KPR Institute of Engineering and Technology

Learn Beyond (Autonomous, NAAC "A")

Avinashi Road, Arasur, Coimbatore.

Great Place To Work. Certified MAR 2022 - MAR 2023 INDIA

B.E. – Electrical and Electronics Engineering

Curriculum and Syllabi

Regulation - 2021

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B.E. – Electrical and Electronics Engineering

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I. Vision and Mission of the Institute

Vision

To become a premier institute of academic excellence by imparting technical, intellectual and professional skills to students for meeting the diverse needs of the industry, society, the nation and the world at large.

Mission

- Commitment to offer value-based education and enhancement of practical skills
- Continuous assessment of teaching and learning processes through scholarly activities
- Enriching research and innovation activities in collaboration with industry and institutes of repute
- Ensuring the academic processes to uphold culture, ethics and social responsibility

II. Vision and Mission of the Department

Vision

To be a premier centre for quality education, innovation and research in the field of Electrical and Electronics Engineering to meet the global challenges with professional ethics and social consciousness.

Mission

- Provide a holistic environment to students through knowledge-centric and skill-based education
- Collaborate with industries for effective research and innovation in Electrical Engineering and allied areas
- Enable students to serve the society through prolific ideas with professionalism and ethical values

III. Program Educational Objectives (PEOs)

The Graduates of B.E. Electrical and Electronics Engineering, after four years of graduation, will

PEO1: Apply the acquired knowledge and skills to meet the emerging needs of the society and also excel in their chosen profession.

PEO2: Adapt to emerging technologies and continuously upskill through active research in Electrical Engineering and allied areas.

PEO3: Demonstrate leadership skills and practice their profession conforming to ethical and human values.

IV. Program Outcomes (POs)

Graduates of Electrical and Electronics Engineering will be able to

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 **Design/ development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

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PO4 Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 The engineer and society: Apply reasoning informed by the contextual knowledge to access societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

V. Program Specific Outcomes (PSOs)

The Graduates of Electrical and Electronics Engineering will be able to

PSO1: Analyse, design and test power electronic components integrated with computer-based systems to meet industrial and societal needs.

PSO2: Deploy modern engineering tools to model, simulate, fabricate and integrate electrical systems with renewable energy to enhance sustainability.

VI. PEO/PO Mapping

Following three levels of correlation should be used:

1: Low

2: Medium

3. High

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PEO	3	3	3	3	-	-	-	-	3	3	-	-
PEO	3	3	3	3	3	2	2	3	2	3	3	3
PEO	3	3	3	3	-	2	2	2	-	3	3	3

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KPRIET
LEARN BEYOND

KPR Institute of Engineering and Technology
Centre for Academic Courses
Coimbatore

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

REGULATIONS – 2021

For the students admitted in 2021

CHOICE BASED CREDIT SYSTEM

CURRICULUM FOR I - VIII SEMESTERS

SEMESTER I

Sl.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21MA102	Calculus and Linear Algebra	BSC	2	1	0	0	3
2	U21EE101	Foundation for Electrical Engineering	ESC	3	0	0	0	3
	THEORY COURSE WITH LABORATORY COMPONENT							
3	U21EN101	English for Technologists	HSMC	1	0	2	0	2
4	U21PH101	Engineering Physics	BSC	2	0	2	0	3
5	U21CY101	Engineering Chemistry	BSC	2	0	2	0	3
6	U21CSG01	Problem Solving and C Programming	ESC	2	0	2	0	3
	LABORATORY COURSES							
7	U21MEG01	Engineering Graphics	ESC	0	0	4	0	2
8	U21MEG02	Manufacturing Practices	ESC	0	0	4	0	2
	MANDATORY NON CREDIT COURSES							
9	U21MYC01	Induction program	MNC	Three Weeks				
			TOTAL	12	1	16	0	21

SEMESTER II

Sl.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21MA201	Laplace Transforms and Complex Variables	BSC	3	1	0	0	4
2	U21PH201	Materials Science	BSC	2	0	0	0	2
3	U21EE201	Electric Circuit Analysis	ESC	3	0	0	0	3
4	U21MEG04	Basics of Civil and Mechanical Engineering	ESC	3	0	0	0	3
	THEORY COURSE WITH LABORATORY COMPONENT							
5	U21EN201	Personality Enhancement	HSMC	1	0	2	0	2
6	U21CSG02	Python Programming	ESC	2	0	2	0	3
7	U21EE202	Digital Electronics and Applications	PCC	2	0	2	0	3
	LABORATORY COURSES							
8	U21EE203	Electric Circuits Laboratory	ESC	0	0	4	0	2
	MANDATORY NON CREDIT COURSES							
9	U21MYC02	Environmental Sciences	MNC	1	0	0	0	0
			TOTAL	17	1	10	0	22

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SEMESTER III

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21MA303	Fourier Analysis and Boundary Value Problems	BSC	3	1	0	0	4
2	U21EE301	Electromagnetic Theory	ESC	2	1	0	0	3
3	U21EE302	Electrical Machines-I	PCC	3	0	0	0	3
4	U21EE303	Analog Electronics and Applications	PCC	3	0	0	0	3
	THEORY COURSE WITH LABORATORY COMPONENT / THEORY COURSE WITH PROJECT COMPONENT							
5	U21CSG03	Data Structures	ESC	2	0	2	0	3
6	U21EE304	Measurements and Instrumentation	PCC	2	0	2	0	3
	LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT							
7	U21EE305	Electrical Machines Laboratory – I	PCC	0	0	4	0	2
8	U21EE306	Analog Electronics and Applications Laboratory	PCC	0	0	4	0	2
	MANDATORY NON CREDIT COURSES							
9	U21MYC03	Essence of Indian Traditional Knowledge	MNC	1	0	0	0	0
			TOTAL	16	2	12	0	23

SEMESTER IV

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21MA404	Statistics and Numerical Methods	BSC	3	0	0	0	3
2	U21EE401	Electrical Machines-II	PCC	3	0	0	0	3
3	U21EE402	Control Systems	PCC	3	0	0	0	3
4		Open Elective – I	OEC	3	0	0	0	3
	THEORY COURSE WITH LABORATORY COMPONENT / THEORY COURSE WITH PROJECT COMPONENT							
5	U21CSG04	Java Programming	ESC	2	0	2	0	3
6	U21EE403	Transmission and Distribution	PCC	2	0	2	0	3
	LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT							
7	U21SSG01	Soft Skills – I	HSMC	0	0	2	0	1
8	U21EE404	Electrical Machines Laboratory – II	PCC	0	0	4	0	2
9	U21EE405	Control Systems Laboratory	PCC	0	0	4	2	3
	MANDATORY NON CREDIT COURSES							
10	U21MYC04	Indian Constitution	MNC	1	0	0	0	0
			TOTAL	17	0	14	2	24

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SEMESTER V

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21EE501	Power System Analysis	PCC	2	1	0	0	3
2	U21EE502	Power Electronics and Drives	PCC	3	0	0	0	3
3		Professional Elective – I	PEC	3	0	0	0	3
4		Professional Elective – II	PEC	3	0	0	0	3
5		Open Elective – II	OEC	3	0	0	0	3
	THEORY COURSE WITH LABORATORY COMPONENT / THEORY COURSE WITH PROJECT COMPONENT							
6	U21EE503	Microprocessor, Microcontroller and Applications	PCC	2	0	2	0	3
	LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT							
7	U21SSG02	Soft Skills – II	HSMC	0	0	2	0	1
8		[Live in Labs-I]	HSMC	-	-	-	-	[3]
9	U21EE504	Power Electronics and Drives Laboratory	PCC	0	0	4	2	3
10	U21EE505	Power Engineering Laboratory	PCC	0	0	4	0	2
	MANDATORY NON CREDIT COURSES							
11	U21MYC05	Cyber Security Essentials	MNC	1	0	0	0	0
			TOTAL	17	1	12	2	24

SEMESTER VI

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21EE601	Protection and Switchgear	PCC	3	0	0	0	3
2	U21EE602	Embedded System Design	PCC	3	0	0	0	3
3	U21AMG02	Machine Learning	PCC	3	0	0	0	3
4		Professional Elective – III	PEC	3	0	0	0	3
5		Professional Elective – IV	PEC	3	0	0	0	3
6		Open Elective – III	OEC	3	0	0	0	3
	LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT							
7	U21SSG03	Soft Skills – III	HSMC	0	0	2	0	1
8		[Live in Labs-II]	HSMC	-	-	-	-	[3]
9	U21EE603	Embedded System Design Laboratory	PCC	0	0	4	2	3
10	U21AMG03	Machine Learning Laboratory	PCC	0	0	2	0	1
	MANDATORY NON CREDIT COURSES							
11	U21MYC06	Introduction to UN SDGs: An Integrative Approach	MNC	1	0	0	0	0
			TOTAL	19	0	08	2	23

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SEMESTER VII

Sl.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21EE701	Principles of Management	HSMC	3	0	0	0	3
2		Professional Elective – V	PEC	3	0	0	0	3
3		Professional Elective – VI	PEC	3	0	0	0	3
4		Open Elective – IV	OEC	3	0	0	0	3
	LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT							
5	U21EE702	Electrical Application Laboratory	PCC	0	0	2	2	2
6	U21EE703	Project Work Phase – I	EEC	0	0	0	4	2
			TOTAL	12	0	2	6	16

SEMESTER VIII

Sl.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EE801	Project Work Phase – II	EEC	0	0	0	20	10
			TOTAL	0	0	0	20	10

INDUSTRIAL TRAINING / INTERNSHIP

Sl.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EEI01	Industrial Training / Internship**	EEC	0	0	0	0	2
			TOTAL	0	0	0	0	2

***Four Weeks during any semester vacation from III to VI Semester**

NCC CREDIT COURSES:

Sl.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21NCC01	National Cadet Corps I	-	1	0	2	0	2
2	U21NCC02	National Cadet Corps II	-	1	0	2	0	2
3	U21NCC03	National Cadet Corps III	-	1	0	2	0	2
4	U21NCC04	National Cadet Corps IV	-	2	0	2	0	3
5	U21NCC05	National Cadet Corps V	-	1	0	2	0	2
6	U21NCC06	National Cadet Corps VI	-	2	0	2	0	3
				8	-	12	-	14

NCC Credit Course (Level 1 – Level 6) are offered for NCC students only. The grades earned by the students will be recorded in the mark sheet, however the same shall not be considered for the computation of CGPA.

TOTAL CREDITS: 165

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KPRIET

PROFESSIONAL ELECTIVE COURSES: VERTICALS

Vertical I Power Systems	Vertical II Converters and Drives	Vertical III Electric and Hybrid Vehicles	Vertical IV Artificial Intelligence for Electrical Engineering	Vertical V Embedded Systems	Vertical VI Energy Engineering
Power System Operation and Control	Advanced Semiconductor Devices	Battery Management Systems	Artificial Intelligence Applications in Power Systems	Smart Sensors and Applications	Power Plant Technology
High Voltage Engineering	SMPS and UPS	Electric Vehicles and Dynamics	Data Science for Electrical Engineers	MEMS and its Applications	Fuel Cell Technology
Microgrid	Electrical Machine Design	EV Standards and Testing	Fundamentals of AR and VR	Discrete Time Signal Processing	Solar Energy Technology
Computer Aided Power System Analysis	HVDC Transmission	Hybrid Electric Vehicles	Artificial Neural Networks and Applications	Real Time Operating Systems	Bio Energy Technology
Power Quality	Advanced Electric Motors and Control	Electric Vehicles in Smart Grid	Fuzzy Logic Control	Computer Networks for Electrical Engineers	Wind Energy Technology
Power System Security	Flexible AC Transmission Systems	Automotive Transmission	Deep Learning for Electrical Engineering	Software for Embedded Systems	Energy Efficient Buildings
EHVAC Transmission	Analysis of Inverters	Energy Storage Systems	Tensor Flow for Engineering Applications	IoT System Design and Security	Electrical Energy Utilization and Cost Estimation
Smart Grid Technologies	Simulation of Power Converters	IoT in EV Applications	Fundamentals of Natural Language Processing	Advanced Industrial Automation	Energy Management and Auditing

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered in Semesters V and VII. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VII.

