives. Assemble software programs with Algorithms.

Interfacing with 8051: Interfacing with keyboards, LEDs, 7-segment LEDs, LCDs, Interfacing with ADCs. Interfacing with DACs, etc.

UNIT IV

High-end processors: (9hrs)

Introduction to 80386, 80486, and Pentium Processors.

List of Experiments:

(Note: Minimum 8 experiments are to be performed**)**

1. Introduction to the 8086 Microprocessor architecture and pin diagram.
2. Study of 8086 Instruction Set.

3. Write a program to transfer a set of data from memory location 2050-205Fh to 2060-206Fh using an 8085 microprocessors.
4. Write a program to find the smallest number from a given set of data stored at location 2040h to 205Fh using the 8085 microprocessors.
5. Write a program for 16-bit addition using 8086 microprocessors
6. Write a program to sum n consecutive numbers
7. To interface Programmable Peripheral Interface (PPI) IC-8255 with 8085 Microprocessor in Mode 0
8. To generate a square wave on port pin PC7 of 8255 in BSR mode
9. To study 8051 architecture and pin diagram
10. To study the Instruction Set of 8051
11. Write a program for the addition of 8-bit numbers using 8051
12. Write a program for the subtraction of 8-bit numbers using 8051

References

1. Ramesh S. Gaonkar "Microprocessor Architecture, Programming, and Applications with the 8085", Prentice Hall PTR, 2002.
2. A.K. Ray & K. M. Bhurchandi, "Advanced microprocessors and Peripherals", Tata McGraw Hill.
3. James L. Antonakos, "An Introduction to the Intel family of Microprocessors" Pearson Education 1999.
4. Barry.B.Breg," The Intel Microprocessors Architecture , Programming and Interfacing , PHI,2002.
5. James L. Antonakos , " The Pentium Microprocessor '' Pearson Education , 1997.

BEE-381	**:**	**Minor Project-1**
Course category	**:**	Project (P)
Pre- requisites	**:**	Nil
Contact hours/week	**:**	Lecture: 0, Tutorial :0, Practical :0
Number of Credits	**:**	0
Course Assessment Methods	**:**	Continuous assessment through one viva voce/presentation, final project report, Evaluation of Development of hardware based or software-based simulation module ,contribution made to literary world through one viva voce/presentation at Institute .
Course Outcomes(COs) :		The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Ability to learn, design & analysis of electrical engineering system modules.
2. Development of hardware based electrical engineering module.
3. Development of software-based simulation module.
4. Innovative tool-based research work in electrical engineering.
5. Communicate with engineers and the community at large in written an oral form.
6. Design engineering solutions to complex problems utilizing a systems approach.

BEE-481 : Minor Project-2

Course category	**:**	Project (P)
Pre- requisites	**:**	Nil
Contact hours/week	**:**	Lecture: 0, Tutorial :0, Practical :12
Number of Credits	**:**	6
Course Assessment Methods	**:**	Continuous assessment through one viva voce/presentation, final project report, Evaluation of Development of hardware based or software-based simulation module ,contribution made to literary world through one viva voce/presentation at Institute .
Course Outcomes(COs) :		The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Ability to learn, design & analysis of electrical engineering system modules.
2. Development of hardware based electrical engineering module.
3. Development of software-based simulation module.
4. Innovative tool-based research work in electrical engineering.
5. Communicate with engineers and the community at large in written an oral form.
6. Design engineering solutions to complex problems utilizing a systems approach.

EEE-701	**: Application of Optimization in Industry**
Course Category	**:** Professional Elective (PE)
Pre-requisites	**:** Nil
Contact Hours/Week	**:** Lecture: 3, Tutorial: 1, Practical: 0
Credits	**:** 4
Course Assessment Methods	• **:**Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test • Final Evaluation: One Major Theory Examination
Course Outcomes (COs)	**:** The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Formulate basic manufacturing optimization problems.
2. Apply optimization to production and facility planning.
3. Solve logistics and supply chain optimization problems.
4. Analyze optimization problems in energy and power systems.
5. Apply optimization techniques to industrial design and control.
6. Use standard optimization tools for real-world case studies

Topics Covered

UNIT 1: Optimization in Manufacturing and Production Systems (9hrs)

Production Planning and Scheduling using LP and Integer Programming**,** Assembly Line Balancing and Facility Layout Optimization**,** Resource Allocation in Job Shops and Flow Shops**,** Toolpath Optimization in CNC Machines

UNIT 2: Supply Chain and Logistics Optimization (9hrs)

Vehicle Routing Problem (VRP), Travelling Salesman Problem (TSP)**,** Inventory Optimization: EOQ Models, Safety Stock, Reorder Points**,** Warehouse Location and Distribution Network Design**,** Demand Forecasting and Transportation Optimization

UNIT 3: Optimization in Energy and Power Systems **(9hrs)** Unit Commitment and Economic Load Dispatch**,** Optimal Placement of Capacitors, PMUs, and FACTS Devices**,** Renewable Energy Integration and Microgrid Optimization**,** Demand Response and Load Forecasting

UNIT 4: Optimization in Industrial Design for Process/Control **(9hrs)** Design Optimization in Automotive and Aerospace Systems**,** Process Parameter Optimization in Chemical and Pharma Industries**,** Quality Control and Six Sigma Optimization Techniques**,** Multi-Objective Optimization in Product Design

TEXTBOOK

1. Winston, W. L. (2004). *Operations Research: Applications and Algorithms* (4th ed.). Belmont, CA: Thomson Brooks/Cole.
2. Rardin, R. L. (1998). *Optimization in Operations Research*. Upper Saddle River, NJ: Prentice Hall.
3. Rao, S. S. (2009). *Engineering Optimization: Theory and Practice* (4th ed.). Hoboken, NJ: John Wiley & Sons.
4. Ravindran, A., & Warsing, D. P. Jr. (2012). *Supply Chain Engineering: Models and Applications*. Boca Raton, FL: CRC Press

EEE-702	**: Applications of Power Electronics in Emerging Technologies**
Course Category	**:** Professional Elective (PE)
Pre-requisites	**:** NIL
Contact Hours/Week	**:** Lecture: 3, Tutorial: 1, Practical: 0
Credits	**:** 4
Course Assessment Methods	• Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test • Final Evaluation: One Major Theory Examination
Course Outcomes (COs)	: The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Describe the role of power electronics in renewable energy systems like solar and wind.
2. Evaluate converter systems used in electric vehicles, including charging and braking.
3. Apply power electronics in industrial drives and automation.
4. Assess the integration of power electronics in smart grids and IoT-enabled systems.
5. Analyse the performance and control of power electronic converters used in renewable energy, electric vehicle, and industrial applications
6. Apply modern tools and simulation techniques to study power electronic systems used in smart grids, microgrids, and IoT-enabled energy systems.

Topics Covered

Unit I: **(9hrs)**

Power Electronics in Renewable Energy: Grid-connected PV inverters, Wind turbine power interfaces, MPPT algorithms and converter control, Hybrid RES systems and interface issues, Standards and protection in RES, Grid compliance and synchronization

Unit II: (9hrs)

Power Electronics for Electric Vehicles: DC-DC and DC-AC converters in EVs, Battery charging and regenerative braking, Drive train architecture, EV powertrain design and simulation, Bidirectional converters for EV, Battery management systems (BMS)

Unit III: (9hrs)

Power Electronics in Industrial Automation: VFDs and soft starters, Robotics and servo drives, Industrial power quality improvement, Harmonic filtering and compensation, Smart sensors and PLC interfacing, Industrial automation protocols, Custom power devices

Unit IV: (9hrs)

Power Electronics in Smart Grids and IoT: Role in smart meters, distributed generation Solid-state transformers and microgrid interfaces, IoT-enabled converters and cloud integration, Cybersecurity in smart power electronics, Real-time simulation, and hardware-in-loop

Books & References

1. **Ali Emadi**, *Advanced Electric Drive Vehicles*, CRC Press.
2. **S. N. Singh**, *Electric Power Generation, Transmission and Distribution*, PHI Learning
3. **Mukund R. Patel**, *Wind and Solar Power Systems: Design, Analysis, and Operation*, CRC Press.
4. **Frede Blaabjerg (Ed.)**, *Control of Power Electronic Converters and Systems*, Academic Press

EEE-703	**:**	**Industrial Instrumentation and Process Control**
Course Category	:	Professional Elective (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial:1, Practical: 0
No of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, one minor test, and one major theory examination.
Course Objectives	:	To provide foundational knowledge of instrumentation, transducers, sensors, and process control systems for accurate measurement, monitoring, and automation in engineering applications.
Course Outcomes (COs)	:	The students are expected to demonstrate the following knowledge, skills, and attitudes after the completion of this course:

1. Understand the fundamentals and performance characteristics of instrumentation systems.
2. Select and apply appropriate transducers for measuring various non-electrical quantities.
3. Analyze and utilize different types of sensors and recording devices in engineering applications.
4. Design and evaluate process control systems using P, I, D, and PID controllers.
5. Analyze the dynamic response and transfer functions of instrumentation systems of different orders to assess system performance.
6. Apply instrumentation, sensors, and control techniques in industrial automation and process control applications.

Topics Covered

Unit I: Fundamentals of Instrumentation Engineering (9hrs)

Fundamentals of instrumentation engineering, Performance characteristics of instruments, Static Performance Characteristics, Dynamic Performance Characteristics & Environmental

Performance Characteristics, generalized input-output configuration of instrumentation, order of systems, Response of zero, first, seconds order systems, Transfer functions.

Unit II: Transducers for Measurement of Non-Electrical Quantities **(9hrs)**

Advantages of electrical transducers, definition, description, classification, characteristics, factors affecting the choice of transducers, Introduction to resistive, inductive & capacitive transducers. Transducers for measurement of displacement, velocity, acceleration, force, pressure, temperature, humidity, moisture, flow and liquid level monitoring & control. Piezo-resistive, Photo voltaic, Hall Effect, and fiber optics.

Unit III: Sensors and Recorders: **(9hrs)**

Piezoelectric sensors, ultrasonic sensor, optoelectronics sensor, dissolved oxygen sensor, pollution measurement, smart sensor. Analog and digital recorders, X-Y recorder, strip chart, magnetic tape recorder, RZ & NRZ, role of microprocessor in industrial automation.

Unit IV: Process Control **(9hrs)**

Principle, Elements of process control system, Process characteristics, Electronic, pneumatic & digital controllers, ON/OFF controller. Proportional (P), Integral (I), Derivative (D) and PID controllers, Introduction to PLC.

Textbooks:

1. A.K.Sawhney, "Advanced Measurements & Instrumentation", Dhanpat Rai& Sons.
2. B.C. Nakra & K.Chaudhry, "Instrumentation, Measurement and Analysis", Tata McGraw Hill 2nd Edition.
3. Rangan, Mani, Sharma, "Instrumentation Devices & Systems", Tata McGraw Hill Publishing 1997.
4. W.D. Cooper and A.P. Beltried, "Electronics Instrumentation and Measurement Techniques" Prentice Hall International.
5. K Krishnaswamy and S Vijayachitra, "Industrial Instrumentation" New Age International Publisher.

EME-711 **: Sustainable Energy and EVs**
Course Category **:** Professional Elective (PE)
Pre-requisites **:** NIL
Contact Hours/Week **:** Lecture: 3, Tutorial: 1, Practical: 0

Credits **:** 4
Course Assessment Methods
- Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test
- Final Evaluation: One Major Theory Examination

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

1. To understand the various types of energy resources and its climatic effect
2. Ability to analyze and understand the various energy storage concepts
3. To understand the electric vehicle dynamics and its subsystems
4. To understand the various types of electric vehicle controllers
5. Ability to understand the characteristics of Battery
6. To understand the battery thermal management system

Topics Covered

Unit I:

Introduction **(9hrs)**

Introduction and Fundamental Concepts, Renewable and Non-renewable energy, Energy Scenario in Modern World, Fossil Fuels, Climate Change Impacts and Overview of Renewable Energy Technology, Carbon- Capture

Unit II:

Renewable energy and storage systems **(9hrs)**

Hydropower, Wind Energy, Solar Energy, Bioenergy and Biofuels, Geothermal Energy, Hydrogen energy

Introduction of Energy storage systems, Mechanical energy storage technologies, Energy storage system through Capacitor, Electrochemical Energy Storage Systems, Thermal Energy Storage Systems, Trends in Energy Storage Types and their Characteristics.

Unit III:

Electric Vehicles **(9hrs)**

Overview of Electric Vehicles in India, Vehicle Dynamics, Vehicle Subsystems: EV Power-train, Storage for EVs, EV Battery Pack design, EV Motors and Controllers, Fundamentals and Design, Vehicle Accessories, Battery Charging and Swapping

Unit IV:

Battery and thermal management system **(9hrs)**

Introduction to Electrochemical Cells, Batteries, Primary and secondary Batteries, Battery Electrode Reaction, Types of Battery: lithium-ion , lead-acid, nickel-metal hydride , solid-state , Fuel Cells, Battery Management System

Books & References

1. Energy storage, Robert A. Huggins, Springer Science & Business Media, 2010
2. The Physics of Solar Cells, Jenny A. Nelson, World Scientific Publishing Company
3. Fuel Cell Fundamentals, R. O'Hayre, S-W. Cha, W. Colella, F. B. Prinz, John Wiley and Sons, USA, 2005
4. Advanced Batteries: Materials Science Aspects, Robert Huggins, Springer; 2009.