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PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL I: POWER SYSTEMS

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EEP01	Power System Operation and Control	PEC	3	0	0	0	3
2	U21EEP02	High Voltage Engineering	PEC	3	0	0	0	3
3	U21EEP03	Microgrid	PEC	3	0	0	0	3
4	U21EEP04	Computer Aided Power System Analysis	PEC	3	0	0	0	3
5	U21EEP05	Power Quality	PEC	3	0	0	0	3
6	U21EEP06	Power System Security	PEC	3	0	0	0	3
7	U21EEP07	EHV AC Transmission	PEC	3	0	0	0	3
8	U21EEP08	Smart Grid Technologies	PEC	3	0	0	0	3

VERTICAL II: CONVERTERS AND DRIVES

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EEP09	Advanced Semiconductor Devices	PEC	3	0	0	0	3
2	U21EEP10	SMPS and UPS	PEC	3	0	0	0	3
3	U21EEP11	Electrical Machine Design	PEC	3	0	0	0	3
4	U21EEP12	HVDC Transmission	PEC	3	0	0	0	3
5	U21EEP13	Advanced Electric Motors and Control	PEC	3	0	0	0	3
6	U21EEP14	Flexible AC Transmission Systems	PEC	3	0	0	0	3
7	U21EEP15	Analysis of Inverters	PEC	3	0	0	0	3
8	U21EEP16	Simulation of Power Converters	PEC	3	0	0	0	3

VERTICAL III: ELECTRIC AND HYBRID VEHICLES

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EEP17	Battery Management Systems	PEC	3	0	0	0	3
2	U21EEP18	Electric Vehicles and Dynamics	PEC	3	0	0	0	3
3	U21EEP19	EV Standards and Testing	PEC	3	0	0	0	3
4	U21EEP20	Hybrid Electric Vehicles	PEC	3	0	0	0	3

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5	U21EEP21	Electric Vehicles in Smart Grid	PEC	3	0	0	0	3
6	U21EEP22	Automotive Transmission	PEC	3	0	0	0	3
7	U21EEP23	Energy Storage Systems	PEC	3	0	0	0	3
8	U21EEP24	IoT in EV Applications	PEC	3	0	0	0	3

VERTICAL IV: ARTIFICIAL INTELLIGENCE FOR ELECTRICAL ENGINEERING

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EEP25	Artificial Intelligence Applications in Power Systems	PEC	3	0	0	0	3
2	U21EEP26	Data Science for Electrical Engineers	PEC	3	0	0	0	3
3	U21EEP27	Fundamentals of AR and VR	PEC	3	0	0	0	3
4	U21EEP28	Artificial Neural Networks and Applications	PEC	3	0	0	0	3
5	U21EEP29	Fuzzy Logic Control	PEC	3	0	0	0	3
6	U21EEP30	Deep Learning for Electrical Engineering	PEC	3	0	0	0	3
7	U21EEP31	Tensor Flow for Engineering Applications	PEC	3	0	0	0	3
8	U21EEP32	Fundamentals of Natural Language Processing	PEC	3	0	0	0	3

VERTICAL V: EMBEDDED SYSTEMS

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EEP33	Smart Sensors and Applications	PEC	3	0	0	0	3
2	U21EEP34	MEMS and its Applications	PEC	3	0	0	0	3
3	U21EEP35	Discrete Time Signal Processing	PEC	3	0	0	0	3
4	U21EEP36	Real Time Operating Systems	PEC	3	0	0	0	3
5	U21EEP37	Computer Networks for Electrical Engineers	PEC	3	0	0	0	3
6	U21EEP38	Software for Embedded Systems	PEC	3	0	0	0	3
7	U21EEP39	IoT System Design and Security	PEC	3	0	0	0	3
8	U21EEP40	Advanced Industrial Automation	PEC	3	0	0	0	3

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VERTICAL VI: ENERGY ENGINEERING

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EEP41	Power Plant Technology	PEC	3	0	0	0	3
2	U21EEP42	Fuel Cell Technology	PEC	3	0	0	0	3
3	U21EEP43	Solar Energy Technology	PEC	3	0	0	0	3
4	U21EEP44	Bio Energy Technology	PEC	3	0	0	0	3
5	U21EEP45	Wind Energy Technology	PEC	3	0	0	0	3
6	U21EEP46	Energy Efficient Buildings	PEC	3	0	0	0	3
7	U21EEP47	Electrical Energy Utilization and Cost Estimation	PEC	3	0	0	0	3
8	U21EEP48	Energy Management and Auditing	PEC	3	0	0	0	3

OPEN ELECTIVES

(Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories).

OPEN ELECTIVES – I (SEMESTER: IV)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EEX01	Electrical Safety Practices and Standards	OEC	3	0	0	0	3
2	U21EEX02	Electric Vehicles	OEC	3	0	0	0	3

OPEN ELECTIVES – II (SEMESTER: V)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EEX03	Energy Technology	OEC	3	0	0	0	3
2	U21EEX04	Home Automation	OEC	3	0	0	0	3

OPEN ELECTIVES – III (SEMESTER: VI)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EEX05	Battery Technology	OEC	3	0	0	0	3
2	U21EEX05	Energy Audit	OEC	3	0	0	0	3

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SEMESTER V

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21EE501	Power System Analysis	PCC	2	1	0	0	3
2	U21EE502	Power Electronics and Drives	PCC	3	0	0	0	3
3		Professional Elective – I	PEC	3	0	0	0	3
4		Professional Elective – II	PEC	3	0	0	0	3
5		Open Elective – II	OEC	3	0	0	0	3
	THEORY COURSE WITH LABORATORY COMPONENT / THEORY COURSE WITH PROJECT COMPONENT							
6	U21EE503	Microprocessor, Microcontroller and Applications	PCC	2	0	2	0	3
	LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT							
7	U21SSG02	Soft Skills – II	HSMC	0	0	2	0	1
8		[Live in Labs-I]	HSMC	-	-	-	-	[3]
9	U21EE504	Power Electronics and Drives Laboratory	PCC	0	0	4	2	3
10	U21EE505	Power Engineering Laboratory	PCC	0	0	4	0	2
	MANDATORY NON CREDIT COURSES							
11	U21MYC05	Cyber Security Essentials	MNC	1	0	0	0	0
			TOTAL	17	1	12	2	24

SEMESTER VI

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21EE601	Protection and Switchgear	PCC	3	0	0	0	3
2	U21EE602	Embedded System Design	PCC	3	0	0	0	3
3	U21AMG02	Machine Learning	PCC	3	0	0	0	3
4		Professional Elective – III	PEC	3	0	0	0	3
5		Professional Elective – IV	PEC	3	0	0	0	3
6		Open Elective – III	OEC	3	0	0	0	3
	LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT							
7	U21SSG03	Soft Skills – III	HSMC	0	0	2	0	1
8		[Live in Labs-II]	HSMC	-	-	-	-	[3]
9	U21EE603	Embedded System Design Laboratory	PCC	0	0	4	2	3
10	U21AMG03	Machine Learning Laboratory	PCC	0	0	2	0	1
	MANDATORY NON CREDIT COURSES							
11	U21MYC06	Introduction to UN SDGs: An Integrative Approach	MNC	1	0	0	0	0
			TOTAL	19	0	08	2	23

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SEMESTER VII

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21EE701	Principles of Management	HSMC	3	0	0	0	3
2		Professional Elective – V	PEC	3	0	0	0	3
3		Professional Elective – VI	PEC	3	0	0	0	3
4		Open Elective – IV	OEC	3	0	0	0	3
	LABORATORY COURSES / LABORATORY COURSE WITH PROJECT COMPONENT							
5	U21EE702	Special Laboratory	PCC	0	0	2	2	2
6	U21EE703	Project Work Phase – I	EEC	0	0	0	4	2
			TOTAL	12	0	2	6	16

SEMESTER VIII

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EE801	Project Work Phase – II	EEC	0	0	0	20	10
			TOTAL	0	0	0	20	10

INDUSTRIAL TRAINING / INTERNSHIP

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EEI01	Industrial Training / Internship**	EEC	0	0	0	0	2
			TOTAL	0	0	0	0	2

***Four Weeks during any semester vacation from III to VI Semester**

NCC CREDIT COURSES:

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21NCC01	National Cadet Corps I	-	1	0	2	0	2
2	U21NCC02	National Cadet Corps II	-	1	0	2	0	2
3	U21NCC03	National Cadet Corps III	-	1	0	2	0	2
4	U21NCC04	National Cadet Corps IV	-	2	0	2	0	3
5	U21NCC05	National Cadet Corps V	-	1	0	2	0	2
6	U21NCC06	National Cadet Corps VI	-	2	0	2	0	3
				8	-	12	-	14

NCC Credit Course (Level 1 – Level 6) are offered for NCC students only. The grades earned by the students will be recorded in the mark sheet, however the same shall not be considered for the computation of CGPA.

TOTAL CREDITS: 165

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PROFESSIONAL ELECTIVE COURSES: VERTICALS

Vertical I Power Systems	Vertical II Converters and Drives	Vertical III Electric and Hybrid Vehicles	Vertical IV Artificial Intelligence for Electrical Engineering	Vertical V Embedded Systems	Vertical VI Energy Engineering
Power System Operation and Control	Advanced Semiconductor Devices	Battery Management Systems	Artificial Intelligence Applications in Power Systems	Smart Sensors and Applications	Power Plant Technology
High Voltage Engineering	SMPS and UPS	Electric Vehicles and Dynamics	Data Science for Electrical Engineers	MEMS and its Applications	Fuel Cell Technology
Microgrid	Electrical Machine Design	EV Standards and Testing	Fundamentals of AR and VR	Discrete Time Signal Processing	Solar Energy Technology
Computer Aided Power System Analysis	HVDC Transmission	Hybrid Electric Vehicles	Artificial Neural Networks and Applications	Real Time Operating Systems	Bio Energy Technology
Power Quality	Advanced Electric Motors and Control	Electric Vehicles in Smart Grid	Fuzzy Logic Control	Computer Networks for Electrical Engineers	Wind Energy Technology
Power System Security	Flexible AC Transmission Systems	Automotive Transmission	Deep Learning for Electrical Engineering	Software for Embedded Systems	Energy Efficient Buildings
EHVAC Transmission	Analysis of Inverters	Energy Storage Systems	Tensor Flow for Engineering Applications	IoT System Design and Security	Electrical Energy Utilization and Cost Estimation
Smart Grid Technologies	Simulation of Power Converters	IoT in EV Applications	Fundamentals of Natural Language Processing	Advanced Industrial Automation	Energy Management and Auditing

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered in Semesters V and VII. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VII.

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PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL I: POWER SYSTEMS

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EEP01	Power System Operation and Control	PEC	3	0	0	0	3
2	U21EEP02	High Voltage Engineering	PEC	3	0	0	0	3
3	U21EEP03	Microgrid	PEC	3	0	0	0	3
4	U21EEP04	Computer Aided Power System Analysis	PEC	3	0	0	0	3
5	U21EEP05	Power Quality	PEC	3	0	0	0	3
6	U21EEP06	Power System Security	PEC	3	0	0	0	3
7	U21EEP07	EHV AC Transmission	PEC	3	0	0	0	3
8	U21EEP08	Smart Grid Technologies	PEC	3	0	0	0	3

VERTICAL II: CONVERTERS AND DRIVES

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EEP09	Advanced Semiconductor Devices	PEC	3	0	0	0	3
2	U21EEP10	SMPS and UPS	PEC	3	0	0	0	3
3	U21EEP11	Electrical Machine Design	PEC	3	0	0	0	3
4	U21EEP12	HVDC Transmission	PEC	3	0	0	0	3
5	U21EEP13	Advanced Electric Motors and Control	PEC	3	0	0	0	3
6	U21EEP14	Flexible AC Transmission Systems	PEC	3	0	0	0	3
7	U21EEP15	Analysis of Inverters	PEC	3	0	0	0	3
8	U21EEP16	Simulation of Power Converters	PEC	3	0	0	0	3

VERTICAL III: ELECTRIC AND HYBRID VEHICLES

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EEP17	Battery Management Systems	PEC	3	0	0	0	3
2	U21EEP18	Electric Vehicles and Dynamics	PEC	3	0	0	0	3
3	U21EEP19	EV Standards and Testing	PEC	3	0	0	0	3
4	U21EEP20	Hybrid Electric Vehicles	PEC	3	0	0	0	3

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5	U21EEP21	Electric Vehicles in Smart Grid	PEC	3	0	0	0	3
6	U21EEP22	Automotive Transmission	PEC	3	0	0	0	3
7	U21EEP23	Energy Storage Systems	PEC	3	0	0	0	3
8	U21EEP24	IoT in EV Applications	PEC	3	0	0	0	3

VERTICAL IV: ARTIFICIAL INTELLIGENCE FOR ELECTRICAL ENGINEERING

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EEP25	Artificial Intelligence Applications in Power Systems	PEC	3	0	0	0	3
2	U21EEP26	Data Science for Electrical Engineers	PEC	3	0	0	0	3
3	U21EEP27	Fundamentals of AR and VR	PEC	3	0	0	0	3
4	U21EEP28	Artificial Neural Networks and Applications	PEC	3	0	0	0	3
5	U21EEP29	Fuzzy Logic Control	PEC	3	0	0	0	3
6	U21EEP30	Deep Learning for Electrical Engineering	PEC	3	0	0	0	3
7	U21EEP31	Tensor Flow for Engineering Applications	PEC	3	0	0	0	3
8	U21EEP32	Fundamentals of Natural Language Processing	PEC	3	0	0	0	3

VERTICAL V: EMBEDDED SYSTEMS

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EEP33	Smart Sensors and Applications	PEC	3	0	0	0	3
2	U21EEP34	MEMS and its Applications	PEC	3	0	0	0	3
3	U21EEP35	Discrete Time Signal Processing	PEC	3	0	0	0	3
4	U21EEP36	Real Time Operating Systems	PEC	3	0	0	0	3
5	U21EEP37	Computer Networks for Electrical Engineers	PEC	3	0	0	0	3
6	U21EEP38	Software for Embedded Systems	PEC	3	0	0	0	3
7	U21EEP39	IoT System Design and Security	PEC	3	0	0	0	3
8	U21EEP40	Advanced Industrial Automation	PEC	3	0	0	0	3

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VERTICAL VI: ENERGY ENGINEERING

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EEP41	Power Plant Technology	PEC	3	0	0	0	3
2	U21EEP42	Fuel Cell Technology	PEC	3	0	0	0	3
3	U21EEP43	Solar Energy Technology	PEC	3	0	0	0	3
4	U21EEP44	Bio Energy Technology	PEC	3	0	0	0	3
5	U21EEP45	Wind Energy Technology	PEC	3	0	0	0	3
6	U21EEP46	Energy Efficient Buildings	PEC	3	0	0	0	3
7	U21EEP47	Electrical Energy Utilization and Cost Estimation	PEC	3	0	0	0	3
8	U21EEP48	Energy Management and Auditing	PEC	3	0	0	0	3

OPEN ELECTIVES

(Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories).

OPEN ELECTIVES – I (SEMESTER: IV)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EEX01	Electrical Safety Practices and Standards	OEC	3	0	0	0	3
2	U21EEX02	Electric Vehicles	OEC	3	0	0	0	3

OPEN ELECTIVES – II (SEMESTER: V)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EEX03	Energy Technology	OEC	3	0	0	0	3
2	U21EEX04	Home Automation	OEC	3	0	0	0	3

OPEN ELECTIVES – III (SEMESTER: VI)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EEX05	Battery Technology	OEC	3	0	0	0	3
2	U21EEX08	Energy Audit	OEC	3	0	0	0	3

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OPEN ELECTIVES – IV (SEMESTER: VII)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21EEX06	Solar PV System: Installation and Maintenance	OEC	3	0	0	0	3
2	U21EEX07	Optimization Techniques for Engineering Applications	OEC	3	0	0	0	3

Scheme of Credit distribution – Summary

SI.NO.	Stream	Credits/Semester								Credits
		I	II	III	IV	V	VI	VII	VIII	
1.	Humanities and Social Sciences including Management (HSMC)	2	2	-	1	1	1	3	-	10
2.	Basic Science Courses (BSC)	9	6	4	3	-	-	-	-	22
3.	Engineering Science Courses (ESC)	10	11	6	3	-	-	-	-	30
4.	Professional Core Courses (PCC)	-	3	13	14	14	13	2	-	59
5.	Professional Elective Courses (PEC)	-	-	-	-	6	6	6	-	18
6.	Open Elective Courses (OEC)	-	-	-	3	3	3	3	-	12
7.	Employability Enhancement Courses (EEC)	-	-	-	-	-	-	2	10	12
8.	Industrial Training/ Internship	-	-	-	-	-	-	-	2	2
9.	Mandatory Non-Credit Course (MNC)	-	-	-	-	-	-	-	-	-
Total		21	22	23	24	24	23	16	12	165

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7.7.2022

Head
Centre for Academic Courses
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SEMESTER I

		Category: BSC				
U21MA102	**CALCULUS AND LINEAR ALGEBRA** (For EE)	**L**	**T**	**P**	**J**	**C**
		2	**1**	**0**	**0**	**3**

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the concepts of matrices and calculus which will enable them to model and analyze physical phenomena involving continuous change
- To understand the methodologies involved in solving problems related to fundamental principles of calculus
- To understand postulates of vector spaces and linear transformations

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply the knowledge of matrices with the concepts of eigenvalues to study their problems in core areas (Apply)

CO2: Apply the basic techniques and theorems of functions of several variables in other areas of mathematics (Apply)

CO3: Analyze the triple integrals techniques over a region in two dimensional and three dimensional geometry (Apply)

CO4: Use the concepts of base and dimension of vector space and express vector spaces in different dimensions (Understand)

CO5: Analyze the functions defined between vector spaces and express required conditions for a transformation in order to be a linear transformation (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	1	1	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	1	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	1	-
CO4	3	2	-	-	-	-	-	-	-	-	-	1	1	-
CO5	2	2	-	-	-	-	-	-	-	-	-	-	1	-
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)						3: Substantial (High)					

SYLLABUS:

UNIT I MATRICES **6 + 3**

Eigenvalues and eigenvectors – Properties (without proof) – Cayley Hamilton theorem (without proof) – Diagonalization using orthogonal transformation – Applications

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UNIT II FUNCTIONS OF SEVERAL VARIABLES **6 + 3**

Partial derivatives – Total derivative – Jacobians – Taylor's series expansion – Extreme values of functions of two variables – Lagrange multipliers method

UNIT III MULTIPLE INTEGRALS **6 + 3**

Double integrals – Change of order of integration – Triple integrals – Applications: Area and volume

UNIT IV VECTOR SPACES **6 + 3**

Vector spaces – Subspaces – Linear combinations and linear system of equations – Linear independence and linear dependence – Bases and dimensions

UNIT V LINEAR TRANSFORMATION **6 + 3**

General linear transformations – Kernel and range – Matrices of general linear transformation – Geometry linear operators – Change of basis

Contact Periods:

Lecture: 30 Periods Tutorial: 15 Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th edition Wiley India Pvt Ltd, New Delhi, 2018.
2. Howard Anton and Chris Rorres, "Elementary Linear Algebra", 11th edition, John Wiley & Sons Inc, 2013.

REFERENCES:

1. Bali N P and Dr Manish Goyal, "A text book of Engineering Mathematics", 12th edition, Laxmi Publications, 2016.
2. Thomas G B and Finney R L, "Calculus and Analytic Geometry", 9th edition, Pearson Education India, 2018.
3. Maurice D Weir, Joel Hass and Christopher Heil, "Thomas Calculus", 14th edition, Pearson Education, India, 2018.
4. Gilbert Strang, "Linear Algebra and its Applications", 4th edition, Cengage India Pvt. Ltd, 2005.

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Seminar / MCQ	Written Test	*Individual Assignment / Seminar / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER I

U21EE101	FOUNDATION FOR ELECTRICAL ENGINEERING	Category: ESC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the fundamental knowledge on electricity, residential and industrial wiring
- To understand the concept of electrical accessories and various tariff
- To apply the concepts of supply utility and tariff calculation in practical applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Interpret the basic electrical quantities and their significance (Understand)

CO2: Classify the different types of lamps, fuses and circuit breakers (Understand)

CO3: Illustrate the residential and industrial wiring (Understand)

CO4: Demonstrate the illumination system for different work places (Understand)

CO5: Estimate the tariff and energy consumption for a load (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	1	-	-	-	-	-	-	1	1	-
CO2	3	1	-	-	-	-	-	-	-	-	-	1	1	-
CO3	3	1	-	-	-	1	-	1	-	-	-	1	1	-
CO4	3	1	1	-	1	-	-	1	-	-	1	1	1	-
CO5	3	1	1	-	-	1	-	1	-	-	1	1	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)							3: Substantial (High)			

SYLLABUS:

UNIT I FUNDAMENTALS OF ELECTRICITY 9

Evolution of electricity – Electrical quantities: DC and AC Current, Voltage, resistance, inductance, capacitance, frequency, impedance triangle – Types of loads – Electrical and mechanical – Electrical Safety measures

UNIT II ELECTRICAL ACCESSORIES 9

Types of Lamps – Incandescent lamp, fluorescent lamp, CFL – Basics of fuses, relays, switches, MCBs, ELCBs and cables

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UNIT III RESIDENTIAL AND INDUSTRIAL WIRING 9

Introduction to electrical wiring layouts: Residential, staircase and industrial wiring – Importance of grounding, neutral and earthing – Types of earthing – Measurement of earth resistance – Field visit

UNIT IV LIGHTING SCHEMES USING DIALux 9

DIALux demo – Lighting plan – Standards of Illumination – Floor lighting – Building lighting – Outdoor lighting – Industrial lighting – Street lighting

UNIT V UTILITY SUPPLY AND TARIFF 9

Basics of utility supply – Single phase and three phase connection schemes – Electrical tariff and types – Calculation of energy – Introduction to energy audit and importance of energy saving

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Kothari D.P. and Nagrath I.J., "Basic Electrical Engineering", 3rd edition, Tata McGraw-Hill Education, 2011
2. Uppal S.L., "Electrical Wiring, Estimating and Costing", 8th reprint, Khanna Publishers, 2018

REFERENCES:

1. Theraja B.L., "Fundamentals of Electrical Engineering and Electronics", 28th edition, S Chand & Company, 2020
2. "General Aspects of Energy Management and Energy Audit", Bureau of Energy Efficiency, Ministry of Power, Government of India
3. Open-source tools like DIALux, Relux and LuxRender

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th rowspan="2">Total Internal Assessments</th><th rowspan="3">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td></td></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>200</td><td>100</td></tr>
<tr><td colspan="4" rowspan="2">Total</td><td>40</td><td>60</td></tr>
<tr><td colspan="2">100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER I

		Category: HSMC				
U21EN101	ENGLISH FOR TECHNOLOGISTS (Common to AD, BM, CH, CE, CS, CS(AIML), EE, EC, ME, MI, IT)	L	T	P	J	C
		1	0	2	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To infer and interpret the meaning of Technical, Business, Social and Academic contexts.
- To enhance the listening skills and facilitate effective pronunciation.
- To make effective presentation and conversation in technical and professional environment.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Comprehend language and learn strategies for error-free communication (Understand)

CO2: Improve speaking skills in academic and social contexts (Apply)

CO3: Enhance both reading and writing skills to excel in professional career (Analyse)

CO4: Evaluate different perspectives on a topic (Analyse)

CO5: Develop listening skills to understand complex business communication in a variety of global English accents through Personality Development (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	3	-	1	-	-
CO2	-	-	-	-	-	-	-	-	2	3	-	-	-	-
CO3	-	-	-	-	-	-	-	-	2	3	-	1	-	-
CO4	-	-	-	-	-	-	-	-	2	3	-	-	-	-
CO5	-	-	-	-	-	-	-	2	-	3	-	1	-	-

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I SUBJECTIVE INTROSPECTION 9