EEE-801	**: Smart Grid and Resilient Power System**
Course Category	**:** Professional Elective (PE)
Pre-requisites	**:** NIL
Contact Hours/Week	**:** Lecture: 3, Tutorial: 1, Practical: 0
Credits	**:** 4
Course Assessment Methods	• Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test • Final Evaluation: One Major Theory Examination

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

1. Explain the evolution, architecture, and core components of smart grids.
2. Compare conventional power grids with smart grids in terms of functionality and performance.
3. Analyze key smart grid technologies such as PMUs, WAMS, AMI, EMS, and SCADA.
4. Evaluate the integration of DERs, EVs, and demand response in smart grid operation.
5. Assess power system resilience and security issues, including cyber threats and mitigation strategies.
6. Examine real-world smart grid case studies and emerging trends for future power systems

Topics Covered

UNIT 1: Introduction to Smart Grids (9hrs)

Evolution of the electrical grid to smart grids**;** Smart grid architecture and functional components**;** Comparison: Conventional grid vs. Smart grid**;** Key technologies: Sensors, communication systems, and IoT in power systems**;** Advanced metering infrastructure (AMI) and smart meters**;** Role of ICT in smart grids**;** Standards and interoperability (IEC 61850, IEEE 2030)

UNIT 2: Smart Grid Technologies and Applications (9hrs)

Wide Area Monitoring Systems (WAMS) and Phasor Measurement Units (PMUs)**;** Distribution automation and self-healing grids**;** Energy management systems (EMS) and SCADA**;** Demand response and real-time pricing**;** Integration of distributed energy resources (DERs): Solar, wind, storage**;** Electric vehicles (EVs) and vehicle-to-grid (V2G)

UNIT 3: Power System Resilience and Security (9hrs)

Definitions and metrics of resilience: Reliability vs. resilience**;** Threats to power systems: Natural disasters, cyber-attacks, equipment failures**;** Grid hardening vs. operational resilience strategies**;** Islanding and black start capabilities**;** Cybersecurity in smart grids: Threat detection, protection, and response**;** Resilience modeling and assessment tools**;** Regulatory frameworks and standards (NERC-CIP, IEEE 1547)

UNIT 4: Case Studies, Tools, and Future Trends (9hrs)

Smart grid implementation case studies: India (National Smart Grid Mission (NSGM)), USA (Self-Generation Incentive Program (SGIP)), Europe (Grid4EU)**;** Resilience enhancement using AI/ML and data analytics**;** Role of blockchain in energy transactions and grid security**;** Future trends: Transactive energy, peer-to-peer trading, energy prosumers**;** Policy and regulatory landscape for smart and resilient grids**;** Socio-economic impacts and sustainability aspects

Books and References

1. James Momoh, *Smart Grid: Fundamentals of Design and Analysis*, 1st Edition, Wiley-IEEE Press, 2012.
2. Gilbert N. Sorebo and Michael C. Echols, *Smart Grid Security: An End-to-End View of Security in the New Electrical Grid*, 1st Edition, CRC Press, 2012.
3. Janaka Ekanayake et al., *Smart Grid: Technology and Applications*, 1st Edition, Wiley, 2012.
4. S.K. Khaitan and James D. McCalley, *Cyber Physical Systems Approach to Smart Electric Power Grid*, 1st Edition, Springer, 2015.
5. Clark W. Gellings, *The Smart Grid: Enabling Energy Efficiency and Demand Response*, 2nd Edition, CRC Press, 2015.

EEE-802 : EV - Vehicle Dynamics and Electric Motor Drives

Course Category : Professional Elective (PE)

Pre-requisites	**:** Power Systems
Contact Hours/Week	**:** Lecture: 3, Tutorial: 1, Practical: 0
Credits	**:** 4
Course Assessment Methods	• Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test • Final Evaluation: One Major Theory Examination
Course Outcomes (COs)	: The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Identify EV architectures and major subsystems
2. Evaluate EV performance parameters and energy consumption
3. Model vehicle longitudinal dynamics for driving conditions
4. Design and control DC motor drives for EV applications
5. Implement induction and PMSM drive control techniques
6. Apply power electronic converters and modulation methods for EV efficiency.

Topics Covered

Unit I: (9hrs)

Introduction and Vehicle Dynamics: Overview of Electric Vehicles: EV classification, architecture, components, types of EVs. Performance parameters: Range, acceleration, gradeability, and energy consumption, Fundamentals of Vehicle Dynamics: Longitudinal dynamics, tractive effort, road load, power train sizing, Simulation of EV dynamics using MATLAB/Simulink.

Unit II: (9hrs)

DC Motor Drives for EVs: Fundamentals of DC motors: Types, torque-speed characteristics, Power converters for DC drives: Chopper control and regenerative braking, Modelling of DC motor drives, PI control of DC motors, closed-loop speed and torque control, Case study: EV applications using DC motor drives.

Unit III: (9hrs)

Induction Motor Drives and Power Electronics: Introduction to Induction Motors (IM): Construction, operating principles, torque-speed curves. V/f Control of IMs for EVs. PWM Techniques: Sine PWM, Space Vector PWM (SVPWM), Hysteresis control. Realization of Inverter circuits for IM control. Converter sizing and modulation strategy for efficiency improvement.

Unit IV: (9hrs)

PMSM Drives and Vector Control: Permanent Magnet Synchronous Motors (PMSM): Types, advantages in EVs. Mathematical modeling of PMSM. Field Oriented Control (FOC) and vector control concepts. Implementation of vector control using DSP/microcontroller. Case studies: PMSM control in commercial EV platforms.

EEE-803	**:**	**Nonlinear Control System**
Course Category	:	Professional Elective (PE)
Pre-requisite Subject	:	Nil
Contact hours/week	:	Lecture: 3, Tutorial:1, Practical: 0
No of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, One minor test, and one major theory examination.

Course Objectives : The course explores the dynamics of nonlinear systems, highlighting key differences from linear systems. It equips students with analytical tools for behavior prediction and stability assessment, forming a foundation for advanced control system design.

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

1. A thorough knowledge of theory and methods for nonlinear dynamical systems.
2. Ability to analyze nonlinear systems using Phase Plane, Describing functions; Lyapunov's direct stability method.
3. Design and implement systems to improve nonlinear system performance in the presence of constraints.
4. Analyse the stability of nonlinear systems using various approaches.
5. Ability to apply nonlinear control design tools to derive feedback control of nonlinear dynamical systems.
6. Able to improve the learning capacity independently through the design of nonlinear control and able to use MATLAB/Simulink in designing of nonlinear control system.

Topics Covered

Unit I **(9hrs)**

Why nonlinear systems? - Non-linear Models of Physical Systems, Mathematical Preliminaries: Finite dimensional normed spaces, Euclidean space and its topology, Infinite dimensional Banach spaces - Contraction mapping theorem.

Unit II **(9hrs)**

Existence and Uniqueness results for solutions to nonlinear, ODEs as vector fields - One dimensional systems - Phase portrait of second order linear systems - Equilibrium points, linearization and their classification, Examples: Simple pendulum, Bead on a hoop, Lotka-Volterra models for predation and competition, biological transcriptional system, van der Pol oscillator and conservative systems, nonlinear circuits - Limit cycles.

Unit III **(9hrs)**

Bifurcations in two-dimensional flows: Saddle-node, pitchfork, transcritical, and Hopf bifurcations with their normal forms. Stability concepts: Lyapunov and LaSalle's theorems. Construction of Lyapunov functions: For linear systems and using the variable gradient method. Introduction to the Center Manifold Theorem.

Unit IV: **(9hrs)**

Physical Non-linearities - Interconnections and feedback - Aizermann's conjecture – Passivity, PR systems - Dissipation equality - Passive filters, KYP Lemma - Popov and circle criterion

Textbooks:

1. P. Ioannou and J. Sun, Robust Adaptive Control, Upper Saddle River, NJ: Prentice Hall 1996
2. Miroslav Krstic, Ioannis Kanellakopoulos, Petar V. Kokotovic Nonlinear and Adaptive Control Design, Wiley Series, July 1995
3. S. Sastry and M. Bodson, Adaptive Control: Stability, Convergence and Robustness, Upper Saddle River, NJ: Prentice Hall 1989
4. K. S. Narendra and A. M. Annaswamy, Stable Adaptive Systems, Dover Publications, 2005
5. H. K. Khalil, Nonlinear Systems, Pearson Publications, Third Edition, 2002
6. M. Vidyasagar, Nonlinear Systems Analysis, Second Edition, SIAM, 2002

EEE-811 **: Electric Drives**

Course category **:** Professional Elective (PE)

Pre- requisites **:** Nil
Contact hours/week : Lecture: 3, Tutorial: 0,Practical: 2
Number of Credits **:** 4
Course Assessment Methods **:** Continuous assessment through tutorials, assignments, quizzes, Lab/practical work, record, viva voce , one minor test ,One Major Theory & Practical Examination.

Course Outcomes(COs) **:** The student are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Knowledge of electric drive and its parts, significance of power modulator, electric motors, sensing units, loads and control units in electric drives, advantages and classification of electric drive, multi quadrant operation of the drive
2. Knowledge of dynamic behaviour of motor, thermal motor of drives, concept of braking & energy loss.
3. Control of separately excited and dc series motor dc drive by single phase and three phase converter, dual converter control of dc drive, applications and limitations of various control, chopper control of dc series and servo motor.
4. Static control of dc motor by single phase, three phase and dual converters. chopper control of dc series and servomotor, idea, and effect of supply harmonics
5. Static control of three phase induction motor by CSI, VSI and Cycloconverter. static voltage and frequency control, static rotor resistance control and slip power recovery scheme, selection of motor for application.
6. Constructional features, working and of switched reluctance and brush less motor, selection of motor for services.

Topic Covered

UNIT I

Introduction to Electric Drives: (9hrs)

Electric Drives and its parts, advantages of electric drives, Classification of electric drives, Speed-torque conventions and multi-quadrant operations, Constant torque and constant power operation. Types of load torque components, nature and classification. Dynamics of motor-load combination; Steady state stability of Electric Drive; Transient stability of electric Drive, Thermal model of motor for heating and cooling, classes of motor duty, determination of motor power rating for continuous duty, short time duty and intermittent duty,Load equalization

UNIT II

Braking of Electrical Machines: (9hrs)

Purpose and types of electric braking, braking of dc, three phase induction and synchronous motors, Calculation of acceleration time and energy loss during starting of dc shunt and three phase induction motors, methods of reducing energy loss during starting. Energy relations during braking, dynamics during braking.

UNIT III

Power Electronics Control of DC Drives: (9hrs)

Single phase and three phase controlled converter fed separately excited dc motor drives (continuous conduction only), dual converter fed separately excited dc motor drive, rectifier control of dc series motor. Supply harmonics, power factor and ripples in motor current, Chopper control of separately excited dc motor and dc series motor**.**

UNIT IV

Power Electronics Control of AC Drives & Special Machine: (9hrs)

Static Voltage control scheme, static frequency control scheme (VSI, CSI, and cyclo – converter based) static rotor resistance and slip power recovery control schemes. Self-controlled scheme of synchronous motor drive, Switched Reluctance motor, Brushless dc motor. Selection of motor for applications

List of Experiments

Note: - Minimum 10 experiments are to be performed

Hardware Based Experiments

1. Speed control of dc drive using four quadrant DC chopper.
2. Speed control of single phase Induction Motor by single phase PWM inverter.
3. Speed control of single phase Induction Motor by single phase bridge cyclo converter.
4. Speed control of three phase Induction Motor by Kramer's drive.
5. Speed control of three phase Induction Motor by Static rotor resistance control.
6. Speed control of Permanent Magnet Synchronous Motor (PMSM) by changing PWM duty cycle.
7. Speed control Brushless DC Motor by changing DC Bus voltage.
8. Speed control of Permanent Magnet Synchronous Motor (PMSM) by taking feedback frequency.
9. Speed- Torque characteristics of Brushless DC Motor with electrical loading using coupled DC generator.
10. To study speed control of separately excited dc motor by varying armature voltage.
11. To study closed loop control of separately excited dc motor.
12. To study speed control of three phase induction motor using three phase current source inverter
13. To study speed control of three phase induction motor using three phase voltage source inverter.
14. To study speed control of three phase induction motor using three phase ac voltage controller.
15. To study speed control of three phase slip ring induction motor using static scherbius slip power recovery control scheme.

Simulation Based Experiments (using MATLAB or any other software)

16. Plot starting transient response of separately excited dc motor
17. Plot speed control curve of separately excited dc motor using single phase fully / half controlled bridge converter in discontinuous and continuous current modes.
18. Plot speed torque control curve of separately excited dc motor using chopper control in motoring and braking modes.
19. Plot starting transient response of three phase induction motor
20. Plot speed control curve of three phase induction motor using (a) constant/V/F control (b) Constant Voltage and frequency control

Textbooks:

1. G.K. Dubey, "Fundamentals of Electric Drives" Narosa publishing House.
2. S.K.Pillai, "A First Course on Electric Drives" New Age International.