Module:1 Vocabulary Building

Activity: Word Puzzles, Snappy words, Word Sleuthing

Module:2 Introducing and Sharing Information

Activity: Get to know oneself, Introducing Peer Members

Module:3 Opinion Paragraph

Activity: Note making, analyzing and writing a review

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UNIT II	**CAREER ENHANCEMENT**	**9**

Module:4 Reading Comprehension

Activity: Reading Newspaper articles/Blogs, Sentence completion

Module:5 E-mail Communication

Activity: Drafting personal and professional emails

Module:6 Career Profiling

Activity: Resume Writing & Digital Profiling

UNIT III	**LANGUAGE ADEPTNESS**	**9**

Module:7 Rewriting passages

Activity: Conversion of voices & Rephrasing Articles

Module:8 Enhancing Pronunciation skills

Activity: Listening to short technical Reels and reproducing it

Module:9 Making Conversations

Activity: Role play & Narrating Incidents

UNIT IV	**TECHNICAL WRITING**	**9**

Module:10 Spotting Errors

Activity: Proof reading, Rewriting sentences

Module:11 Data interpretation

Activity: Interpretation of Graphics/Charts/Graphs

Module:12 Expository Writing

Activity: Picture inference, Captions for Posters& Products

UNIT V	**LANGUAGE UPSKILLING**	**9**

Module:13 Listening for Specific Information

Activity: TED talks/Announcement/Documentaries

Module:14 Presentation

Activity: Extempore & Persuasive Speech

Module:15 Team Communication

Activity: Team building activities, Group Discussion

LIST OF EXERCISES

1. Introducing oneself
2. Role play
3. Listening to short technical Reels
4. Listening to TED Talks/ Announcements/ Documentaries
5. Presentation
6. Group Discussion

Contact Periods:

Lecture: 15 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 45 Periods

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TEXT BOOKS: ,

1. Ashraf Rizvi, "Effective Technical Communication", 2nd edition, Mc Graw – Hill. India 2017.
2. Rod Ellis, "English for Engineers & Technologists", Vol. II: (English for Engineers and Technologist: A Skills Approach). 2nd edition, Orient Black Swan, 1990.

REFERENCES:

1. Raymond Murphy, "Intermediate English Grammar", 2nd edition, Cambridge University Press, 2009.
2. Thomas L Means, "English and Communication for Colleges", 4th edition, Cengage 2017.
3. Using English: "A Course book for Undergraduate Engineers and Technologists", 1st edition, Orient Black Swan, 2017.

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th>End Semester Examinations</th></tr>
<tr><td colspan="2">Assessment I
(Theory)
(100 Marks)</td><td colspan="2">Assessment II
(Practical)
(100 Marks)</td><td rowspan="2">Practical Examinations

(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>*Individual Assignment / Seminar / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)</td><td>Test</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td><td></td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>50</td></tr>
<tr><td colspan="4">50</td><td>50</td></tr>
<tr><td colspan="5">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER I

U21PH101	ENGINEERING PHYSICS (Common to all branches)	Category: BSC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the fundamental principles of laser and fibre optics with their applications
- To acquire the knowledge of ultrasonic waves, thermal conductivity and properties of liquids
- To understand the concepts of crystals

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Demonstrate the types of laser for various industrial and medical applications (Understand)

CO2: Apply the concepts of fibre optics in engineering (Understand)

CO3: Understand the production methods of ultrasonic waves and uses in engineering and medicine (Understand)

CO4: Apply the concepts of thermal conductivity in hybrid vehicles and viscosity of liquids in engineering applications (Understand)

CO5: Explain the basic concepts of crystals and its growth techniques (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	-	1	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	1	-
CO3	3	2	1	-	-	-	-	-	-	-	-	-	1	-
CO4	3	2	1	-	-	-	-	-	-	-	-	-	-	1
CO5	3	2	1	-	-	-	-	-	-	-	-	-	-	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I LASER **6**

Laser characteristics – Spontaneous and stimulated emission – Pumping methods – CO_2 laser – Semiconductor laser – Material Processing – Selective laser Sintering – Hologram – Medical applications (Opthalmology)

UNIT II FIBER OPTICS **6**

Total internal reflection – Numerical aperture and acceptance angle – Classification of optical fibers (Materials, modes and refractive index profile) – Fiber optical communication system – Displacement and temperature sensor – Medical Endoscopy

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UNIT III ULTRASONICS 6

Properties of ultrasonic waves – Piezoelecrtic generator – Acoustic grating – Applications of ultrasonics in industry – SONAR – NDT – Ultrasonic scanning methods – Fetal heart movement

UNIT IV THERMAL PHYSICS AND PROPERTIES OF FLUIDS 6

Modes of heat transfer – Thermal conductivity – Lee's disc method – Solar thermal power generation – Hybrid vehicles – Microwave oven – Surface tension and coefficient of viscosity – Poiseuille's flow experiment

UNIT V CRYSTAL PHYSICS 6

Unit cell – Bravais lattices – SC, BCC, FCC structures – Miller indices – d spacing in cubic lattice – Crystal growth from melt: Bridgeman Technique – Silicon ingots from Czochralski method – Silicon wafers from ingots and its applications

LIST OF EXPERIMENTS

1. Determination of the wavelength of a given laser source
2. Determination of acceptance angle and numerical aperture of an optical fibre
3. Determination of velocity of sound and compressibility of a liquid using Ultrasonic interferometer
4. Determination of thermal conductivity of a bad conductor using Lee's disc method
5. Determination of viscosity of the given liquid using Poiseuille's flow method

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Bhattacharya D K and Poonam Tandon, "Engineering Physics", 2nd edition, Oxford University Press, Chennai, 2017
2. Marikani A, "Engineering Physics", 3rd edition, PHI publishers, Chennai, 2021

REFERENCES:

1. Shatendra Sharma and Jyotsna Sharma, "Engineering Physics", 2nd edition, Pearson India Education Services Private Limited, Chennai, 2018
2. Avadhanulu M N, Kshirsagar P G and Arun Murthy TVS, "A Text book of Engineering Physics", 2nd edition, S Chand Publishing, New delhi, 2018
3. Thyagaran K, Ajoy Ghatak, "Lasers – Fundamantals and Applications", 2nd edition, Laxmi Publications Pvt Limited, New delhi, 2019
4. https://nptel.ac.in/downloads/104104085/.
5. https://nptel.ac.in/courses/122107035/8/

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER I

		Category: BSC				
		L	T	P	J	C
U21CY101	ENGINEERING CHEMISTRY (Common to all BE./B.Tech. courses)	2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To inculcate the fundamentals of water technology and electrochemistry
- To gain basic knowledge of corrosion of metals and alloys
- To acquire knowledge about the properties of fuels and applications of polymers

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply the principles of water technology in treatment of industrial and domestic water and estimate the various constituents of industrial water (Apply)

CO2: Describe the principles and applications of electrochemical cells, fuel cells and solar cells (Understand)

CO3: Outline the different types of corrosion processes and preventive methods adopted in industries (Understand)

CO4: Explain the analysis and calorific value of different types of fuels (Understand)

CO5: Classify the polymers and their engineering applications (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	2	-	1	-	-	1	-	-
CO2	3	1	-	-	-	-	2	-	1	-	-	1	-	1
CO3	3	1	-	-	-	-	2	-	1	-	-	1	-	-
CO4	3	1	-	-	-	-	2	-	1	-	-	1	-	-
CO5	3	1	-	-	-	-	2	-	1	-	-	1	-	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)					3: Substantial (High)						

SYLLABUS:

UNIT I CHARACTERISTICS OF WATER AND ITS TREATMENT 6

Characteristics of water – Hardness – Types, Dissolved oxygen, Total dissolved solids, Disadvantages due to hard water in industries – (Scale, Sludge, Priming, Foaming and Caustic embrittlement), Water softening methods – Lime-soda, Zeolite, Ion exchange processes and reverse Osmosis and their applications. Specifications of domestic water (ICMR and WHO).

Water treatment for municipal supply – Sedimentation with coagulant – Sand Filtration – Chlorination, Disinfection methods – UV treatment, Ozonolysis, Electro dialysis

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UNIT II ELECTROCHEMISTRY AND ENERGY STORAGE SYSTEMS 6

Introduction, Electrodes – (Calomel electrode), Electrochemical series and its applications, Brief introduction to conventional primary and secondary batteries – (Pb acid, Lithium)

Fuel cells – Polymer membrane fuel cells, Solid-oxide fuel cells – Working principles, advantages, applications. Solar cells – Dye sensitized solar cells – Working principles, characteristics and applications

UNIT III CORROSION AND ITS CONTROL 6

Types – Dry – Chemical corrosion and Wet – Galvanic and differential aeration (Pitting, Crevice, pipeline) – Factors influencing rate of corrosion – Corrosion control methods – Sacrificial anode and impressed current method – Protective coating – Electroplating – Ni plating.

Alloys – Ferrous (stainless steel), Heat treatment – Non-ferrous alloys (Brass -Dutch metal, German Silver) – Composition, properties and uses

UNIT IV FUELS AND COMBUSTION 6

Fuels- Solid fuel: Coal - Analysis of coal (Proximate analysis only) – Liquid fuel – Manufacture of synthetic petrol (Bergius process) – Octane number, cetane number, Knocking in engines- Anti-knocking agents, Gasoline additives, Gaseous fuel: Compressed natural gas (CNG) – Liquefied petroleum gases (LPG) – Composition only.

Calorific value – Higher and lower calorific values – Flue gas analysis (ORSAT method). Measurement of calorific value using bomb calorimeter, Three-way catalytic converter – Selective catalytic reduction of NO_x

UNIT V POLYMERS 6

Introduction – Monomer, dimers, functionality, degree of polymerisation, transition glass temperature Classification of polymers, Difference between thermoplastics and thermosetting plastics, Engineering application of plastics - ABS, PVC, PTFE and Bakelite.

Types of compounding of plastics – Moulding, Injection moulding, Extrusion moulding, Compression moulding

Conducting polymers – Polypyrrole, Polyacetylene, Polyaniline – Structure and applications, Composites – FRP – Properties and applications

LIST OF EXPERIMENTS

1. Determination of total, permanent and temporary hardness of a given sample water by EDTA method
2. Estimation of ferrous ion by potentiometric titration
3. Estimation of Copper in Brass by EDTA method
4. Determination of percentage of moisture, volatile, ash and carbon content in a given sample of coal.
5. Determination of molecular weight and degree of polymerization of an oil sample by viscosity measurement (Ostwald's viscometer).
6. Determination of chloride content in the water sample
7. Determination of strength of HCl by pH metric method

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Jain P C and Monika Jain, "Engineering Chemistry", 16th edition, Dhanpat Rai Publishing Company, Pvt. Ltd., New Delhi, 2015
2. Vairam S, Kalyani P and Suba Ramesh, "Engineering Chemistry", 2nd edition, Wiley India Pvt. Ltd, New Delhi, 2014

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REFERENCES:

1. Friedrich Emich, "Engineering Chemistry", 2nd edition, Scientific International Pvt. Ltd, New Delhi, 2014
2. Prasanta Rath, "Engineering Chemistry", 1st edition, Cengage Learning India, Pvt. Ltd, Delhi, 2015
3. Shikha Agarwal, "Engineering Chemistry, Fundamentals and Applications", 1st edition, Cambridge University Press, 2015
4. https://nptel.ac.in/courses/113/104/113104008/

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th colspan="2">End Semester Examinations</th></tr>
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<tr><td colspan="2">25</td><td colspan="2">25</td><td>25</td><td>25</td></tr>
<tr><td colspan="4">50</td><td colspan="2">50</td></tr>
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</table>

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SEMESTER I

U21CSG01	PROBLEM SOLVING AND C PROGRAMMING (Common to All Branches)	Category: ESC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To provide exposure to problem-solving through programming
- To develop computational thinking perspective of one's own discipline
- To write, compile and debug programs using C language

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Formulate the algorithmic solutions for a given computational problem (Understand)

CO2: Describe modularization, structures and pointers in C language (Understand)

CO3: Design and implement algorithms for a given problem using C control structures (Apply)