Reference Books:

3. M.Chilkin, "Electric Drives",Mir Publishers, Moscow.
4. Mohammed A. El-Sharkawi, "Fundamentals of Electric Drives", Thomson Asia, Pvt. Ltd. Singapore.
5. N.K. De and Prashant K.Sen, "Electric Drives", Prentice Hall of India Ltd.
6. V.Subrahmanyam, "Electric Drives: Concepts and Applications", Tata McGraw Hill.

EEE-812 : Power System Operation And Control

Course category	:	Professional Elective (PE)
Pre- requisites	**:**	Nil
Contact hours/week	**:**	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	**:**	Continuous assessment through tutorials, assignments, quizzes, One minor test and One Major Theory Examination.

Course Outcomes (COs) : The student are expected to be able to demonstrate the Following knowledge, skills and attitudes after completing this course

1. Ability an understanding of Energy control center, analysis of real time control of power system parameters, learn about SCADA system
2. Ability to solve load dispatch problems with computer aided techniques for economy load dispatch.
3. Ability to analysis of real & reactive power control, load frequency control & Interconnected power systems
4. Ability to analysis of automatic excitation control systems and explore static and dynamic responses of system.
5. Explain methods to regulate the power for optimum power system stability.
6. Ability to explain the importance of FACTS devices & their controllers.

Topic Covered

UNIT-I

Introduction: (9hrs)

Overview of power system operation, Energy control centre and real time computer control, SCADA system, power system operation and control in India, system security, voltage stability and instability, role of information technology in energy control system, contingency analysis, system states and transient diagrams

UNIT II

Economic Operation: (9hrs)

Energy demand, demand factor, load factor, diversity factor, types of loads, Economic operation of power system and unit commitment, Input-output characteristics of power plants, Economy loading with and without transmission losses, Penalty factor, and computerized approach for economy load dispatch.

UNIT III

Load Frequency Control: (9hrs)

Role of system frequency in real power control, Concept of load frequency control, control area concept, single area and multi area load frequency control scheme, steady state and dynamic response, Automatic load frequency control for interconnected power systems, Automatic load dispatching

UNIT IV

Voltage and Reactive Power control: (9hrs)

Schematic diagram and block diagram representation, automatic excitation control systems, static and dynamic response, low power factor causes, improvement in power factor, concept of real and reactive power, Shunt compensation, series compensation, Flexible AC Transmission Systems**:** Concept and objectives of FACTS controllers, Working & Characteristics of different FACTS Controllers (SVC,TCSC,TCPR).

Textbooks:

1. D.P. Kothari & I.J. Nagrath, "Modern Power System Analysis" Tata McGraw Hill, 3rd Edition.
2. P.S.R. Murty, "Operation and control in Power Systems" B.S. Publications.
3. N. G. Hingorani & L. Gyugyi, "Understanding FACTs" Concepts and Technology of Flexible AC Transmission Systems"
4. J. Wood & B.F. Wollenburg, "Power Generation, Operation and Control "John Wiley Sons.

Reference Books:

5. O.I. Elgerd, "Electric Energy System Theory" Tata McGraw Hill.
6. P. Kundur, "Power System Stability and Control McGraw Hill.

7. M.H. Rashid, "Power Electronics: Circuits, devices and Applications" Prentice Hall of India,3rd Edition.
8.T. K. Nagsarkar & M.S.Sukhiza,' Power System Analysis' Oxford University Press.

EEE-813 : Power Quality

Course category : Professional Elective (PE)
Pre- requisites : Nil
Contact hours/week **:** Lecture : 3, Tutorial :1 , Practical :0
Number of Credits **:** 4
Course Assessment Methods **:** Continuous assessment through assignments, quizzes, and One minor test and One Major Theory Examination.
Course Outcomes(COs) **:** The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Acquire the knowledge of different terms and definitions of power quality.
2. Gains knowledge on causes and effects of voltage sags and its mitigations.
3. Understand power quality monitoring and classification techniques.
4. Gains knowledge on power system transients and harmonics with their effects and mitigation techniques.
5. Know about various power quality measuring, analyzing and testing devices.
6. Get introductory knowledge of custom power devices for further knowledge enhancement

Topic Covered

UNIT I

Introduction to Power Quality: (9hrs)

Terms and definitions of transients, Long Duration Voltage Variations: under Voltage, Under Voltage and Sustained Interruptions**;** Short Duration Voltage Variations: interruption, Sag, Swell; Voltage Imbalance; Notching D C offset, waveform distortion; voltage fluctuation; power frequency variations**.**

UNIT II

Voltage Sag: (9hrs)

Sources of voltage sag: motor starting, arc furnace, fault clearing etc; estimating voltage sag performance and principle of its protection; solutions at end user level- Isolation Transformer, Voltage Regulator, Static UPS, Rotary UPS, Active Series Compensator.

UNIT III

Electrical Transients: (9hrs)

Sources of Transient Over voltages- Atmospheric and switching transients- motor starting transients, pf correction capacitor switching transients, ups switching transients, neutral voltage swing etc; devices for over voltage protection.

Harmonics: Causes of harmonics; current and voltage harmonics: measurement of harmonics; effects of harmonics on – Transformers, AC Motors, Capacitor Banks, Cables, and Protection Devices, Energy Metering, Communication Lines etc. harmonic mitigation techniques.

UNIT IV

Measurement and Solving of Power Quality Problems: (9hrs)

Power quality measurement devices- Harmonic Analyzer, Transient Disturbance Analyzer, wiring and grounding tester, Flicker Meter, Oscilloscope, multimeter etc.

Introduction to Custom Power Devices-Network Reconfiguration devices; Load compensation and voltage regulation using DSTATCOM; protecting sensitive loads using DVR; Unified power Quality Conditioner.

Textbooks:

1. Roger C Dugan, McGrahan, Santoso&Beaty, "Electrical Power System Quality" McGraw Hill

2. Arinthom Ghosh& Gerard Ledwich, "Power Quality Enhancement Using Custom Power Devices" Kluwer Academic Publishers
3. C. Sankaran, "Power Quality" CRC Press.
4. Bhim Singh, Ambrish Chandra, and Kamal Al-Haddad, "Power Quality: Problems and Mitigation Techniques," Wiley.

EEE-814 **Optimal And Adaptive Control Systems**

Course Category : Professional Elective (PE)

Pre-requisite Subject : NIL

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

No of Credits : 4

Course Assessment Methods : Continuous assessment through tutorials, attendance, home assignments, quizzes, One minor test, and one major theory examination.

Course Objectives : This is an advanced course on control system design, covering fundamental aspects of Optimal and adaptive control. A general methodology is developed for systematic design of controllers for 'systems in optimal sense' and 'systems with parametric uncertainty'. It is expected that the students interested in taking this course should have a basic understanding of Lyapunov Stability Theory and working knowledge of MATLAB/Simulink.

Course Outcomes(COs) : The students are expected to demonstrate the following knowledge, skills, and attitudes after the completion of this course:

1. Apply the concept of different types of optimal control for solving problems
2. Apply the concept of calculus of variation and principal of optimality for solving problems
3. Apply the concept of Linear Quadratic method for solving problems
4. Apply the concept of adaptive control technique for solving problems
5. Apply the concept of Self Tuning Regulators.
6. Apply Model Reference Adaptive System for solving problems.

Topics Covered

Unit I: Introduction to Optimal Control **(9hrs)**

Statement of optimal control problem, Problem formulation and types of optimal control, Selection of performance measures, General Model of feedback control systems, Transient performance analysis, Tracking performance analysis, Disturbance rejection analysis, Cost functions and norms, Mathematical preliminary to optimal control

Unit II: Optimal Control of Continuous-time System **(9hrs)**

The calculus of variation, Fundamental concepts, Functional of a single function, Functional involving several functions, Continuous-time LQR, Steady state closed-loop control and sub-optimal feedback, tracking problems.

Unit III: Introduction to Adaptive Control **(9hrs)**

Introduction: Linear feedback, effects of process variations, adaptive schemes, adaptive control problem. Self-tuning Regulators (STR): Pole placement design, indirect STR, direct STR, stochastic and predictive STR, applications.

Unit IV: Model-reference Adaptive Control **(9hrs)**

The MIT rule, determination of adaptive gain, design of MRAS' using Lyapunov theory, BlBO stability, output feedback, relation between MRAS and STR, applications.

Textbooks:

1. Optimal control theory-An Introduction by Donald E.Krik - Prentice Hall Networks series, 2008.
2. Karl J Astrom and Bjorn Wittenmark, "Adaptive Control", Pearson education Inc., New Delhi, Second Edition, 2008.
3. D S Naidu "Optimal Control Systems", CRC Press 2002

References:

1. A.P. Sage - Optimum Systems Control, Prentice Hall.
2. Yoan D. Landu - Adaptive Control - Model Reference Approach, Marcel Dekker
3. HSU and Meyer - Modern Control. Principles and Applications, McGraw Hill

EEE-815 : Power Electronics Applications

Course Category	:	Professional Elective (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial:1, Practical: 0
No of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, One minor test, and one major theory examination.
Course Objectives	:	To learn and apply power electronic converters and controllers for power quality improvement, FACTS devices and renewable energy integration.
Course Outcomes(COs)	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

CO1: Capability in designing of flexible AC transmission system (FACTS) using power electronics devices.
CO2: Ability to analysis of Sag & swell through power inverter circuit.
CO3: Competency in operation and types of Power converters for renewable energy sources.
CO4: To analysis of power quality active filter.
CO5: Competency in operation and types of DC-AC Inverter for renewable energy sources
CO6: Competency in operation and types of DC-DC converters for renewable energy sources.

UNIT 1: (9hrs)

Basics of Flexible AC transmission systems (FACTS), Principles of series and shunt compensation, Thyristor controlled compensators-static var compensators (SVC), series compensators (TCSC), phase shifters (PS), series compensator (SSSC) and Unified power flow controller (UPFC) -structure and circuit analysis

UNIT 2: (9hrs)

Power quality problems, distribution system and their mitigation using power electronic converters: harmonic mitigation using passive filters, Active filters, hybrid filters.

UNIT 3: (9hrs)

Sag & swell mitigation using Dynamic voltage restorers, STATCOM/DSTATCOM, Unified power quality conditioners (UPQC), Active Front End Rectifiers: Power factor correction, single phase and three-phase, control schemes.

UNIT 4: (9hrs)

Power converters for renewable energy sources: Block diagram of converter for various renewable energy sources, working principle of converter for various renewable energy sources, design of converter,

control of converters, selection of line commutated converters (inversion-mode), Boost and buck-boost converters and filtering requirements, load requirement.

References

1. T.J.E. Miller, Static Reactive Power Compensation, John Wiley & Sons, New York,1982.
2. Arindam Ghosh & Gerard Ledwich, "Power Quality Enhancement Using Custom Power Devices," IEEE Press.

EEE-816 : Energy Efficiency & Conservation

Course category : Professional Elective (PE)
Pre- requisites : Nil
Contact hours/week : Lecture : 3, Tutorial :1 , Practical :0
Number of Credits : 4
Course Assessment Methods : Continuous assessment through tutorials, assignments, quizzes, and One minor test and One Major Theory Examination.

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

1. Conceptual knowledge of the technology, economics and regulation related issues associated with energy conservation and energy auditing.
2. The concepts of Energy conservation& Energy Audit.
3. The concept of Demand Side Management.
4. Understand the concepts of Voltage and Reactive power in Distribution System.
5. Ability to analyse the viability of energy conservation projects
6. The concept of Efficiency in Motors and Lighting system.

Topic covered

UNIT I

Energy conservation: (9hrs)

Principles of Energy Conservation, Energy conservation Planning, Energy conservation in small scale industries, large scale industries ,electrical generation, transmission, and distribution

Energy Audit: -

Aim of energy Audit, Strategy of Energy Audit, Energy management Team Considerations in implementing energy conservation Programme, Instruments for energy audit

UNIT II

Demand Side Management: (9hrs)

Concept and Scope of Demand Side Management, Evolution of Demand Side Management, DSM Strategy, Planning, Implementation and its application. Customer Acceptance & its implementation issues. National and International Experiences with DSM.

UNIT III

Voltage and Reactive power in Distribution System: (9hrs)

Voltage and reactive power calculations and control: Voltage classes and nomenclature, voltage drop calculations, Voltage control, VAR requirements and power factor, Capacitors unit and bank rating, Protection of capacitors and switching, Controls for switched capacitors and fields testing.

UNIT IV

Efficiency in Motors and Lighting system: (9hrs)

Load scheduling/shifting, Motor drives- motor efficiency testing, energy efficient motors, and motor speed control. Lighting- lighting levels, efficient options, fixtures, day lighting, timers, Energy efficient windows, Indian Electricity Act 1956, Distribution Code and Electricity Bill 2003

Text / Reference Books

1. Tripathy S. C., "Electric Energy Utilization and conservation", Tata McGraw Hill.
2. Industrial Energy Conservation Manuals, MIT Press, Mass, 1982.
3. "The Efficient Use of Energy", Edited by I.G.C.Dryden, Butterworths, London, 1982.
4. Energy Management Handbook, Edited by W.C.Turner, Wiley, New York, 1982.
5. L.C.Witte, "P.S.Schmidt, D.R. Brown, Industrial Energy Management and Utilization", Hemisphere Publ, Washington, 1988
6. Power Capacitor Handbook, Butterworth & Co (Publishers) Ltd, 1984.
7. Electrical Systems Analysis and Design for Industrial Plants, McGraw-Hill Book Company.
8. IEEE Bronze Book, 'Recommended Practice for Energy Conservation and cost-effective planning in Industrial facilities, IEEE Press.