CO4: Apply the C programming constructs for searching and sorting techniques (Apply)

CO5: Solve real time problems using suitable non-primitive data structures in C (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	2	-	-	-	1	2	2	-	3	1	-
CO2	2	1	1	2	-	-	-	1	2	2	-	2	1	-
CO3	3	2	2	2	-	2	-	1	2	2	-	2	1	-
CO4	3	2	2	2	-	-	-	1	2	2	-	2	1	-
CO5	3	2	2	2	-	-	-	1	2	2	-	2	1	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

UNIT I COMPUTATIONAL THINKING 6

Computational Thinking – Modern Computer – Information based Problem solving – Real world information and Computable Data – Data types and data encoding – Number Systems – Introduction to programming languages – Basics of C programming – variables– Data types – keywords – C program structure – Simple programs in C

UNIT II ALGORITHMIC APPROACH 6

Logic – Boolean Logic – Applications of Propositional logic – Problem Definition – Logical Reasoning and Algorithmic thinking – Pseudo code and Flow chart – Constituents of algorithms – Sequence, Selection and Repetition – Problem understanding and analysis – Control structures in C – Algorithm design and implementation using control structures

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UNIT III SEARCHING, SORTING, AND MODULARIZATION 6

Data Organization – Arrays – Introduction to Searching and Sorting – Linear Search, Binary Search – Basic sorting techniques – Two-dimensional arrays – Matrix manipulation – Modularization – Functions – Function prototype – Function definition – Function call – Built-in functions (string functions and math functions) – Recursion

UNIT IV STRUCTURES AND POINTERS 6

Pointers – Pointer operators – Pointer arithmetic – Arrays and pointers – Array of pointers – Example Program – Sorting of names – Parameter passing – Pass by value – Pass by reference – Structure – Nested structures – Pointer and Structures – Array of structures – Example Program using structures and pointers – Unions

UNIT V FILES 6

Files – Types of file processing – Sequential access – Random access – Sequential access file – Example Program – Finding average of numbers stored in sequential access file – Random access file – Example Program – Transaction processing using random access files – Command line arguments

LIST OF EXPERIMENTS

A. Lab Programs

1. Using IO Statements, get higher secondary marks of a student. Calculate and display the medical and engineering cut-off marks. [Assume the calculation formula]
2. Develop a C program to emulate the operations of an ATM using control structures. Authentication, Deposit, Withdrawal, and Balance check and pin change operations are to be supported.
3. Develop a calculator to perform the operations including addition, subtraction, multiplication, division and square of a number.
4. Given different prices of a vegetable which is varying through the day (from morning to evening), find out the best buy price and sell price for the maximum profit. Eg. For the prices [33, 35, 28, 36, 39, 25, 22, 31], best buy is at 28 and best sell is at 39.
5. Collect height and weight of 4 of your friends and calculate their body mass index. Use 2 dimensional array to store the values.
6. Weights of 10 students of your class who are standing in a line is given in a random order. Find out if there is a heavy person whose weight is the sum of previous two persons.
7. Convert the given decimal number into binary, octal and hexadecimal numbers using user defined functions.
8. From a given paragraph perform the following using built-in functions:
    a) Find the total number of words.
    b) Capitalize the first word of each sentence.
9. Solve Towers of Hanoi using recursion.
10. Develop an expense manager which reads date, product, price and product category. The program should display the total expense amount based on product category or date as per user's selection. Use structures.
11. Develop a banking application to store details of accounts in a file. Count the number of account holders based on a search condition such as - whose balance is less than the minimum balance.

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B. Mini Project (SAMPLE)

Create a Railway Reservation system with the following modules of Booking,

- Availability checking
- Cancellation
- Prepare chart

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. David D. Railey and Kenny A.Hunt , "Computational Thinking for Modern problem Solver", 1st Edition, CRC Press, 2014
2. Brian W. Kernighan and Dennis Ritchie, "The C Programming Language", 2nd Edition, Pearson, 2015

REFERENCES:

1. Paolo Ferragina and Fabrizio Luccio, "Computational Thinking First Algorithms", Then Code" ,1st Edition,Springer International Publishing, 2018
2. Reema Thareja, "Programming in C", 2nd Edition, Oxford University Press, 2016
3. Paul Deitel and Harvey Deitel, "C How to Program", 7th Edition, Pearson Publication
4. Juneja, B. L and Anita Seth, "Programming in C",1st Edition, Cengage Learning India Pvt. Ltd., 2011
5. Pradip Dey, Manas Ghosh, "Fundamentals of Computing and Programming in C", 1st Edition, Oxford University Press, 2009

EVALUATION PATTERN:

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*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER I

		Category: ESC				
U21MEG01	ENGINEERING GRAPHICS	L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To expose the standards and conventions followed in preparation of engineering drawings
- To develop graphic skills for communication of concepts, ideas and engineering drawings
- To expose on 2D & 3D drawings and its projections

COURSE OUTCOME:

Upon completion of the course, the student will be able to

CO1: Sketch the curves and orthographic projections of points as per BIS conventions (Apply)

CO2: Illustrate the orthographic projections of straight lines and plane surfaces (Apply)

CO3: Sketch the orthographic projections of solids, lateral surfaces of frustums, truncated solids and its development (Apply)

CO4: Develop the lateral surfaces of simple solids (Apply)

CO5: Interpret the orthographic and isometric views of simple components (Apply)

CO PO Mapping:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	3	-	-	1	-	2	-	1	-	-
CO2	3	2	2	-	3	-	-	-	-	2	-	1	-	-
CO3	3	2	2	-	3	-	-	-	-	3	-	1	-	-
CO4	3	2	2	-	3	-	-	-	-	3	-	1	-	-
CO5	3	2	2	-	3	-	-	-	-	3	-	1	-	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

BASICS OF ENGINEERING DRAWING AND CAD (Not for examination)

Introduction – Drawing instruments and its uses – Sheet layout – BIS conventions – Lines – Lettering and dimensioning practices – Lines – Co – Ordinate points – Axes – Poly lines – Square – Rectangle – Polygons – Splines – Circles – Ellipse – Text – Move – Copy – Off – Set – Mirror – Rotate – Trim – Extend – Break – Chamfer – Fillet – Curves – Constraints viz. agency – Parallelism – Inclination and perpendicularity

UNIT I CONICS, SPECIAL CURVES AND PROJECTION OF POINTS **12**

Construction of parabola – Ellipse and hyperbola using eccentricity method – Construction of involutes for squares and circles – Construction of Tangent and normal to the above curves – Introduction –

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Method of projection – Planes of projection – Reference line and notations – Orthographic Projection of points – Points in all four quadrants

UNIT II PROJECTION OF STRAIGHT LINES AND SURFACES **12**

Projection of straight lines – Lines inclined to HP / VP plane – Inclined to both HP and VP planes (straight lines are assumed to be in first quadrant only) – Projection of planes – Projection of square – Rectangle – Pentagon – Hexagon and circular plane – Inclined to both the plane by change of position method

UNIT III PROJECTION OF SOLIDS **12**

Introduction – Projection of solids – Prisms – Pyramids – Cylinders and cones with axis inclined to both the planes (Solids resting on HP only)

UNIT IV DEVELOPMENT OF LATERAL SURFACES OF SOLIDS **12**

Introduction – Cutting plane – Sectional views of right regular solids resting with base on HP – Prisms – Pyramids – Cylinder and cone – True shapes of the sections – Development of lateral surfaces of right regular prisms – pyramids – Cylinders – Cones resting with base on HP only – Development of the frustums and truncations

UNIT V ORTHOGRAPHIC AND ISOMETRIC PROJECTIONS **12**

Orthographic projection – Simple machine components using free hand sketching – Isometric projection – Simple Solid exercises and combination of solids

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. ND Bhat & VM Panchal, "Engineering Drawing", 51st edition, Charotar Publishing House, Gujarat, 2013.
2. Venugopal K. and Prabhu Raja V, "Engineering Graphics", 6th edition, New Age International (P) Limited, 2019.

REFERENCES:

1. Natrajan K.V., A text book of Engineering Graphics, 21st edition, Dhanalakshmi Publishers, Chennai, 2017.
2. Sam Tickoo, AutoCAD 2013 for Engineers and Designers, 1st edition, Dream tech Press, 2013.
3. Annaiah M H & Rajashekar Patil, Computer Aided Engineering Drawing, 4th edition, New Age International Publishers,,2012.
4. Basant Aggarwal, Engineering Drawing, 1st edition, Tata Mc Graw Hill Education Private Limited, 2010.
5. Kulkarni D M, A.P.Rastogi, A.K.Sarkar, "Engineering Graphics with AutoCAD", Revised edition, PHI Learning Private Limited, New Delhi, 2010.

EVALUATION PATTERN:

Continuous Internal Assessments		End Semester Examinations
Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test	
75	25	
100		100
60		40
100		

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SEMESTER I

U21MEG02	MANUFACTURING PRACTICES	Category: ESC				
		L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To provide exposure on workshop tools and additive manufacturing processes
- To provide hands on training experiences in sheet metal, carpentry welding and plumbing operations
- To provide hands on experience on soldering and simple electrical circuit wiring

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify the various tools and measuring equipment used for assembly and dismantling practice (Apply)

CO2: Develop simple components using 3D printer (Apply)

CO3: Fabricate products using sheet metal and carpentry (Apply)

CO4: Perform operations such as welding and plumbing (Apply)

CO5: Connect and test the electrical and electronics components for the given circuit diagram (Apply)

CO PO Mapping:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	-	1	-	1	-	1	1	-	1	-	-
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CO4	3	1	1	-	1	-	1	-	3	2	-	1	-	-
CO5	3	1	1	-	1	-	1	-	3	2	-	1	-	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

UNIT I PRODUCT WORKSHOP 9

Disassemble the product of sub assembly – Measure various dimensions using measuring instruments. Free hand rough sketch of the assembly and components – Name of the components and indicate the various materials used – Study the functioning of the assembly and parts – Study the assembly and components design for compactness – Processing – Ease of assembly and disassembly – Assemble the product or subassembly

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UNIT II ADDITIVE MANUFACTURING WORKSHOP 9

Study of 3 axis 3D printing machine – Methods of 3D printing – SLA and FDM methods – Pre –processing – Geometry creation – Support generation and slicing – Post Processing – Requirement and Techniques Support Removal – Sanding – Acetone treatment – Polishing

UNIT III SHEET METAL AND CARPENTRY WORKSHOP 9

Study of tools and equipment – Draw development drawing of simple objects on sheet metal (cone – Cylinder – Pyramid – Prism – Tray etc.) – Fabrication of components using small shearing and bending machines – Riveting practice – Study of carpentry process – Fabrication of wood joints like Lap – Tee – Dovetail and mortise & tenon joint

UNIT IV WELDING AND PLUMBING WORKSHOP 9

Study of tools and equipment – Study of various welding – Arc welding practice – Fitting – Square butt joint and lap joint – Plumbing tools – Make a piping joint to a simple piping layout (should include cutting – Threading and pipe fixing)

UNIT V ELECTRICAL AND ELECTRONICS ENGINEERING WORKSHOP 9

Study of tools and equipment – Study of basic electrical components and symbols – Simple Wiring – Staircase Wiring – fluorescent wiring – Study of soldering tools and methods of soldering

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project: – Periods

Total: 60 Periods

LIST OF EXPERIMENTS

1. Study on measuring instruments used in workshop practices.
2. Dismantling, measuring and reassembling of centrifugal pump.
3. 3D prototyping of simple components using FDM method.
4. 3D Printing of simple geometric shapes using SLA printer.
5. Fabrication of sheet metal tray and funnel.
6. Fabrication of wood joints.
7. Preparation of MS plate for Lap, butt and Tee joints using arc welding
8. Installation of water lines for washbasin and showers faucets.
9. Preparation of wiring for tube light, staircase and electric fan.
10. Soldering of a simple circuit consists of THC and SMD components.