EEE-817 : Bio Instrumentation

Course category : Professional Elective (PE)
Pre- requisites : Nil
Contact hours/week : Lecture : 3, Tutorial :1 , Practical :0
Number of Credits : 4
Course Assessment Methods : Continuous assessment through tutorials, assignments, quizzes, and One minor tests and One Major Theory Examination.

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

1. The Fundamentals of Bio-Medical Instrumentation.
2. Acquire the knowledge of biomedical instrumentation principles in aspects of device design and applications.
3. Ability to analyze contemporary bioinstrumentation studies to make connections and decisions based on their scientific merit.
4. The concept of the Cardiovascular System and Measurements.
5. The concept of the Nervous & Respiratory System and its Measurements.
6. Patient Care Monitoring & Imaging Techniques.

Topic covered

UNIT I

Fundamentals of Bio-Medical Instrumentation: (9hrs)

Introduction to bioinstrumentation, anatomy & physiology, basic medical instrumentation scheme, different physiological systems of body, Problems encountered in measuring living systems, Transducers for biomedical applications. Generation, propagation, and distribution of different bioelectric potentials (ECG, EEG, EMG etc.). Bio-potentials electrodes, electrode theory, types of electrodes, biochemical transducers. Action& resting potentials.

UNIT II

The Cardiovascular System and Measurements: (9hrs)

The heart, electrical &mechanical activity, cardiovascular systems, Electrocardiography, ECG lead configurations ECG recording and their types, Einthoven triangle, interferences. measurement methods of blood flow, heart sound, Phonocardiogram, circulation block diagram of blood pressure and measurement.

UNIT III

The Nervous & Respiratory System and its Measurements (9hrs)

The anatomy of nervous system, Neuronal communication, EPSP & IPSP, Organization of the brain, Measurements from the nervous system, Respiratory system, Different types of Spirometers, Body & skin temperature measurements.

UNIT IV

Patient Care Monitoring & Imaging Techniques: (9hrs)

Elements of intensive care, Organization of the Hospital (HIS) for patient-care monitoring, Pace-makers-types, modes and generators, Defibrillators-types. Instrumentation for diagnostic; X Rays, Ultrasonic, CT & MRI, biomedical computer applications. Shock hazards from electrical equipments, methods of accident prevention.

Textbook:

1. T. Cromwell, F.J. Weibell & F. A. Pfieffer, "Biomedical Instrumentation & Measurements" Prentice Hall International

Reference Books:

2. R.S. Khanpur, "Handbook of Biomedical Instrumentation" Tata McGraw Hill
3. H.E. Thomas, "Handbook of Biomedical Instrumentation and Measurement" Restone Publishing Company
4. J.G. Webester, "Medical Instrumentation", Houghton Mifflin.

IEE-410	**:**	**Industrial Practices**
Course category	:	Industrial Practices (IP)
Pre-requisite Subject	:	Nil
Contact hours/week	:	Lecture:0, Tutorial:0, Practical:20
Number of Credits	:	10
Course Assessment methods	:	The industrial training of the students will be evaluated in three stages: (i) Evaluation by Industry (ii) Evaluation by faculty supervisor (iii) Evaluation through seminar presentation/viva-voce at the Institute.
Course Objectives	:	1. Participate in the projects in industries during his or her industrial training. 2. Interact with industrial personnel and follow engineering practices and discipline prescribed in industry.
Course Outcomes(COs)	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Learn to apply the technical knowledge in real industrial situations.
2. Promote academic, professional and/or personal development
3. Expose students to the engineer's responsibilities and ethics.
4. Familiarize with various materials, processes, products, and their applications along with relevant aspects of quality control. Gain experience in writing technical reports/projects
5. Expose the students to future employers.
6. Understand the social, economic, and administrative considerations that influence the working environment of industrial organizations

IEE-411 : Major Project

Course category	**:**	Major Project(MP)
Pre- requisites	**:**	Nil
Contact hours/week	**:**	Lecture: 0, Tutorial :0, Practical :20
Number of Credits	**:**	10
Course Assessment Methods	**:**	Continuous assessment through one viva voce/presentation, project report Submission, Evaluation of Development of hardware based or software-based simulation module by faculty supervisor through seminar presentation/viva-voce at the Institute.
Course Outcomes(COs) **:**		The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

1. Ability to learn, design & analysis of electrical engineering system modules.
2. Acquire knowledge by developing of hardware-based engineering module.
3. Acquire knowledge by developing of software-based simulation module.
4. Obtain the knowledge about the recent tool-based research work in engineering.
5. Communicate with engineers and the community at large in written an oral form.
6. Design engineering solutions to complex problems utilizing a systems approach.

EEE-901	**: Computational Tools for Optimization**
Course Category	**:** Professional Elective (PE)
Pre-requisites	**:** Nil
Contact Hours/Week	**:** Lecture: 3, Tutorial: 1, Practical: 0
Credits	**:** 4
Course Assessment Methods	• Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test • Final Evaluation: One Major Theory Examination
Course Outcomes (COs)	**:** The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Identify commonly used computational tools for optimization.
2. Formulate objective functions and constraints using software tools.

3. Solve linear and nonlinear optimization problems using MATLAB.
4. Implement optimization models using Python-based libraries.
5. Apply evolutionary optimization techniques for complex problems.
6. Compare and select appropriate optimization tools for practical applications.

Unit 1: Introduction to Computational Tools for Optimization (9hrs)

Overview of optimization software: MATLAB, Excel Solver, GAMS, Installation, and setup of optimization environments (MATLAB Toolboxes), Introduction to syntax and interfaces for optimization functions, defining objective functions and constraints using tools

Unit 2: Optimization using MATLAB (9hrs)

MATLAB Optimization Toolbox: fmincon, fminunc, linprog, quadprog, ga**,** solving linear and nonlinear optimization problems**,** Working with constraint functions (equality, inequality, bounds)**,** Multi-objective optimization using gamultiobj

Unit 3: Optimization using Python (9hrs)

Python libraries: SciPy.optimize, Pyomo, cvxpy, pulp, DEAP**,** Linear, nonlinear, and integer programming using SciPy.optimize**,** Model building with Pyomo: Variables, objectives, constraints

Unit 4: Advance Evolutionary Tools for Optimization (9hrs) Genetic Algorithm (GA), Particle Swarm Optimization (PSO), and Simulated Annealing in MATLAB**,** Comparative study: MATLAB vs Python tools for optimization**,** Optimization using MATLAB for industrial problems**.** A case study with a current optimization method.

Text Book

1. Rao, S. S. (2017). *Engineering Optimization: Theory and Practice* (4th ed.). Wiley.
2. Nocedal, J., & Wright, S. J. (2006). *Numerical Optimization* (2nd ed.). Springer.
3. Chapra, S. C., & Canale, R. P. (2015). *Numerical Methods for Engineers* (7th ed.). McGraw-Hill Education.
4. Sanderson, A. C., & Zopounidis, C. (2019). *Handbook of Research on Soft Computing and Nature-Inspired Algorithms*. IGI Global.

EEE-902	**Intelligent Grid Systems and Microgrid Integration**
Course Category	**:** Professional Elective (PE)
Pre-requisites	**:** Nil
Contact Hours/Week	**:** Lecture: 3, Tutorial: 1, Practical: 0
Credits	**:** 4
Course Assessment Methods	• Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test • Final Evaluation: One Major Theory Examination
Course Outcomes (COs)	: The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Explain the characteristics, operation, and switching behaviour of key power semiconductor devices including SCR, MOSFET, IGBT, and BJT.
2. Analyze the operation and performance of AC-DC rectifiers and understand power factor implications.
3. Evaluate the principles, design, and performance of DC-DC converters in both continuous and discontinuous modes.
4. Apply various modulation techniques (PWM, SVM) to DC-AC inverters and assess harmonic content and efficiency.
5. Explain the working and control of AC-AC converters, matrix converters, and active rectifiers.

6. Assess practical aspects such as gate drive design, snubber circuits, and thermal management in power electronics systems.
7. Illustrate the role and application of power electronics in renewable energy systems, power conditioning, and smart grid technologies.

Topics Covered

Unit I: (9hrs)

Power Semiconductor Devices and AC-DC Converters: Characteristics and operation of power semiconductor devices. Diodes, SCRs, BJTs, MOSFETs, and IGBTs.Review of basic semiconductor physics. Uncontrolled and controlled rectifiers (single-phase and three-phase). Performance parameters: average voltage/current, ripple, and efficiency. Power factor considerations and effect of source impedance

Unit II: (9hrs)

DC-DC and DC-AC Converters: Principles and operation of DC-DC converters: Buck, Boost, Buck-Boost, and Cuk, Continuous and discontinuous conduction modes (CCM and DCM), Single-phase and three-phase inverters, PWM techniques: Sinusoidal PWM, carrier-based PWM, Harmonic reduction techniques, Introduction to current source inverters (CSI)

Unit III: (9hrs)

AC-AC Converters and Control of Power Converters: AC-AC converters: Voltage controllers and cycloconverters, Control strategies: Feedback and feedforward control, Classical control approaches: PI/PID for converter regulation, Introduction to space vector modulation (SVM), Specialized converters: Matrix converters and active rectifiers, Control implementation basics (sampling, modulation timing, etc.)

Unit IV: (9hrs)

Practical Aspects and Applications: Gate drive circuits and isolation techniques, Snubber circuit design, Heat sinking, thermal modeling, and management, Applications in renewable energy systems (solar PV, wind), Power conditioning and quality improvement techniques, Overview of power electronics in modern energy systems (smart grid, microgrids)

Books & References

1. *Fundamentals of Power Electronics* by R. W. Erickson and D. Maksimović
2. *Power Electronics: Converters, Applications, and Design* by Ned Mohan

EEE-903		**Numerical Methods & Optimization Techniques**
Course Category	:	Professional Elective (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial:1, Practical: 0
No of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, one minor test, and one major theory examination.
Course Objectives	:	To equip students with numerical and optimization techniques for solving engineering problems involving equations, interpolation, integration, and constrained optimization.
Course Outcomes(COs)	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

1. Apply methods like Newton-Raphson, Bisection, and Regula-Falsi to find solutions within a specific tolerance
2. To interpolate a curve using Gauss, Newton’s interpolation formula.

3. Use the theory of optimization methods and algorithms developed for various types of optimization problems.
4. To apply the mathematical results and numerical techniques of optimization theory to Engineering problems.
5. Solve systems using Gauss-Elimination and Gauss-Seidel iterations.
6. Understand unconstrained and constrained optimization, including the use of Lagrange Multipliers.

Topics Covered

Unit I: Numerical Methods I **(9hrs)**

Solution of algebraic and transcendental equations by Bisection, Regula- Falsi and Newton Raphson methods. Interpolation: Newton's forward and backward interpolation formulae, Lagrange's formula, and Newton's divided difference formula.

Unit II: Numerical Methods II **(9hrs)**

Solution of system of linear equations by Gauss Jacobi method, Guass- Siedel method, Relaxation method and LU decomposition method, Cholesky method. Numerical differentiation, Numerical Integration: Trapezoidal Rule, Simpson's one-third and three-eight rules.

Unit III: Classical Optimization Techniques **(9hrs)**

Introduction, Review of single and multi-variable optimization methods with and without constraints, Non-linear one-dimensional minimization problems, and Examples.

Unit IV: Constrained Optimization Techniques **(9hrs)**

Introduction, Direct Methods, Cutting plane method, Indirect methods, convex programming problems, Exterior penalty function method, Examples, and problems. Unconstrained optimization techniques: Introduction, Descent methods, Steepest Descent methods Newton's method, Quasi-Newton's method.

Text Books

1. S.S.Rao; Engineering Optimization, New Age International.
2. E.J. Haug and J.S. Arora, Applied Optimal Design; Wiley New York.
3. P. Kandasamy, K.Thilagavathy & K.Gunavathy, Numerical Methods, S. chand Publ.

EEE-904	**Smart Grid: Basics to Advanced Technologies**
Course Category	**:** Professional Elective (PE)
Pre-requisites	**:** NIL
Contact Hours/Week	**:** Lecture: 3, Tutorial: 1, Practical: 0
Credits	**:** 4
Course Assessment Methods	• Continuous Assessment: Tutorials, Assignments, Attendance, Quizzes, One Minor Test • Final Evaluation: One Major Theory Examination
Course Outcomes (COs)	: The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Explain smart grid architecture, components, and communication standards..
2. Analyze distributed generation and energy storage systems in smart grids.
3. Model AC, DC, and hybrid microgrids with suitable control strategies.
4. Apply monitoring, protection, and islanding detection techniques in smart grids
5. Apply monitoring, protection, and islanding detection techniques in smart grid
6. Assess demand response, energy management, and ancillary services in smart grids.

Topics Covered

Unit I: **(9hrs)**

Fundamentals of Micro Grid Systems: Introduction to Smart Grid Concepts: Need, evolution, and objectives. Architecture and communication standards of smart grid systems. Key elements and enabling technologies of smart grids. Distributed Generation (DG) resources: Solar PV, wind, small hydro, and biomass systems.

Unit II: **(9hrs)**

Energy Storage, Monitoring, and Protection: Energy Storage Technologies: Types, modeling, and battery management systems. Optimal sizing and placement of energy storage in smart grids. Wide Area Monitoring Systems (WAMS): Architecture, Phasor Measurement Units (PMU). Islanding detection techniques. Smart grid protection systems: Digital relays and coordination

Unit III: **(9hrs)**

Microgrid Operation and Control: Introduction to AC, DC, and hybrid AC-DC microgrids. Modeling of smart grid components and storage devices. Operation and control strategies for AC, DC, and hybrid microgrids. Hierarchical control techniques for microgrid management. PMU placement strategies and cyber security issues.

Unit IV: **(9hrs)**

Demonstrations, Case Studies, and Energy Management: Demand-side management and demand response. Virtual inertia and ancillary services from smart grid resources. Demonstration modules: Solar, wind, EV charging, and BMS. Harmonic mitigation and simulation of AC/DC/Hybrid microgrids. Practical smart grid design, case studies, and energy management demonstrations

Books & References:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai, *Integration of Green and Renewable Energy in Electric Power Systems*, Wiley, 2010.
2. James Momoh, *Smart Grid: Fundamentals of Design and Analysis*, Wiley, 2012.
3. S. Chowdhury, S. P. Chowdhury, P. Crossley, *Microgrids and Active Distribution Networks*, IET, 2009.
4. NPTEL Course: *Smart Grid: Basics to Advanced Technologies* by Prof. N. P. Padhy and Prof. P. Jena, IIT Roorkee.
5. H. Farhangi, *The Path of the Smart Grid*, IEEE Power and Energy Magazine, 2010.

EEE-911	**: Non-Conventional Energy Resources**
Course category	: Professional Elective (PE)
Pre- requisites	: Nil
Contact hours/week	: Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:04
Course Assessment Methods	: Continuous assessment through tutorials/assignments, attendance, quizzes/record, One minor test and one major theory examination.
Course Outcomes(COs)	:The student are expected to be able to demonstrate the following knowledge and skills after completing this course

1. Identify non-conventional energy sources and explain basics of solar PV and biomass conversion..

2. Describe solar thermal collectors/plants and basic thermo-electric/thermionic conversion..
3. Explain geothermal conversion, and outline working of MHD and fuel cells..
4. Describe wind energy conversion and basics of OTEC, wave/tidal, and waste-to-energy plants.
5. Compare renewable technologies by resource, performance, and limitations.
6. Choose an appropriate technology for a site/application considering sustainability and environment.

Topic Covered

UNIT-I

Introduction **(9hrs)**

Various non-conventional energy resources- Introduction, availability, classification, relative merits, and demerits. **Solar, wind, geothermal, ocean, and biomass resources overview. Introduction to United Nations Sustainable Development Goals**

Solar Cells: Theory of solar cells, photovoltaic effect, basic working principle. Solar cell materials, solar cell array, solar cell power plant, limitations.

Biomass: Availability of biomass and its conversion theory.

UNIT-II

Solar Thermal Energy: **(9hrs)**

Solar radiation, flat plate collectors and their materials, applications, and performance, focusing of collectors and their materials, applications and performance**,** parabolic troughs, dishes, solar concentrators. Solar thermal power plants, thermal energy storage for solar heating and cooling, limitations.

Thermo-electrical and thermionic Conversions: Principle of working, performance, and limitations. Seebeck and peltier effects.

UNIT-III **(9hrs)**

Geothermal Energy:

Resources of geothermal energy, thermodynamics of geo-thermal energy conversion-electrical conversion, non-electrical conversion, environmental considerations.

Magneto-hydrodynamics (MHD): Principle of working of MHD Power plant, performance and limitations.

Fuel Cells: Principle of working of various types of fuel cells and their working, performance and limitations.

UNIT-IV

Wind Energy: **(9hrs)**

Wind power and its sources, site selection, criterion, momentum theory, classification of rotors, concentrations and augments, wind characteristics. performance and limitations of energy conversion systems.

Ocean Thermal Energy Conversion (OTEC): Availability, theory and working principle, performance, and limitations.

Wave and Tidal Wave: Principle of working, performance, and limitations. Waste Recycling Plants. Tidal barrages, waste-to-energy plants.

Text/References: Books/Reports/Resolution/Review Paper-

1. Raja etal, “Introduction to Non-Conventional Energy Resources” Scitech Publications.
2. John Twideu and Tony Weir, “Renewal Energy Resources” BSP Publications, 2006.

3. M.V.R. Koteswara Rao, "Energy Resources: Conventional & Non-Conventional "BSP Publications,2006.
4. D.S. Chauhan,"Non-conventional Energy Resources" New Age International.
5. C.S. Solanki, "Renewal Energy Technologies: A Practical Guide for Beginners" PHI Learning.
6. Peter Auer, "Advances in Energy System and Technology". Vol. 1 & II Edited by Academic Press.
7. W. Leal Filho, A. M. Azul, L. Brandli, A. L. Salvia, and T. Wall, Eds., Affordable and Clean Energy: Encyclopedia of the UN Sustainable Development Goals, Springer, doi: 10.1007/978-3-319-71057-0
8. United Nations General Assembly, Transforming our world: The 2030 Agenda for Sustainable Development, Resolution A/RES/70/1, 2015, Available: https://sdgs.un.org/2030agenda
9. S. Sorooshian, "The sustainable development goals of the United Nations: A comparative midterm research review," Journal of Cleaner Production, vol. 453, Art. no. 142272, 2024. doi: 10.1016/j.jclepro.2024.142272

EEE-912 : Utilization and Traction
Course category : Professional Elective (PE)
Pre- requisites : Nil
Contact hours/week : Lecture : 3, Tutorial :1 , Practical :0
Number of Credits : 4
Course Assessment Methods : Continuous assessment through tutorials, assignments, Quizzes and One Minor Test and One Major Theory

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

1. Advantages and methods of electrical heating, concept of resistance heating, electrical arc heating, induction heating and dielectric heating.
2. Knowledge of electric arc welding, resistance welding and electronic welding control, laws of electrolysis, concept of electro deposition and application of electrolysis.
3. Laws of illumination, requirement of good lighting, design of indoor and outdoor lighting, concept of refrigeration and air condoning systems, domestic refrigerator and water cooler, concept of window air conditioner.
4. Knowledge of types of electric traction, system of electrification, traction mechanism, speed time curve specific energy consumption mechanism of train movement, coefficient of adhesion and its influence.
5. Salient features of traction drives, series parallel control of traction drives and energy saving, power electronic control dc and ac traction drives, diesel electric traction.
6. Select most suitable type and specification of illumination source for efficient conversion and recognize different process of utilizing electric energy for heating and electrolytic process in industries purposes mostly in commercial along with few household applications.

Topic Covered

UNIT I

Electric Heating: (9hrs)

Advantages and methods of electric heating, Resistance heating, Electric arc heating, Induction heating, Dielectric heating**,** Electric Arc Welding, Electric Resistance welding, electronic welding control, Principles of electro deposition, Laws of electrolysis, applications of electrolysis

UNIT II

Illumination: (9hrs)

Various definitions, Laws of illumination, requirements of good lighting, Design of indoor lighting and outdoor lighting systems, Refrigeration systems, domestic refrigerator, water cooler, Types of air conditioning, Window air conditioner

UNIT III

Electric Traction: (9hrs)

Types of electric traction, systems of track electrification, types of services, speed time curve and its simplification, average and schedule speeds, Tractive effort, specific energy consumption, mechanics of train movement, coefficient of adhesion and its influence

UNIT IV

Modern Electric Traction (9hrs)

Salient features of traction drives, Series – parallel control of dc traction drives (bridge transition) and energy saving, Power Electronic control of dc and ac traction drives, Diesel electric traction.

Textbooks:

1. H. Partab, "Art and Science of Electrical Energy" Dhanpat Rai& Sons.
2. G.K. Dubey, "Fundamentals of Electric Drives" Narosa Publishing House

Reference Books:

3. H. Partab, "Modern Electric Traction" Dhanpat Rai& Sons.
4. C.L. Wadhwa, "Generation, Distribution and Utilization of Electrical Energy" New Age International

EEE-913 : SCADA & Energy Management System

Course category **:** Professional Elective (PE)
Pre- requisites **:** Nil
Contact hours/week **:** Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits : 4
Course Assessment Methods **:** Continuous assessment through tutorials, assignments**,** Quizzes and One Minor Test and One Major Theory

Course Outcomes(COs) **:** The student are expected to be able to demonstrate the Following knowledge, skills and attitudes after completing this course

1. Understand the fundamentals of energy management functions.
2. Understand the concepts of SCADA & its use in power system.
3. The concept of energy management system.
4. Enhance the knowledge in lighting and cogeneration.
5. SCADA System Components and Applications.
6. Expose to the concept of supervisory control and data acquisition.

Topic covered

UNIT I

An Introduction to SCADA: (9hrs)

Purpose and necessity, general structure, data acquisition, transmission & monitoring, general power system hierarchical Structure. Overview of the methods of data acquisition systems, transducers, RTUs, Master terminal unit, various communication channels- cables, telephone lines, power line, microwaves, optical fibre channels and satellites.

UNIT II

SCADA in Power System: (9hrs)

Tasks in power system operation, Operational tasks at various hierarchical levels, National load control centre, regional load control centre, generating station control management, SCADA types, Automatic generation control, SCADA in power distribution, SCADA in power grid, distribution substation and feeder automation

UNIT III

Supervisory Power Management: (9hrs)

Energy Management system, power system operational states, security analysis, state estimation, load forecasting, classification of load forecast, effecting factors, methods of load forecasting, energy audit, utility distributed system design, regulation and distribution automation, fault control management.

UNIT IV

SCADA System Components and Applications: (9hrs)

Intelligent electronic device, SCADA server, Human-Machine interface, Components of control system, Programmable logic controllers, SCADA applications for transmission and distribution sector, SCADA base Instrumentation, Case studies on SCADA.

Textbooks:

1. Torsten Cergrell, "Power System Control Technology", Prentice Hall International.
2. George L Kusic "Computer Aided Power System Analysis", Prentice Hall of India,
3. A. J. Wood and B. Woolenberg, "Power Generation Operation and Control", John Wiley & Sons.
4. T.K Bisht, "SCADA and Energy Management System" S K Kataria and sons

EEE-914 : Introduction to Battery Technology and Management System

Course Category	**:**	Professional Elective (PE)
Pre-requisite Subject	**:**	Elementary knowledge of electrical circuit analysis and electrical circuit simulations.
Contact hours/week	**:**	Lecture : 3, Tutorial : 1, Practical : 0
Number of Credits	**:**	4
Course Assessment Methods	**:**	Continuous assessment through tutorials, assignments, Quizzes, one minor test and Major Theory Examination.
Course Outcomes(COs)	**:**	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

1. To gain thorough knowledge of battery fundamentals, important terms and characteristics used in battery technology.
2. To understand the industrial specifications of batteries and mathematical modeling of battery cell used in simulation circuits.
3. To Describe the recent developments battery systems and battery packs.
4. To acquire knowledge about battery management system and its design.
5. To get knowledge about battery charging and its simulation.
6. To able to understand the thermal management of battery packs and recent trends in energy storage systems.

Unit-1: (9hrs)

Energy and Electrochemistry: Sources of energy for propulsion and their comparison, net calorific value and conversion efficiency, history and background of battery technology, electrochemistry fundamentals and technologies, Lithium-ion battery and different chemistries.

Important Terms and Characteristics: Portable power applications and electrical load requirements, Factors affecting the choice of EV battery systems, Commercially available lithium-ion cells, Electrical characteristics of battery: Capacity, C-rate, impedance, DOD, SOC, SOH, Life cycle, Mechanical characteristics, Form factor, safety.

Unit-2: (9hrs)

Mathematical Modelling: Reading cell manufacturer's specifications, Cell characterization, Tools and standard testing, Battery capacity estimation algorithms, Electrical equivalent circuit and mathematical model used in simulation.

Battery Pack Construction: Battery modules and complete battery pack system, Assembly methods, Electrical connections, Cell level protection system, Battery pack level protection system, Understanding laptop battery pack system.

New Energy Storage Technologies: New battery technologies, ultra capacitor, fuel cell, flywheel, sources of energy for propulsion and their comparison: net calorific value & conversion efficiency, hybridization of energy storage systems.

Unit-3: (9hrs)

Battery Management System and Design: Introduction, Battery pack requirements: measurement, protection and management, cell balancing, battery packs electronics, battery management system: functionality, technology and topology (centralized, modular, master-slave, distributed).BMS application specific integral circuit (ASIC) selection, analog BMS design, digital BMS design, BMS deploying: Installing, testing and troubleshooting.**Battery Charging:** Battery charge management, simulation of battery charging circuit, charger circuit overview, Charging behavior: life cycle and safety.

Unit-4: (9hrs)

Thermal Management: Types of temperature sensors, thermal management system, thermal model of battery pack, drive cycle simulation and vehicle range estimation, cooling materials and methods.

Recent Trends and Economy: Communication system for battery pack, review of electric car battery pack, important considerations, recent trends: grid level energy storage, solar and wind integration, recycling and pricing.