TEXT BOOKS:

1. Hajra Choudhury, "Elements of Mechanical Engineering", 11th edition, Media Promoters, 2010.
2. S.K. Hajra Choudhury, A.K. Hajra Choudhury, Nirjhar Roy the Elements of Workshop Technology – Vol I & II, 11th edition, Media Promoters and Publishers, Mumbai, 2001

REFERENCES:

1. Workshop manual prepared by Department of Mechanical Engineering

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EVALUATION PATTERN:

Continuous Internal Assessments		**End Semester Examinations**
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test	
75	25	
100		100
60		40
100		

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SEMESTER II

		Category: BSC				
U21MA201	LAPLACE TRANSFORMS AND COMPLEX VARIABLES (Common to CE, EE, CH, ME, MI)	L	T	P	J	C
		3	1	0	0	4

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the mathematical aspects of conversion time domain to frequency domain using Laplace transform and Inverse Laplace transform vice versa
- To use the concepts of complex analysis, in the study of heat flow, fluid dynamics and electrostatics
- To understand the concepts of singularities in the various domains of engineering fields

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply the concepts of Laplace transform in core engineering applications (Apply)
CO2: Apply the concepts of Inverse Laplace transform with their properties in engineering field (Apply)
CO3: Analyze the complex functions and their mapping in certain complex planes (Understand)
CO4: Evaluate complex contour integrals directly and use the Cauchy integral theorem in its various versions (Understand)
CO5: Compute the residues of a function at given points or singularities and use the residue theorem to evaluate a contour integral (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	-	-	-	1	1	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	1	-
CO3	2	2	-	-	-	-	-	-	-	-	-	-	1	-
CO4	2	2	-	-	-	-	-	-	-	-	-	-	1	-
CO5	3	3	-	-	-	-	-	-	-	-	-	-	1	-

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I LAPLACE TRANSFORM **9 + 3**

Laplace transform – Conditions for existence – Transform of elementary functions – Standard properties (statement only) – Transforms of unit step function – Impulse function – Periodic function – Initial and final value theorems – Convolution theorem (without proof)

UNIT II INVERSE LAPLACE TRANSFORM **9 + 3**

Inverse Laplace transform – Standard properties (statement only) – Second order linear differential equations with constant coefficients

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UNIT III COMPLEX DIFFERENTIATION **9 + 3**

Analytic functions: Cauchy-Riemann equations (Cartesian form) and sufficient conditions (excluding proofs) – Harmonic and orthogonal properties of analytic function – Construction of analytic functions – Bilinear transformations

UNIT IV COMPLEX INTEGRATION **9 + 3**

Complex integration – Statement and applications of Cauchy's integral theorem and Cauchy's integral formula

UNIT V SINGULARITIES AND RESIDUES **9 + 3**

Taylor's and Laurent's series expansions – Singular points – Classification of singularities – Residues – Cauchy's residue theorem

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: – Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th edition, Wiley India Pvt Ltd, New Delhi, 2018.
2. Grewal B S, "Higher Engineering Mathematics", 44th edition, Khanna Publishers, New Delhi, 2017.

REFERENCES:

1. Bali N P and Dr Manish Goyal, "A text book of Engineering Mathematics", 12th edition, Laxmi Publications, 2016.
2. Thomas G B and Finney R L, "Calculus and Analytic Geometry", 14th edition, Pearson Education India, 2018.
3. James Stewart, "Calculus: Early Transcendental", 7th edition, Cengage Learning, New Delhi, 2015.

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Seminar / MCQ	Written Test	*Individual Assignment / Seminar / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER II

		Category: BSC				
U21PH201	MATERIALS SCIENCE (Common to all branches except BME)	L	T	P	J	C
		2	0	0	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To gain the knowledge of conducting and semiconducting materials
- To understand the concepts of magnetic, dielectric and optical properties of materials
- To enhance the knowledge of new engineering materials

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Demonstrate the electrical characteristics of conducting materials (Understand)

CO2: Interpret the properties and types of semiconducting materials (Understand)

CO3: Compare various types of magnetic materials for engineering applications (Understand)

CO4: Explain the fundamental concepts of dielectric and optical materials (Understand)

CO5: Examine new engineering materials for industrial applications (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	1	-	-	-	-	-	1	1	-
CO2	3	2	-	-	-	1	-	-	-	-	-	1	1	-
CO3	3	2	-	-	-	1	-	-	-	-	-	1	1	-
CO4	3	2	-	-	-	1	-	-	-	-	-	1	1	-
CO5	3	2	-	-	-	1	-	-	-	-	-	1	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I CONDUCTING MATERIALS 6

Classical free electron theory – Expression for electrical conductivity and thermal conductivity – Wiedemann - Franz law – Drawbacks – Fermi distribution function – Density of energy states in metals

UNIT II SEMICONDUCTING MATERIALS 6

Intrinsic and Extrinsic semiconductor – Carrier concentration in n-type semiconductor – P-type semiconductor(qualitative) – Applications of semiconductors – Solar cell – LED – Hall effect and its experimental determination

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UNIT III MAGNETIC MATERIALS 6

Origin of magnetism – Dia, para and ferro magnetic materials – Domain theory – Soft and hard magnetic materials – Magnetic bubble memories – GMR sensor

UNIT IV DIELECTRIC AND OPTICAL MATERIALS 6

Dielectrics – Types of polarisation – Electronic polarisation – Dielectric breakdown – Ferroelectrics – Applications of dielectrics – Classification of optical materials – Nonlinear optics – Applications

UNIT V NEW ENGINEERNG MATERIALS AND CHARACTERIZATION TECHNIQUES 6

SMA – SiC – GaN – Rheological materials – Nanomaterials – Synthesis (Ball milling and CVD) – Quantum dot, quantum wire and quantum well (qualitative) – Characterisation techniques – Powder XRD (qualitative) – SEM

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 30 Periods

TEXT BOOKS:

1. Wahab M A, "Solid State Physics: Structure and Properties of Materials", 3rd edition, Narosa Publishing House, Chennai, 2018
2. Marikani A, "Materials Science", 1st edition, PHI publishers, Chennai, 2017

REFERENCES:

1. Pillai S O "Solid State Physics", 9th edition, New Age International Publishers, New Delhi, 2020
2. Bangwei Zhang, "Physical Fundamentals of Nanomaterials", Chemical Industry Press, China, 2018
3. Joginder Singh Galsin, "Solid State Physics – An Introduction to Theory", Academic Press, India, 2019
4. https://nptel.ac.in/courses/108/108/108108122/
5. https://nptel.ac.in/courses/113/105/113105081/

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER II

		Category: ESC				
U21EE201	**ELECTRIC CIRCUIT ANALYSIS**	**L**	**T**	**P**	**J**	**C**
		3	**0**	**0**	**0**	**3**

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To introduce the electric circuits and its analysis
- To identify the major parameters of two port networks
- To introduce the phenomenon of resonance and coupled circuits

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Solve an electric network by applying basic laws (Apply)

CO2: Apply the concept of network reduction techniques for electric circuits (Apply)

CO3: Explain the concepts of three phase circuits and its power measurement (Understand)

CO4: Analyze the transient response of electric circuits and to infer two port network parameters (Apply)

CO5: Interpret the resonance phenomenon and coupled circuits (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	-	-	-	1	2	-
CO2	3	2	1	1	-	-	-	-	-	-	-	1	2	-
CO3	3	2	1	1	-	-	-	-	-	-	-	1	2	-
CO4	3	2	1	1	-	-	-	-	-	-	-	1	2	-
CO5	3	2	1	1	-	-	-	-	-	-	-	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I BASIC CIRCUIT ANALYSIS 9

Ohm's law and Kirchoff's laws – Complex impedance – Phasor diagram – Voltage and current division – Source transformation – Mesh and nodal analysis – Power, power factor and energy

UNIT II NETWORK REDUCTION TECHNIQUES 9

Star and delta conversion – Superposition theorem – Thevenin's and Norton's theorem – Maximum power transfer theorem

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UNIT III THREE PHASE CIRCUITS 9

Three phase system – Phasor diagram – Three phase three wire – Three phase four wire – Balanced and unbalanced star and delta load – Power measurement

UNIT IV TRANSIENT RESPONSE AND TWO PORT NETWORKS 9

Transient response of RL, RC and RLC circuits with DC and AC excitations – Two port networks – Z and Y parameters

UNIT V RESONANCE AND COUPLED CIRCUITS 9

Series and parallel resonance – Frequency response, quality factor, bandwidth and half power frequencies – Coupled circuits – Self and mutual inductance – Coupling coefficient – Dot rule – Single tuned circuits

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Sudhakar A and Shyammohan S Palli, "Circuits and Network Analysis", 5th edition, McGraw-Hill Education, New Delhi, 2019
2. William H. Hayt, Jr., Jack E. Kemmerly, Steven M. Durbin, "Engineering Circuit Analysis", 8th edition, McGraw-Hill Education, New Delhi, 2013

REFERENCES:

1. Joseph A. Edminister, Mahmood Nahvi, "Electric Circuits", 5th edition, Schaum's outline series, McGraw Hill Education, New Delhi, 2017
2. Allan H. Robbins, Wilhelm C. Miller, "Circuits Analysis Theory and Practice", 5th edition, Cengage Learning, India, 2013
3. Charles K. Alexander, Matthew N. O. Sadiku, "Electric Circuits", 6th edition, McGraw Hill Education, New Delhi, 2019

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER II

U21MEG04	BASICS OF CIVIL AND MECHANICAL ENGINEERING (for B.E Electrical and Electronics Engineering)	Category: ESC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To familiarize with the basic mechanical elements, cycles and power plants.
- To learn the concepts of safety and Industrial principles.
- To provide knowledge about different types of building materials.
- To teach the difference between conventional and modern infrastructure systems.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Recognize various mechanical elements and list out the applications and functions (Understand)

CO2: Understand the working of power plants, machinery and IC Engines (Understand)

CO3: Recall various safety requirements and software required for mechanical engineering (Understand)

CO4: Understand the importance of building materials and structures (Understand)

CO5: Recognize and relate the various infrastructures and its services (Understand)

CO–PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	1	-	-	-	-	-	1	-	-
CO2	3	2	-	-	-	1	-	-	-	-	-	1	-	-
CO3	3	2	-	-	-	1	-	-	-	-	-	1	-	-
CO4	3	2	-	-	-	1	-	-	-	-	-	1	-	-
CO5	3	2	-	-	-	1	-	-	-	-	-	1	-	-

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I BASIC MECHANICAL ELEMENTS 9

Basic Concepts and demonstration: Bearings – Gears – Belt drives – Chain drives – Cable drives – chain block – Conveyers – Shafts – Keys – Spline shafts – Springs – Fasteners – screws – Bolts – Nuts and their specifications Fundamental Hydraulics and Pneumatics – Valves and Cylinders

UNIT II MECHANICAL CYCLES, POWER PLANTS AND IC ENGINES 9

Rankine Cycle – Refrigeration and Air conditioning – VARC and VCRC systems – Power Plants – Steam – Gas – Diesel – Hydroelectric and Nuclear Power plants – Turbines and Pumps – Classification and functions – IC Engines – SI and CI engines – Two stroke and four stroke Engines

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UNIT III INDUSTRIAL ENGINEERING 9

Introduction to safety engineering – Evolution of Safety – Improvements Required – Safety Organization – Safety Functions – Workplace Operations Requiring Safety – Safety Benefits – Software in Mechanical Industry – introduction to Modelling and Analysis software – Basic Concepts and Application of IoT to industrial processes

CIVIL ENGINEERING

UNIT IV BUILDING MATERIALS AND COMPONENTS 9

Building Materials: Introduction – Bricks – Stones – Sand – Cement – Mortar – Concrete – Steel – Wood – Smart materials. **Surveying:** Objects – Classification – **Sub Structures:** Soil – Classification – Bearing capacity – Foundation – Function – Requirements – Types of foundations – **Super Structures:** Brick masonry – Stone masonry – Beams – Columns – lintels – Roofing – Flooring – Plastering – Damp proofing – Weathering course

UNIT V BASIC INFRASTRUCTURE AND SERVICES 9

Introduction to Highways – Railways – Airways and Waterways – Building Information Modelling (BIM) – Solid waste management system – Concept of Green Building – Benefits of Green Buildings – Green Building Materials – Smart Cities

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Basant Agarwal and C.M. Agarwal, "Basics of Mechanical Engineering", 3rd edition, Wiley India Pvt. Ltd, New Delhi, 2018.
2. Shanmugam Gand Palanichamy MS,"Basic Civil and Mechanical Engineering", Tata McGraw Hill Publishing Co., NewDelhi,1996.