Reference Books :

1. T. Minami, M. Tatsumisago, M. Wakihara, C. Iwakura, S. Kohijiya, Solid state ionics for batteries, Springer Publication, 2009
2. Sandeep Dhameja, Electric Vehicle Battery Systems, Newnes publication, 2001.
3. Bard, Allen J., and Larry R. Faulkner. Electrochemical Methods: Fundamentals and Applications. 2nd ed., Wiley– VCH, Verlag, GmbH, 2000.
4. Masataka Wakihara and Osamu Yamamoto, Lithium ion Batteries Fundamental and Performance, Wiley–VCH, Verlag GmbH, 1999.
5. Robert A.Huggins, Advanced Batteries – Materials science aspects, Springer, 2009.
6. Mark A Rosen and Aida Farsi Battery Technology: From fundamentals to thermal behavior and Management, Elseweir, Academic Press 2023.
7. Xiaojun Tan, Andrea Vezzini, Yuqian Fan, Neeta Khare, You Xu, Liangliang Wei; Battery Management System and its Applications, Wiley, 2022, © 2023 China Machine Press.

EEE-915 : Industrial Process Control
Course category : Professional Elective (PE)
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 Outcomes (COs): The student are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course:

1. Understand the need of process control, basic principles of various manufacturing processes and apply engineering knowledge to do problem analysis in process control.

2. Define common dynamics of processes found in many industries and model them mathematically.
3. Select the proper controller and apply the tuning rules to achieve optimum performance.
4. Understand, interpret, and implement tuning of the controllers using various methods.
5. Select advanced control strategy to enhance the performance.
6. Gain the insight of some of the state-of-the-art control schemes.

Unit-1:

Introduction (9hrs)

Introduction to Process Control. Control objectives, Servo and Regulatory control, Classification of process variables.

Modelling of Some Chemical Process Systems

Modelling basics, Degree of Freedom, Mass Balance, Energy Balance equations, linearization of nonlinear systems, Modelling of Level Tank System, Continuous Stirred Tank Heater, Continuous Stirred Tank Reactor, Transfer function

Unit-2:

Elements of Process Control (9hrs)

Dead time, Interacting and non-interacting systems, Self-regulation, Inverse response, Capacity of process, Integrating systems, Multi-capacity process.

Process Identification

Dynamic behaviour of first and second order processes, Obtaining First Order Plus Time Delay (FOPTD) model with Process Reaction curve. Obtaining second order model of processes.

Unit-3:

Common Controller Modes (9hrs)

Controller Modes, ON OFF, Multi position, Proportional controller, Integral and Derivative modes, PI, PD, PID Controller, Electronics Controller, Dynamic Behaviour of closed loop systems with P, I, D, PI, PID modes.

Tuning of Controllers

Application and tuning, ZN Tuning (Open loop and Closed loop), Performance criteria, Integral criteria.

Unit-4: (9hrs)

Some Advance Control Techniques

Feed forward and Feedback Control, Cascade Control, Ratio Control, Optimal Control Basics, Fractional Order Control, Basics of Sliding Mode Control

Text Books:

1. **G. Stephanopolous**, "Chemical Process Control an Introduction to Theory and Practice", Prentice Hall India, August 2000.
2. **Surekha Bhanot**, "Process Control Principles and Applications", Oxford, 2008 3. C.D. Johnson, "Process Control Instrumentation Technology", Prentice Hall India.
3. **Thomas Marlin**, "Process Control Designing Processes and Control for Dynamic Performance",Tata MC Graw Hill, 2012.
4. **F.G. Shinskey**, "Process Control Systems Application Design and Adjustment" 3rd edition, McGraw Hill International,
5. **D. E. Seborg, T.F. Edgar, D. A. Mellichamp**, "Process Dynamics and Control", Wiley, 2004

Annexure-01

Syllabus of Audit Courses

CONSTITUTION OF INDIA

Course Code: : AUC 101 Credits (0-0-0)
Course Category : Audit
Pre-requisite Subject : NIL
Contact Hours/Week : 1/2 Lecture : , Tutorial : , Practical:
Number of Credits : 0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.

Course 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 .imla, H.PAdvanced Study, Sh
- 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

Annexure-02

Minor Degree Courses

Department of Electrical Engineering

Minor Degree 1: Industrial Optimization

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE1	EEE-101	Linear Programming for Optimization	3	0	2	4
PE3	EEE-301	Nonlinear Optimization	3	1	0	4
PE5	EEE-501	AI & Machine Learning for Optimization	3	1	0	4
PE7	EEE-701	Application of Optimization in Industry	3	1	0	4
	EEE-705/NPTEL	Industrial Engineering and Operations Research				
PE9	EEE-901	Computational Tools for Optimization	3	1	0	4
	EEE-905/NPTEL	Artificial Intelligence in Industrial and Management Engineering				
					Total	20

Minor Degree 2: Power Electronics and Advanced Applications

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE1	EEE-102	Fundamentals of Power Electronics	3	1	0	4
PE3	EEE-302	Advanced Power Converter Design	3	1	0	4
PE5	EEE-502	Control and Modulation Techniques in Power Electronics	3	1	0	4
PE7	EEE-702	Applications of Power Electronics in Emerging Technologies	3	1	0	4
PE9	EEE-902/ NPTEL	Intelligent Grid Systems and Microgrid Integration	3	1	0	4
					Total	20

Minor Degree 3: Industrial Automation and Robotics

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE1	EEE-103	Modelling And Simulation Techniques	3	0	2	4
PE3	EEE-303	Linear Control System	3	1	0	4

PE5	EEE-503	Introduction To Robotic Control	3	0	2	4
PE7	EEE-703	Industrial Instrumentation and Process Control	3	1	0	4
PE9	EEE-903	Numerical Methods & Optimization Techniques	3	1	0	4
	EEE-906/(NPTEL)	Industrial Automation and Control				
					Total	20

Minor Degree 4: NEXT GENERATION ELECTRIC VEHICLE

(To be offered by EED , ECED & MED)

Category	**Subject Code**	**Name of Subject**	**Credit**			**Total Credit**	**Department**
			L	T	P		
PE1	EEE-104	Power Electronics Systems and Grid Integration for Electric Vehicles	3	1	0	4	EED
PE3	EEC-311	Embedded System for Electric Vehicle	3	1	0	4	ECED
PE5	EME-511	Vehicle Dynamics and control	3	1	0	4	MED
PE7	EME-711	Sustainable Energy and EVs	3	1	0	4	MED
PE9	EEE-904	Smart Grid: Basics to Advanced Technologies	3	1	0	4	EED
						Total	20

Annexure-03

Micro Specialization Courses

Department of Electrical Engineering

Micro Specialization 1: Smart Power and Energy System

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE2	EEE-201	Power Generation Engineering	3	1	0	4
PE4	EEE-401	Emerging Technologies in Renewable Energy Sources	3	0	2	4
PE6	EEE-601	Power Market- Planning and Operations	3	1	0	4
PE8	EEE-801	Smart Grid and Resilient Power System	3	1	0	4
	EEE-804/NPTEL	Economic Operations and Control of Power Systems				
					Total	16

Micro Specialization 2: EV Power Train and Battery System

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	
PE2	EEE-202	Fundamentals of Electric Vehicles	3	1	0	4
PE4	EEE-402	Energy Storage, Battery Management Systems, and Motor Drives for EVs	3	1	0	4
PE6	EEE-602	EV Grid Integration and Smart Systems	3	1	0	4
PE8	EEE - 802/NPTEL	EV - Vehicle Dynamics and Electric Motor Drives	3	1	0	4
					Total	16

Micro Specialization 3: Systems & Control

Category	Subject Code	Name of Subject	Credit			Total Credit
			L	T	P	

PE2	EEE-203	Scientific And Engineering Computation	2	1	2	4
PE4	EEE-403	Fuzzy Logic Control System & Applications	3	1	0	4
PE6	EEE-603	Modern Control System	3	1	0	4
PE8	EEE-803	Nonlinear Control System	3	1	0	4
					Total	16

Annexure-04

Detail Syllabus of Extra Curricular Activities (ECA) Courses under Council of Student Activities

Skill Development- I (ECA-151)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Participation and Training
Course Outcome	:	Students are expected to learn and develop their skill and their personality through the activities and trainings under the council and should be well versed with the listed activities and events.

UNIT- 1

- **Introduction to TSC and IEEE:** An introduction to technical sub-council and IEEE. An overview of IEEE and the events conducted by them.

UNIT- 2

- **Robotics Classes:** Informative classes conducted on by the students of IEEE about Bot modelling and electronics as well as embedded. It is conducted for both Wired and Wireless Robotics.

UNIT- 3

- **Introduction to Workshops by IEEE:** *Workshop* is a brief intensive course for a small group which emphasizes problem solving. A number of workshops are conducted by IEEE like Ethical hacking, Soft skills, Artificial Intelligence etc.

UNIT- 4

- **Events under TechSrijan:** Techsrijan is the annual techno-management fest held every year like Enigma, Robotics, Incognito, Quizzes, World Parliament, etc.

Skill Development- II (ECA-201)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Participation and Training
Course Outcomes	:	Students are expected to learn and develop their skill and their personality through the activities and trainings under the council and should be well versed with the listed activities and events.

UNIT- 1

- **Introduction to TSC and SAE:** An introduction to technical sub-Council and SAE. An overview of SAE and the events conducted by them.

UNIT- 2

- **Aeromodelling Classes:** Informative classes and workshop conducted on by the students of SAE about Drone and remote-controlled modeling and electronics as well as embedded.

UNIT -3

- **Introduction to Workshops by SAE:** *Workshop* is a brief intensive course for a small group which emphasizes problem solving. A no. of workshops is conducted by SAE like Aeromodelling workshop, Bridge modeling etc.

UNIT- 4

- **Events under TechSrijan by SAE:** Techsrijan is the annual techno-management fest held every year. SAE conducts a number of events in TechSrijan like Junkyard Wars, Bride Kriti, El Tiro etc.

Skill Development- III (ECA-251)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Participation and Training
Course Outcomes	:	Students are expected to learn and develop their skill and their personality through the activities and trainings under the council and should be well versed with the listed activities and events.

UNIT- 1

- **Introduction to TSC and UIC:** The University Innovation Cell supports and provides opportunity for Innovation works. You will get to learn about the things they do and promote.

UNIT -2

- **Introduction to Innowizion:** Every year University Innovation Cell organizes a national level event that provides opportunities for students across all disciplines to team up and use their creativity, passion, and knowledge of technology. Events like I-Expo and I-Quiz.

UNIT- 3

- **Introduction to Spectra:** It is a special event organized by University Innovation Cell which foster an opportunity for students to showcase their creativity and talent. It comprises of three events InQUIZitive, Replica and MindBuzz**.**

UNIT- 4

- **Learnings and Innovation:** Innovation increases your chances to react to changes and discover new opportunities. It can also help foster competitive advantage as it allows you to build better products and services for your customers in the industry.

Skill Development- IV (ECA-301)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Participation and Training
Course Outcomes	:	Students are expected to learn and develop their skill and their personality through the activities and trainings under the council and should be well versed with the listed activities and events.

UNIT- 1

- **Introduction to TSC and SEB:** The Social Engineers Board (SEB) tries to achieve its goals by series of various events conducted throughout the academic year, both inside and outside the university.The members of the board are highly motivated individuals striving for noble cause, and voluntarily take initiatives which ensure betterment of the people and society in

any way possible.

UNIT- 2

- **Introduction to Drishya:** A career counselling event by college final year, and an event

designed to crave out the creativity inside the students and their ability to make something novel out of normality in situation

UNIT- 3

- **Introduction to Dhishan:** Bringing out the oration skill and leadership personality among the students by providing them chance to stand and represent themselves by this event.

UNIT -4

- **Introduction to Paravartan and NGOs:** Paravartan consists of a audio visual round and the second round is a skit presentation developing character of a student. They also collab with NGOs for social works.

Skill Development- Vth (ECA-351)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Participation and Training

Course Outcomes	:	Students are expected to learn and develop their skill and their personality through the activities and trainings under the council and should be well versed with the listed activities and events.

UNIT- 1

- **Introduction to TSC and E CELL:** E-Cell of Madan Mohan Malaviya University of Technology promotes entrepreneurship abilities among the students of the university and conducts events to promote these ideas.

UNIT- 2

- **Introduction to Fresher's Talk:** A creative talk with the freshers of our university in which the fresher students provide some insights of what and how are they feeling about the college and its environment.

UNIT- 3

- **Introduction to Start Up Week:** Understanding the aspects of and entrepreneurial background and train to become one, through various personality developing as well as professionally balanced events.

UNIT- 4

- **Entrepreneurship Development:** It is the process of enhancing the skillset and knowledge of entrepreneurs regarding the development, management and organization of a business venture while keeping in mind the risks associated with it. Students will learn and cultivate skills which will promote entrepreneurship.

Skill Development-VIth (ECA-401)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Participation and Training
Course Outcomes	:	Students are expected to learn and develop their skill and their personality through the activities and trainings under the council and should be well versed with the listed activities and events.

UNIT- 1

- **Introduction to TSC and Robotics Club:** Robotics Club speaks a name for itself in this domain with a sheen of itself that has been set by the high standards of the club members and strict adherence to the tagline Transforming ideas into reality, Events Details

UNIT- 2

- **Introduction to Web D Classes:** Classes on web development helps students to develop skills like Front-end and Back-end development which they can use to make websites.

UNIT -3

- **Introduction to Engineers Week:** a seven-day event paying tribute to all the engineers across the globe by conducting a no. of exciting events for technical development of students.