REFERENCES:

1. Palanikumar, K. "Basic Mechanical Engineering", ARS Publications, 2010.
2. Venugopal K. and Prabhu Raja V., "Basic Mechanical Engineering", Anuradha Publishers, Kumbakonam, 2010.
3. Seetharaman S.,"Basic Civil Engineering", Anuradha Agencies,2005.
4. Subramanian K.P., "Highways, Railways, Airport and Harbour Engineering", Scitech Publications (India), Chennai, 2010.

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER II

U21EN201	PERSONALITY ENHANCEMENT (Common to AD, BM, CH, CE, CS, CS(AIML), EE, EC, ME, MI, IT)	Category: HSMC					
		L	T	P	J	C	
		1	0	2	0	2	

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To develop of personality traits that contributes in the professional environment
- To create a basic awareness about the significance of soft skills in professional and interpersonal communications
- To enhance the level of self-confidence that helps to excel in the leadership skills

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Nurture a deep understanding of personality development and interpersonal relationship for overall self-development (Understand)

CO2: Communicate proficiently in high-end interviews and in all social situations (Understand)

CO3: Synthesize complex concepts and present them in speech and writing (Analyse)

CO4: Negotiate and lead teams towards success (Understand)

CO5: Present ideas in an effective manner using web tools (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	2	3	-	1	-	-
CO2	-	-	-	-	-	-	-	1	2	3	-	1	-	-
CO3	-	-	-	-	-	-	-	-	2	3	-	-	-	-
CO4	-	-	-	-	-	-	-	-	2	3	-	-	-	-
CO5	-	-	-	-	-	-	-	1	-	3	-	-	-	-

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I LEXICAL REASONING 9

Module:1 Establishing Associations

Activity: Verbal Analogy, Logical Reasoning

Module:2 Lateral Thinking

Activity: Reasoning and Assertions

Module:3 Sentence Completion

Activity: Cloze Test, Single Word Substitutes

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UNIT II SOCIAL CORRESPONDENCE 9

Module:4 Etiquettes

Activity: Brain storming & performing in actions

Module:5 Introspection

Activity: SWOT Analysis, Goal Setting

Module:6 Co-verbal Gesture

Activity: Body Language, Non verbal cues

UNIT III ART OF NETWORKING 9

Module:7 Addressing a Multitude

Activity: Welcome address, Vote of Thanks, Public Speaking

Module:8 Persuasive Communication

Activity: Making Technical Presentation

Module:9 Career Oriented Communication

Activity: Face to face Conversation, Mock Interview

UNIT IV CRITICAL THINKING 9

Module:10 Organizing ideas

Activity: Mind Mapping

Module:11 Problem Solving Skills

Activity: Conflict management, Case Study

Module:12 Critical Review

Activity: Book/ Movie Review, Comparative Analysis

UNIT V CONTENT WRITING 9

Module:13 Reports

Activity: Writing Event Report, Project Report

Module:14 Writing for Digital platform

Activity: Writing Posts, Blogs

Module:15 Developing Content

Activity: Product Description, Writing Proposals

LIST OF EXERCISES

1. Listening to Inspirational Speech
2. Listening to Product Description
3. Book/Movie Review
4. Presentation
5. Mock Interview
6. Public Speaking

Contact Periods:

Lecture: 15 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 45 Periods

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TEXT BOOKS:

1. Meenakshi Raman & Sangeetha Sharma. "Professional English: for AKTU",1st edition, Oxford University Press. 2018.
2. Barun. K.Mitra. "Personality Development and Soft Skills", 2nd edition, OUP India, 2016.

REFERENCES:

1. Mathew Allen. "Smart Thinking: Skills for Critical Understanding and Writing", 2nd edition, OUP India, 2016.
2. Means, Thomas L, "English and Communication for Colleges", 4th edition, Cengage, 2017
3. Using English: "A Coursebook for Undergraduate Engineers and Technologists", 1st edition, Orient Black Swan, 2017

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th>End Semester Examinations</th></tr>
<tr><td colspan="2">Assessment I
(Theory)
(100 Marks)</td><td colspan="2">Assessment II
(Practical)
(100 Marks)</td><td rowspan="2">Practical Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>Individual Assignment / Seminar / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)</td><td>Test</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td><td></td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>50</td></tr>
<tr><td colspan="4">50</td><td>50</td></tr>
<tr><td colspan="5">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER II

		Category: ESC				
U21CSG02	PYTHON PROGRAMMING (Common to All Branches)	L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand syntax and semantics of python programming
- To implement programs using python data structures
- To gain expertise in using python libraries for solving real time problems

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Describe the basic operations of tokens in python (Understand)

CO2: Demonstrate the programs using control statements (Apply)

CO3: Develop programs using python data structures (Apply)

CO4: Implement the exceptions in file-handling concepts (Apply)

CO5: Apply the python libraries in real-world problems (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	2	-	-	-	1	2	2	-	2	1	-
CO2	2	1	1	2	-	-	-	1	2	2	-	2	1	-
CO3	3	2	2	2	-	-	-	1	2	2	-	2	1	-
CO4	3	2	2	2	-	-	-	1	2	2	-	2	1	-
CO5	3	2	2	2	1	-	-	1	2	2	-	2	1	-
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)					3: Substantial (High)						

SYLLABUS:

UNIT I LANGUAGE BASICS 6

Python interpreter and interactive mode – Tokens – Data types – Numbers and math functions – Input and Output operations – Comments – Reserved words – Indentation – Operators and expressions – Precedence and associativity – Type conversion – Debugging – Common errors in Python

UNIT II CONTROL STATEMENTS, FUNCTIONS, AND MODULES 6

Selection – Conditional branching statements – if – if-else – Nested-if – if-elif-else statements – Iterative statements – while – for loop – break – continue and pass statements – Functions – Function Definition and Function call – Variable scope and Lifetime – Return statement – Lambda functions or Anonymous functions – Recursion – Modules and Packages

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UNIT III PYTHON DATA STRUCTURES 6

Strings – Slicing – Immutability – Built-in string methods and functions – Concatenating – Appending and Multiplying strings – String modules – List – Creation – Accessing values – Slicing – List methods – In-built functions for Lists – Tuples – Creation – Operations on tuples – Traversing – Indexing and Slicing – Tuple assignment – In-built functions for tuples – Sets – Creation – Operations – Dictionaries – operations and methods

UNIT IV EXCEPTION AND FILE HANDLING 6

Exceptions – Errors and Exceptions – Handling exception – Built-in and User-defined exceptions – Files – Types – Operations – Open – Read – Write – Close

UNIT V NUMPY and PANDAS 6

Numpy – Introduction – Computations using NumPy functions – Computation on Arrays – Aggregation – Indexing and Sorting – Pandas – Introduction and Basic Pandas Concepts – Data frames – Data Handling

LIST OF EXPERIMENTS

1. Programs on selection and Iteration operations.
2. Get an integer input from a user. If the number is odd, then find the factorial of a number and find the number of digits in the factorial of the number. If the number is even, then check the given number is palindrome or not.
3. Strings and its operations.
4. Given two strings, PRINT (YES or NO) whether the second string can be obtained from the first by deletion of none, one or more characters.
5. List and its operations.
6. Programs for positive and negative indexing.
7. Program to check if the given list is in Ascending order or Not.
8. Tuples and its operations.
9. Python program to convert a tuple to a string.
10. Python program to reverse a tuple.
11. Sets and its operations.
12. Python program to check if a set is a subset of another set.
13. Dictionaries and its operations.
14. Python program to iterate over dictionaries using for loops.
15. Computations using NumPy functions.
16. NumPy program to convert a list of numeric value into a one-dimensional NumPy array.
17. NumPy program to convert a list and tuple into arrays.
18. Data manipulations using Pandas.
19. Program to convert a NumPy array and series to data frames.
20. Program to add, subtract, multiple and divide two Pandas Series.
21. Program to retrieve and manipulate data using data frames.

Contact Periods:

Lecture: 30 Periods	Tutorial: – Periods	Practical: 30 Periods	Project: – Periods
			Total: 60 Periods

TEXT BOOKS:

1. Reema Thareja, "Python programming: Using problem solving approach", 1st Edition, Oxford Press, 2017
2. William McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, 2nd Edition, Shroff/O'Reilly Publication, 2017

REFERENCES:

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd Edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016

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2. Ashok Namdev Kamthane and Amit Ashok Kamthane, "Programming and Problem Solving with Python", 2nd Edition, McGrawHill Education, 2018
3. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach",1st Edition, Pearson India Education Services Pvt. Ltd., 2016
4. https://python-iitk.vlabs.ac.in/List%20of%20experiments.html
5. http://greenteapress.com/wp/think-python/

EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER II

		Category: PCC				
U21EE202	DIGITAL ELECTRONICS AND APPLICATIONS	L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge on number systems and Boolean algebra
- To understand the design procedure of combinational, synchronous and asynchronous sequential logic circuits
- To apply the concept of various memory devices, programmable logic devices and digital logic families

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Compute various number systems and simplify the logical expressions using Boolean postulates (Apply)

CO2: Implement combinational logic circuits using K-map (Apply)

CO3: Explain the various types of flip-flops, counters and design synchronous sequential logic circuits (Understand)

CO4: Analyze the behavior of asynchronous sequential logic circuits (Apply)

CO5: Interpret different memory devices, programmable logic devices and digital logic families (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	-	-	-	-	-	-	-	1	2	-
CO2	3	2	2	1	-	-	-	-	-	-	-	1	2	-
CO3	3	2	2	1	-	-	-	-	-	-	-	1	2	-
CO4	3	2	2	1	-	-	-	-	-	-	-	1	2	-
CO5	3	2	2	1	-	-	-	-	-	-	-	1	2	-

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I NUMBER SYSTEMS AND BOOLEAN ALGEBRA **9**

Review of number systems – Number system conversion – Binary codes – Parity and Hamming code – Basic logic gates – Boolean algebra: De-Morgan's theorem

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UNIT II COMBINATIONAL CIRCUITS 9

Switching functions and simplification using K-maps – Design of adder, subtractor, comparators, multiplexers and demultiplexers – Applications

UNIT III SYNCHRONOUS SEQUENTIAL CIRCUITS 9

Flip-flops: SR, D, JK and T – Analysis of synchronous sequential circuits – Design of synchronous sequential circuits – Counters – State diagram, state reduction, state assignment, asynchronous and synchronous type

UNIT IV ASYNCHRONOUS SEQUENTIAL CIRCUITS 9

Analysis of asynchronous sequential logic circuit – Fundamental and pulse mode, state reduction, state assignment – Asynchronous design problem, transition table, flow table – Race conditions

UNIT V PROGRAMMABLE LOGIC DEVICES, MEMORY AND LOGIC FAMILIES 9

X Memories: ROM, PROM, PLA, PAL, PLD – Digital logic families: RTL, DTL, TTL, ECL, MOS families

LIST OF EXPERIMENTS (Indicative)

1. Parity generator and checker
2. Verification of logic gates
3. Implementation of arithmetic circuits
4. Parking system using multiplexer
5. Digital counters

Contact Periods:

Lecture: 30 Periods	Tutorial: – Periods	Practical: 30 Periods	Project: – Periods
			Total: 60 Periods

TEXT BOOKS:

1. Morris Mano M, Michael D. Ciletti, "Digital Design with an Introduction to the Verilog HDL, VHDL and System Verilog", 6th edition, Pearson Education, 2018
2. David J. Comer, "Digital Logic and State Machine Design", 3rd edition, Oxford University Press, 2012

REFERENCES:

1. Soumitra Kumar Mandal, "Digital Electronics Principles and Application", 1st edition, McGraw-Hill Education, 2017
2. William Keitz, "Digital Electronics - A Practical Approach with VHDL", 1st edition, Pearson Education, 2013
3. R.P.Jain, Thomas.L.Floyd, "Digital Fundamentals", 11th edition, Pearson Education, 2017