UNIT- 4

- **Robomania:** Develop the knowledge of robotics and circuitry in the students through training of students on circuits and the conduction of Robo Wars, Electronic chess, diffusion of a bomb

in a set up made by students, demonstration of live game of the virtual events of NFS and Tekken, Lazer strike, Designing of Lazer maze.

Unity and Discipline (NCC)-I (ECA-171)

Course Category	:	NCC
Pre Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Lecture & Practical
Course Outcomes	:	After completing this course, the students will be able to:

- Imbibe the conduct of NCC cadets.
- Do the social services on different occasions.

UNIT -1

Introduction of NCC: History, Aims, Objective of NCC.

UNIT -2

NCC as Organization. Incentives of NCC, Duties of NCC Cadet.

UNIT -3

Celebration of Days of National & International Importance, Social Service and Community Development Activities

UNIT- 4

NCC Parade on Independence Day.

Unity and Discipline (NCC)-II – (ECA- 221)

Course Category	:	NCC
Pre Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Lecture & Practical
Course Outcome	:	After completing this course, the students will be able to: -

- Respect the diversity of different Indian culture.
- Do the social services on different occasions.

UNIT- 1
National Integration & Awareness, Importance & Necessity
UNIT- 2
Factors Affecting National Integration, Unity in Diversity

UNIT -3
Celebration of Days of National & International Importance, Social Service and Community Development Activities
UNIT- 4
NCC Parade on Republic Day.

Unity and Discipline (NCC)-III – (ECA-271)

Course Category	:	NCC
Pre Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Lecture & Practical
Course Outcomes	:	After completing this course, the students will be able to: - • Perform his/her role in Nation Building. • Do the social services on different occasions.

UNIT- 1
Role of NCC in Nation Building.

UNIT- 2
Threats to National Security.

UNIT -3
Celebration of Days of National & International Importance, Social Service and Community Development Activities
UNIT- 4
NCC Parade on Independence Day.

Unity and Discipline (NCC)-IV- (ECA-321)

Course Category	:	NCC
Pre Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Lecture & Practical

Course Outcomes	:	After completing this course, the students will be able to: - • Contribute to environmental awareness and conservation activities. • Develop Leadership Qualities. • Do the social services on different occasions.

UNIT -1
Environmental Awareness and Conservation.

UNIT -2
Leadership Development: Important Leadership traits, Indicators of leadership.

UNIT- 3
Celebration of Days of National & International Importance, Social Service and Community Development Activities

UNIT -4
NCC Parade on Republic Day.

National Service Scheme-I (ECA-172)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Continuous assessment through National Service Scheme related tasks, participation in different events organized, attendance, home assignments

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

- The Motto of NSS "Not Me but You", reflects the essence of democratic living and upholds the need for self-less service.
- NSS helps the students' development & appreciation to other person's point of view and also show consideration towards other living beings.
- The philosophy of the NSS is a good doctrine in this motto, which underlines on the belief that the welfare of an individual is ultimately dependent on the welfare of the society as a whole and therefore, the NSS volunteers shall strive for the well-being of the society.

Introduction to National Service Scheme:

UINIT-I: History and its Objectives

UNIT-II: Organizational structure of N.S.S. at National, State, University and College Levels

UNIT-III: Advisory committee and their functions with special reference to University CSA, Program officer, N.S.S. group leader and N.S.S. volunteers in the implementation**.**

UNIT-IV: Organization/ Participation in "Tree-Plantation Drive"

National Service Scheme- II (ECA-222)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Continuous assessment through National Service Scheme related tasks, participation in different events organized, attendance, home assignments.

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

- The Motto of NSS "Not Me but You", reflects the essence of democratic living and upholds the need for self-less service.
- NSS helps the students' development & appreciation to other person's point of view and also show consideration towards other living beings.
- The philosophy of the NSS is a good doctrine in this motto, which underlines on the belief that the welfare of an individual is ultimately dependent on the welfare of the society as a whole and therefore, the NSS volunteers shall strive for the well-being of the society.

UNIT-I: National Integration, Need and importance of National integration

UNIT-II: Various obstacles in the way of National Integration, such as caste, religion, language and provisional problems etc.

UNIT-III: NSS related Activities: Awareness to various activities under NSS.

UNIT-IV: Organization/Participation in "Cleanliness Drive" at home, hostel, Department and University

UNIT-V: Organization/Participation in "Winter cloth collection and distribution to needy people"

National Service Scheme- III (ECA-272)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Continuous assessment through National Service Scheme related tasks, participation in different events organized, attendance, home assignments.

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

- The Motto of NSS "Not Me but You", reflects the essence of democratic living and upholds the need for self-less service.
- NSS helps the students' development & appreciation to other person's point of view and also show consideration towards other living beings.
- The philosophy of the NSS is a good doctrine in this motto, which underlines on the belief that the welfare of an individual is ultimately dependent on the welfare of the society as a whole and therefore, the NSS volunteers shall strive for the well-being of the society.

UNIT-I: Special Programme in NSS-I

A) Legal awareness
B) Health awareness
C) First-aid

UNIT-II: Special Programme in NSS-II

A) Career guidance
B) Leadership training-cum-Cultural Programme
C) Globalization and its Economic Social Political and Cultural impacts.

UNIT-III: Special Camping programme in NSS-I

A) Nature and its objectives
B) Selection of campsite and physical arrangement
C) Organization of N.S.S. camp through various committees and discipline in the camp.

UNIT-IV: Special Camping programme in NSS-I

A) Activities to be undertaken during the N.S.S. camp.
B) Use of the mass media in the N.S.S. activities.

National Service Scheme- IV (ECA-322)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	NIL
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0

Course Assessment Method : Continuous assessment through National Service Scheme related tasks, participation in different events organized, attendance, home assignments.

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

- The Motto of NSS "Not Me but You", reflects the essence of democratic living and upholds the need for self-less service.
- NSS helps the students' development & appreciation to other person's point of view and also show consideration towards other living beings.
- The philosophy of the NSS is a good doctrine in this motto, which underlines on the belief that the welfare of an individual is ultimately dependent on the welfare of the society as a whole and therefore, the NSS volunteers shall strive for the well-being of the society.

UNIT-I: N.S.S. Regular Activities-I

A) Traffic regulation
B) Working with Police Commissioner's Office
C) Working with Corporation of Gorakhpur District

UNIT-II: N.S.S. Regular Activities-II

A) Working with Health Department
B) Blind assistance
C) Garments collection and distribution

UNIT-III: N.S.S. Regular Activities-III

A) Non-formal Education
B) Environmental Education Awareness and Training (EEAT)'
C) Blood donation

UNIT-IV: N.S.S. Regular Activities-IV

A) Adopted Village related works
B) Disaster/Pandemic management

GAMES & SPORTS-I (ECA-181)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	Physical Education at 12^{th} standard
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Training and Practices.

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

- Understand the concept of skill.
- Acquire the required motor skills.
- Demonstrate and assess various techniques of starts and finish.
- Interpret the rules & regulations.
- Acquire skill of marking track.

Track & Field-

UNIT- 1

- **INTRODUCTION:**

Historical development

- National
- International

Structure and functions of Controlling Bodies

- National
- International

UNIT- 2

- **FUNDAMENTAL SKILLS:**

- Starting techniques: Standing start, Crouch start and its variations, Proper use of blocks.
- Finishing Techniques: Run, Through, Forward lunging, Shoulder Shrug.

UNIT- 3

- **FUNDAMENTAL SKILLS-II:**

- Various patterns of Baton Exchange.
- Understanding of Relay Zones.
- Rules & their interpretation.

UNIT- 4

- **FUNDAMENTAL SKILLS-III:**

- Drills and Lead-up Games.
- Marking and Layout of Track & Field

Books & References

1. Latest Official Rule Books of International Federation
2. Coaching Manuals of International Federation
3. Official Website

GAMES & SPORTS-II (ECA-231)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	Physical Education at 12th standard
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Training and Practices.

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

- Understand the concept of skill.
- Acquire the required motor skills.
- Demonstrate and assess various techniques of starts and finish.
- Interpret the rules & regulations.
- Acquire skill of marking track.

Basketball-

UNIT- 1

- **INTRODUCTION:**

Historical development

- National
- International

Structure and functions of Controlling Bodies

- National
- International

UNIT- 2

- **FUNDAMENTAL SKILLS- I:**

- Player stance and ball handling.
- Passing-Two Hand chest pass, Two hand Bounce Pass, One Hand Baseball pass, Side Arm Pass, Over Head pass, Hook Pass.
- Receiving-Two Hand receiving, One hand receiving, Receiving in stationary position, Receiving while jumping, Receiving while running.

UNIT- 3

- **FUNDAMENTAL SKILLS- II:**

- Dribbling-How to start dribble, how to drop dribble, High dribble, Low dribble, Reverse dribble, Rolling dribble.
- Shooting-Lay-up shot and its variations, one hand set shot, one hand jump shot, Hook shot, and Free throw.
- Individual Defensive-Guarding the man with and without the ball, pivoting.

UNIT- 4

- **FUNDAMENTAL SKILLS-III:**

- Drills and Lead-up Games.
- Marking and Layout of Court.

Books & References

1. Latest Official Rule Books of International Federation
2. Coaching Manuals of International Federation
3. Official Website

GAMES & SPORTS-III (ECA-281)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	Physical Education at 12th standard
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Training and Practices.

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

- Understand the concept of skill.
- Acquire the required motor skills.
- Demonstrate and assess various techniques of starts and finish.
- Interpret the rules & regulations.
- Acquire skill of marking track

Volleyball-

UNIT- 1

- **INTRODUCTION:**

Historical development

- National
- International

Structure and functions of Controlling Bodies

- National
- International

UNIT- 2

- **FUNDAMENTAL SKILLS-I:**
- Service-Under Arm Service, Tennis Service, Floating Service.
- Overhead finger pass.
- The Dig (Under Arm pass).

UNIT- 3

- **FUNDAMENTAL SKILLS –II:**
- Back court defense.
- Defensive and Offensive strategies.
- Smash
- Block–individual and team.

UNIT- 4

- **FUNDAMENTAL SKILLS-III:**
- Drills and Lead-up Games.
- Marking and Layout of Field.

Books & References

1. Latest Official Rule Books of International Federation
2. Coaching Manuals of International Federation
3. Official Website

GAMES & SPORTS-IV (ECA-331)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	Physical Education at 12th standard
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Training and Practices.

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

- Understand the concept of skill.
- Acquire the required motor skills.
- Demonstrate and assess various techniques of starts and finish.
- Interpret the rules & regulations.
- Acquire skill of marking track for running events.

Hockey-

UNIT-1

- **INTRODUCTION:**

Historical development

- National
- International

Structure and functions of Controlling Bodies

- National
- International

UNIT- 2

- **FUNDAMENTAL SKILLS-I:**

- Player stance & Grip,
- Rolling the ball, Dribbling.
- Push, Stopping.
- Hit, Flick, Scoop.
- Reverse hit.

UNIT- 3

- **FUNDAMENTAL SKILLS-II:**

- Passing–Forward pass, square pass, triangular pass, diagonal pass, return Pass.
- Goalkeeping–Hand defense, foot defense.
- Positional play in attack and defense.

UNIT- 4

- **FUNDAMENTAL SKILLS-III:**

- Drills and Lead-up Games.
- Marking and Layout of Court.

Books & References

1. Latest Official Rule Books of International Federation
2. Coaching Manuals of International Federation
3. Official Website

GAMES & SPORTS- V (ECA- 381)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	Physical Education at 12th standard
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Training and Practices.

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

- Understand the concept of skill.
- Acquire the required motor skills.
- Demonstrate and assess various techniques of starts and finish.
- Interpret the rules & regulations.
- Acquire skill of marking track for running events.

UNIT 1

- **YOGA- HOLISTIC HEALTH:**
- Health- Concept of Health, its importance in human life.
- Components of health.

UNIT-II

- **YOGA AND ITS IMPORTANCE:**
- Definition of Yoga.
- Importance of Yoga in daily life.
- Aims and Objective of yoga.
- Misconception of yoga.

UNIT-III

- **SURYA NAMASKAR:**
- Benefits of Surya Namaskar
- Practices of Surya Namaskar

Unit- IV

- **YOGA PRACTICES:**
- Asana- Meditative
  i) Sukhasana
  ii) Padmasana
  iii) Swastikasana
- Cultural- Trikonasana, Makarasana, Bhujangasana, Sarpasana, Dhanurasana.
- Pranayama- Yogic Breathing, Anulom-Vilom.

Books & References

1. Indra Devi, "Yoga For You", Gibbs, Smith publishers, Salt Lake City, 2002 Domen& Publishers, New Delhi-2001.
2. Yoga se Arogya, Indian Yoga Society, Sagar.

Games & Sports -VI (ECA- 431)

Course Category	:	Extra-Curricular Activities
Pre-Requisite	:	Physical Education at 12th standard
Contact/Hours of Work	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Method	:	Practical Training and Practices.

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

- Understand the concept of skill.
- Acquire the required motor skills.
- Demonstrate and assess various techniques of starts and finish.
- Interpret the rules & regulations.
- Acquire skill of marking track for running events.

UNIT- 1

- **Badminton**

INTRODUCTION:

Historical development

- National
- International

Structure and functions of Controlling Bodies

- National
- International.

UNIT-II

- **FUNDAMENTAL SKILLS-I:**
- Racket parts, Racket grips, Shuttle (dimensions).
- The basics stances.
- Basic foot movements.

UNIT-III

- **FUNDAMENTAL SKILLS-II:**
- The basic strokes-Serves.
- Forehand-overhead and underarm.
- Backhand-overhead and underarm.
- Types of games-Singles, doubles, including mixed doubles.

Unit- IV

- **FUNDAMENTAL SKILLS-III:**
- Drills and Lead-up Games.
- Marking and Layout of Court.

Books & References

1. Latest Official Rule Books of International Federation
2. Coaching Manuals of International Federation
3. Official Website

Culture, Art & Literary-I (ECA-182)

Course category	:	Cultural, Art &Literary
Pre-requisite Subject	:	NIL
Contact hours/week	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Methods	:	Practical Participation

Course Outcomes : Students are expected to develop their soft skills and their Personality through cultural and literary activities.

UNIT-1

Workout, Warm up, Stretching, Introduction to various dance forms, Dance form – Bollywood, Footwork, Body Movement, Theatre History, Literature and Aesthetics, Introduction to Acting, Yoga(Breathing, Exercise, Voice Control and Sound Modulation).

UNIT-2

Introduction to music, Basic Terminologies related to music, Origin of sound, Historical study of musical terms, Basic Introduction to Fine Arts, Roll of FAC in cultural sub-council, Basics of Fine Arts and Types, File extension, Editing software, Resources for stock images and video.

UNIT-3

MALVIKA: Basic knowledge of designing software (I) : Adobe In Design ,Photoshop ,Notice Making, Article writing.

UNIT-4

TIRESIA: Basic knowledge of designing software (I): Adobe In Design, Photoshop, Interview skills, Vocabulary development, Knowledge about technical advancements, knowledge of campus activities.

Culture, Art & Literary-II (ECA-232)

Course category	: Cultural, Art &Literary
Pre-requisite Subject	: NIL
Contact hours/week	: 2 Hours/Week
Number of Credits	: 0
Course Assessment Methods	: Practical Participation
Course Outcomes	: Students are expected to develop their soft skills and their personality through cultural and literary activities.

UNIT-1

Intro to basics of sketching, Painting, Craft, Sculpturing.
Sketch-Tools of sketching, Types of Sketching- Pencil/ Pen/ Color Pencil/ Charcoal/ Graphite/Ink/ Chalk / Digital Sketch. History of Indian Music, About life and contributions of Indian Musician sand Musicologists.
Two forms of Indian Classical Music (Hindustani/Karnataka).

UNIT-2

Introduction to Theatre Technique and Design, Character Analysis and practical on principle of Stanislavski Method (relaxations, concentration of attention and emotion memory), Workout, Warm up, Stretching, Dance Form- Hip-Hop, Footwork, Body movement, Choreography, Equipment, Types of lenses, building web site using template.

UNIT-3

ARUNODAY: Development of thinking ability with JAM (Just a Minute), Word Building, Letter rearrangement, Knowledge of spellings, Syllables, Critical thinking skill development, Vocabulary development, Thought expressing skill development, public speaking skill development.

UNIT-4

SPELLCZAR: Word building, Vocabulary development, Decision making ability development, Coordination capabilities.

Culture, Art & Literary-III (ECA-282)

Course category	:	Cultural, Art &Literary
Pre-requisite Subject	:	NIL
Contact hours/week	:	2 Hours/Week
Number of Credits	:	0
Course Assessment Methods	:	Practical Participation
Course Outcomes	:	Students are expected to develop their soft skills and their personality through cultural and literary activities.

UNIT-1

Photo editing (Photoshop)

Ras- (Sringar Ras, Hasya Ras, Rodra Ras, Karun Ras, Vir Ras, Adbhut Ras, Vibath Ras, Bhayanak Ras, Shaant Ras)

UNIT-2

Workout, Warmup, Stretching, Pranam, Types of classical dance forms and their outfits, Dance form-Kathak, Hand movements, Choreography, Basic knowledge of Talas for Instance Teental, Dadra and Kherwa, Practice of AUM and vocal exercises of sargam (sa, re, ga, ma, pa, dha, ni) of 45. Alankaras, Styles of Sketching-Line/
Hatching/Blending/Scribbles/Tattoo/Doodling/Cartoon/Graffiti/Typography/Calligraphy/Caricat Ure

UNIT-3

ANNUAL DEBATE COMPETITION: General Knowledge & Current Affairs, Public speaking skill development, Oratory skill development, Sense of Team spirit, Knowledge of language, Social Study, Development of presentation skills.

UNIT-4

TWIST AND TWAIN: Development of imaginative power and creativity, Development of vocabulary, Development of writing skills, Thinking skill development.

Culture, Art & Literary-IV (ECA-332)

Course category	:	Cultural, Art &Literary
Pre-requisite Subject	:	NIL

Contact hours/week	: 2 Hours/Week
Number of Credits	: 0
Course Assessment methods	: Practical Participation
Course Outcomes	: Students are expected to develop their soft skills and their Personality through cultural and literary activities.

UNIT-1

Video editing, Basic knowledge about musical instruments (Tabla, flute, guitar etc.) about Swarmalika and two bragas-Bhupaliand Yaman.

UNIT-2

Monologue, reciting a poem, reading short stories, developing speech skill, Mime, Working on scene with partner and in a group, Painting-Tools of painting, Styles of painting-Abstract/Imagination/Expression/Cubism/Indian/Chinese/Japanese, All the theory covered upto Praveshi ka Purna, define and explain Kataaksha,Primalu, Nartan Bhedas- Nritta Nrutya and Natya, define Tandav and Lasya, Fourty pesof neck movements according to Abhinaya Darpan, Eight types of eye movements according to Abhinaya Darpan, Define and differentiate "FolkDance" and "Modern Dance" (Uday Shankar style), Life story of: Bindadin Maharaj, Kalka Prasadji, Harihar Prasadji& Hanuman Prasadji, Specialty of Jaipur and Lucknow Gharana,Definition and uses of the following Asanyukta Hasta Mudras: Sarpsheersha, Murga-sheersha, Simha-Mukha, Kangula, Alapadma, Chatura, Bhrama, Hansasya, Hansa-paksha, Sandausha, Mukula, Tamrachuda, Vyagraha, Trishula, Sanyukta HastaMudra: Anjali, Kapota, Karkata, Swastik, Dola, Pushpaputa, Utsanga, Shivalinga, Katakawardhan, Kartari-swastk, Shakata, Shankha.

UNIT-3

VAGMITA1: Development of oratory skill, Development of poetry writing skill, Alankar, Ras, Creative thinking ability development.

UNIT-4

VAGMITA 2: How to overcome camera consciousness, enhancement of the expression and presentation of the participants, development of the public speaking skill, Knowledge of tone adjustment while presenting.

Culture, Art & Literary-V (ECA-382)

Course category	: Cultural, Art &Literary
Pre-requisite Subject	: NIL
Contact hours/week	: 2 Hours/Week
Number of Credits	: 0
Course Assessment methods	: Practical Participation
Course Outcomes	: Students are expected to develop their soft skills and their personality

UNIT-1

Types of painting-Oil painting/ Watercolor painting/ Pastel painting/ Acrylic painting/ Digital painting/Spray Painting, Basic of Contemporary Dance, Foot Position and Transference, Center Technique, Travelling Technique, Dance, Dance (A) Peter Pan, dance (B) Emergence of a Butterfly.

UNIT-2

Improvisation, Elementary knowledge of Acting, Body language, Rhythm, Clarity and fluency in dialogue delivery, Understanding the depth of character, about terms related to Hindustani music like Naad, Shuruti, Saptak, Thaat, Vaadi, Samvadi, Photography Skill.

UNIT-3

MALAVIYAN THINKER: Creative thinking, how to pen down thoughts of our mind, Development of writing skill, Development of Expression, Public Speaking skill development.

UNIT-4

ABHYUDAYA: Multidimensional skill development: Technical skill development with software like Adobe Photoshop, MS word, MS PowerPoint, MS Excel, Content Writing skill development, public addressing, public engagement, Team work Mechanism, Leadership qualities, Time management, art and craft, Pottery, Oratory skill development, Presentation skill, Event management.

Culture, Art & Literary-VI (ECA-432)

Course category	: Cultural, Art &Literary
Pre-requisite Subject	: NIL
Contact hours/week	: 2 Hours/Week
Number of Credits	: 0
Course Assessment methods	: Practical Participation
Course Outcomes	: Students are expected to develop their soft skills and their personality

UNIT-1

Cinematography, Basic knowledge of Thaat system, Raga formation rules, 5 Ragas- Bhupali, Yaman, Bihag, Kafi, Deskar.

UNIT-2

Introduction to Nukkad, Mono Act, Skit, Introduction to Comedy, Tragic Comedy, Tragedy, Melodrama, Craft- Tools of craft, Types of Craft- paperwork/ Wood work/ foam work/ Cloth work, Popping/ Introto music theory, Angles and Movement/Music Theory, Direction and Levels/Rhythms for Grooves, Twists and isolated movements/8 Count Phrasing, Footwork/Floats and Glides, Waves/Movements Dynamics, Waves 2/Musical Phrasing, Putting it all together.

UNIT-3

WRITING SKILLS: Invitation making, Notice making, Article writing.

SKILL FOR INTEVIEWER: How to take formal interview, approaching the personality, Questions preparation, management, platform selection, public engagement.

UNIT-4

INTERVIEW SKILLS FOR INTERVIEWEE: Body language, Attire, Hand gestures, voice tone, Language, General Interview Questions- How to introduce yourself.

Annexure-05

Detailed syllabus of course (BEE-362)

Skill-Based Courses to Qualify for B.Voc (Engg.) in Electrical Engineering

BEE-362		**Integrated Power Systems and Industrial Automation**
Course Category	:	Skill Development
Mode	:	Theory
Contact hours/week	:	Lecture: 3, Tutorial:0, Practical: 0
No of Credits	:	3
Course Assessment Methods	:	Continuous assessment will be carried out through, attendance, home assignments, quizzes, one minor test, one major theory examination.
Course Objectives	:	• Provide a clear understanding of how electricity is traded and regulated in a post-monopoly environment.. • Equip the student with the technical knowledge to use FACTS devices and mitigation techniques to solve power quality issues. • Shift the focus from traditional analog sensing to "Smart" transducer technology and automated process control loops used in modern factories.
Course Outcome	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

- Evaluate the roles of ISOs, GENCOs, and DISCOs while understanding transmission pricing and congestion management.
- Select and justify the use of devices like SVC, TCSC, and STATCOM to improve voltage stability and power flow in a modern grid.
- Identify waveforms for sags, swells, and transients, and design mitigation strategies using active and passive filters.
- Perform calculations for Solar PV and Tidal energy systems, including MPPT logic and grid synchronization challenges.
- Select appropriate transducers for industrial variables and interface "Smart" sensors with control systems.
- Demonstrate a holistic understanding of how power generation, quality control, and industrial automation interact in a real-world engineering environment.

Topics Covered

Unit I **9**

Power System Deregulation and FACTS Devices

- **Restructuring Fundamentals:** Transition from regulated to deregulated power markets; roles of ISOs (Independent System Operators) and Load Dispatch Centers.
- **Market Dynamics:** Concepts of wheeling, congestion management, and transmission pricing.
- **Flexible AC Transmission (FACTS):** Introduction to Thyristor-controlled devices.
- **Operational Benefits:** Using SVC (Static Var Compensators) and TCSC (Thyristor Controlled Series Capacitors) for voltage stability and power flow control.

Unit II **9**

Power Quality and Harmonic Mitigation

- **Power Quality Events:** Understanding Voltage Sags, Swells, Interruptions, and Transients.
- **Sources of Distortion:** Impact of non-linear loads, Variable Frequency Drives (VFDs), and switching power supplies.
- **Harmonic Analysis:** Total Harmonic Distortion (THD) and its effects on industrial equipment (transformers and motors).
- **Mitigation Strategies:** Introduction to Passive and Active Power Filters and IEEE 519 standards for grid compliance.

Unit III **9**

Non-Conventional Energy and Grid Integration

- **Solar PV Systems:** Cell characteristics, PV array configuration, and MPPT (Maximum Power Point Tracking) basics.
- **Wind and Tidal Energy:** Principles of Wind Energy Conversion Systems (WECS); Tidal barrage and stream-based generation.
- **Other Renewables:** Overview of Geothermal energy cycles and Biomass gasification.
- **Hybrid Systems:** Challenges of integrating intermittent renewable sources into the main utility grid.

Unit IV **9**

Industrial Process Control and Smart Transducers

- **Fundamentals Instrumentation and Measurement:** Performance Characteristic of M&I ,Basics of Transducers, Sensors & Pickup.
- **Smart Transducers:** Architecture of "Smart" sensors; integration of sensing elements with microprocessors for self-calibration and self-diagnosis.
- **Process Control Loops:** Basics of feedback control, PID controllers, and their application in automated industrial environments.

Textbooks:

- Power System Analysis and Design by J. Duncan Glover.
- Power System Engineering – I.J. Nagrath & D.P. Kothari
- Control Systems Engineering – Nagrath & Gopal / Benjamin C. Kuo
- A Course in Electrical and Electronic Measurements and Instrumentation – A.K. Sawhney
- Non-Conventional Energy Resources by B.H. Khan.
- Sensors and Transducers by D. Patranabis.