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER II

		Category: ESC				
U21EE203	ELECTRIC CIRCUITS LABORATORY	L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To simulate and verify an electric circuit using network theorems
- To simulate the transient response of an electric circuit
- To design a resonance circuit and sketch its frequency response

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Verify an electric circuit using basic circuit laws (Apply)

CO2: Verify an electric circuit by applying network theorems (Apply)

CO3: Calculate the three-phase power using two wattmeter method (Apply)

CO4: Simulate the transient response of an electric circuit (Apply)

CO5: Design a series and parallel resonance circuit (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	-	-	1	1	1	-	1	2	-
CO2	3	2	1	1	1	-	-	1	1	1	-	1	2	-
CO3	3	2	1	1	1	-	-	1	1	1	-	1	2	-
CO4	3	2	1	1	1	-	-	1	1	1	-	1	2	-
CO5	3	2	1	1	1	-	-	1	1	1	-	1	2	-
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

LIST OF EXPERIMENTS

1. Simulation and experimental verification of Ohm's and Kirchhoff's laws
2. Simulation and experimental verification of an electric circuit using mesh and nodal analysis
3. Simulation and experimental verification of Thevenin's theorem
4. Simulation and experimental verification of Norton's theorem
5. Simulation and experimental verification of superposition theorem
6. Simulation and experimental verification of maximum power transfer theorem
7. Measurement of three phase power using two wattmeter method
8. Simulation of RL, RC and RLC transients with DC and AC excitation

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9. Determination of resonance frequency, half power frequencies, bandwidth and quality factor of a series and parallel resonance circuit

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project: – Periods

Total: 60 Periods

EVALUATION PATTERN:

Continuous Internal Assessments		**End Semester Examinations**
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test	
75	25	
100		100
60		40
100		

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SEMESTER III

U21MA303	FOURIER ANALYSIS AND BOUNDARY VALUE PROBLEMS (Common to CE, EE, ME, MI)	Category: BSC				
		L	T	P	J	C
		3	1	0	0	4

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the concepts of partial differential equations and its solutions
- To understand the concept of Fourier series and Fourier transform techniques in the field of engineering
- To understand the mathematical aspects that contribute to the solution of one and two dimensional PDEs

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply the fundamental concepts of partial differential equations to solve real life practical applications (Apply)

CO2: Demonstrate Fourier series to study the behaviour of periodic functions and their applications in system communications and digital signal processing (Apply)

CO3: Analyze the spectral characteristics of signals using Fourier transforms to find the discrete/continuous function arising in signals (Apply)

CO4: Apply Fourier series to solve an initial-boundary value problem for one dimensional wave and heat equation (Apply)

CO5: Apply Fourier series to solve an initial-boundary value for two dimensional heat equations (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	1	-
CO2	3	2	-	-	-	-	-	-	-	-	-	1	1	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	1	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	1	-
CO5	2	2	-	-	-	-	-	-	-	-	-	-	1	-
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)						3: Substantial (High)					

SYLLABUS:

UNIT I PARTIAL DIFFERENTIAL EQUATIONS **9 + 3**

Formation of partial differential equations – Singular integrals – Solutions of standard types of first order partial differential equations – Lagrange's linear equation – Solution methods for second order homogeneous equations with constant coefficients

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UNIT II FOURIER SERIES **9 + 3**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range series – Parseval's identity – Harmonic analysis

UNIT III FOURIER TRANSFORM **9 + 3**

Fourier transform pair – Fourier sine and cosine transforms – Properties (without proof) – Transforms of simple functions – Convolution theorem – Parseval's identity

UNIT IV ONE DIMENSIONAL BOUNDARY VALUE PROBLEMS **9 + 3**

Fourier series solution – Vibration of strings – One dimensional wave equation – One dimensional heat flow equation (unsteady state)

UNIT V TWO DIMENSIONAL BOUNDARY VALUE PROBLEMS **9 + 3**

Fourier series solution – Two dimensional (steady state) heat flow equations (Cartesian form only) separation of variables

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: – Periods Project – Periods

Total 60 Periods

TEXT BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics",10th edition Wiley India Pvt Ltd, New Delhi, 2018.
2. Grewal B. S, "Higher Engineering Mathematics", 44th edition, Khanna Publishers, 2017.

REFERENCES:

1. Bali N.P and Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications; 12th edition, 2016.
2. Wylie C. R. and Barrett L. C, "Advanced Engineering Mathematics", 6th edition, Tata McGraw-Hill, New Delhi, 2016.
3. Narayanan S, Manicavachagom Pillay T. K. and Ramanaiah G, "Advanced Mathematics for Engineering Students", Vol. II & III, 2nd edition, S. Viswanathan Publishers Pvt. Ltd, Chennai, 1998.

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Seminar / MCQ	Written Test	*Individual Assignment / Seminar / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER III

		Category: ESC				
U21EE301	ELECTROMAGNETIC THEORY	L	T	P	J	C
		2	1	0	0	3

PRE–REQUISITES:

- U21EE201: Electric Circuit Analysis, U21MA102: Calculus and Linear Algebra

COURSE OBJECTIVES:

- To introduce the basic mathematical concepts related to electromagnetic fields
- To impart knowledge on the concepts of electrostatic fields and magnetic fields
- To acquire the knowledge on application of electromagnetic fields

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply the concepts of vector calculus for different coordinate systems (Apply)

CO2: Describe the electric field intensity in various geometric by using appropriate law (Understand)

CO3: Apply the concept of electric potential for different geometrics (Apply)

CO4: Describe the basic concepts on magneto-statics and its applications (Understand)

CO5: Illustrate the concepts of MMF and EMF generation, Maxwell's equations (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	-	-	1	1	1	-	-	-	-
CO2	3	2	1	-	1	-	-	1	1	1	-	1	1	-
CO3	3	2	1	1	1	-	-	1	1	1	-	1	1	-
CO4	3	2	1	-	1	-	-	1	1	1	-	1	1	-
CO5	3	3	1	-	1	-	-	1	1	1	-	1	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I CO-ORDINATE SYSTEMS **6+3**

Introduction to co-ordinate system: Rectangular, Cylindrical, Spherical – Differential elements – Point and vector transformation – Del operator – Divergence, Curl and Gradient – Divergence theorem and Stoke's theorem

UNIT II ELECTROSTATICS I **6+3**

Coulomb's Law – Principle of superposition – Electric field intensity – Electric field intensity due to discrete charges – Electric field due to continuous uniform charge distribution: infinite and finite line, circular disc and sheet – Electric flux density – Gauss Law and its proof – Applications

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UNIT III ELECTROSTATICS II 6+3

Electric potential – Potential due to infinite line charge, circular disc – Electric potential due to dipole moment – Polarization – Potential gradient – Equipotential surface – Continuity equation – Capacitance: parallel plate, sphere – Laplace's and Poisson's equation – Boundary conditions – Energy and energy density – Applications

UNIT IV MAGNETOSTATICS 6+3

Lorentz force equation – Force on current element – Force on parallel conductor – Biot-Savart Law – Magnetic field intensity – Finite and infinite, circular loop – Ampere's circuital law – Magnetic flux density – Dipole moment – Torque – Boundary conditions – Inductance of solenoid and Toroid – Energy and energy density – Applications

UNIT V APPLICATION OF ELECTROMAGNETICS 6+3

Faraday's law – Transformer EMF and Motional EMF – Maxwell's equations: Ampere's circuital law, Faraday's law and Gauss's law – Poynting theorem – Poynting vector – Relationship between circuit theory and field theory

Contact Periods:

Lecture: 30 Periods Tutorial: 15 Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Mathew N.O. Sadiku, Kulkarni S. V, "Principles of Electromagnetic Fields", 6th edition, Oxford University Press, 2015
2. William Hayt Jr. John A. Buck and Jaleel Akhtar M, "Engineering Electromagnetics", 9th edition, TMH publishing Co. Ltd., 2020

REFERENCES:

1. Gangadhar K A, "Electromagnetic Field Theory", 16th edition, Khanna Publishers, 2015
2. Joseph.A. Edminister and Vishnu Priye "Schaum's Outline Series Theory and Problems of Electromagnetics", 5th edition, Tata McGraw Hill, 2017
3. Ghosh S and Lipika Datta, "Electromagnetic Field Theory", 1st edition, Tata McGraw Hill, 2017

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Roll Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER III

		Category: PCC				
U21EE302	ELECTRICAL MACHINES – I	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21EE201: Electric Circuit Analysis

COURSE OBJECTIVES:

- To acquire the knowledge in construction, working principle and characteristics of DC machines
- To impart the knowledge in construction, working principle and performance of transformers
- To acquire the importance of testing of DC machines and transformers

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the construction, principle, and fundamentals of DC generators (Understand)
CO2: Acquire the knowledge of operating principles, starting and speed control of DC motors (Understand)
CO3: Apply various testing methods for the assessment of the performance characteristics of DC machines (Apply)
CO4: Explain the construction and operating principles of transformers (Understand)
CO5: Identify the testing methods of single phase transformers and three phase transformer connections (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	-	1	-	-	-	-	1	2	-
CO2	3	2	1	-	-	-	-	-	-	-	-	1	2	-
CO3	3	2	1	1	-	1	-	1	-	-	-	1	2	-
CO4	3	2	1	-	1	-	1	-	-	-	-	1	2	-
CO5	3	2	1	1	-	-	1	1	-	-	-	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I DC GENERATORS 9

Operating principle – Construction – Armature winding and connections – EMF equation – Methods of excitation – Armature reaction – Commutation – Compensating winding – Characteristics of DC shunt and series generators – Parallel operation – Battery charging and electro-plating

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UNIT II DC MOTORS 9

Principle of operation – Back EMF – Torque equation – Types of motors – Characteristics – Starting and speed control – Application in traction, lathes and elevators – Case studies

UNIT III TESTING OF DC MACHINES 9

Losses and efficiency – Power stages – Testing of DC machines – Open circuit and load tests on generator, Brake test, Swinburne's test and Hopkinson's test – Testing standards – IEC, NEMA

UNIT IV TRANSFORMERS 9

Construction – Principle of operation – EMF equation – No-load and load condition – Phasor diagram – Equivalent circuit – Losses and efficiency – Separation of losses – Voltage regulation – Parallel operation – Auto transformer

UNIT V TESTING OF TRANSFORMERS AND THREE PHASE TRANSFORMERS 9

All day efficiency – Testing – Load test, OC and SC test, Sumpner's test, Polarity test, Voltage ratio test – Three phase transformers – Connections – Scott connection – Introduction to high frequency transformers

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Kothari D.P and Nagrath I.J., "Electric Machines", 5th edition, McGraw-Hill Education Pvt. Ltd, 2017
2. Stephen J. Chapman, "Electric Machinery Fundamentals", 5th edition, McGraw-Hill Education Pvt. Ltd, 2011

REFERENCES:

1. Gupta B.R., 'Fundamental of Electric Machines', 3rd edition, New age International Publishers, Reprint, 2015
2. Rajput R.K., 'Electrical Machines', 6th edition, Laxmi Publications, 2016

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER III

		Category: PCC				
U21EE303	ANALOG ELECTRONICS AND APPLICATIONS	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21PH201: Materials Science

COURSE OBJECTIVES:

- To acquire knowledge in basics of semiconductor devices and their applications
- To understand the characteristics of operational amplifiers
- To apply special ICs and regulator ICs for various applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the construction and characteristics of semiconductor devices (Understand)

CO2: Summarize the characteristics of operational amplifier (Understand)

CO3: Apply the operational amplifiers for various applications (Apply)

CO4: Describe the functional blocks of special ICs (Apply)

CO5: Design the voltage regulators using integrated circuits (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	-	1	-	1	-	-	-	1	1	2	-
CO2	3	1	1	-	1	-	-	-	-	-	1	1	2	-
CO3	3	1	1	-	1	1	-	-	-	-	-	1	2	-
CO4	3	1	1	1	1	1	-	-	-	-	-	1	2	-
CO5	3	1	1	1	1	1	1	-	-	-	1	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I SEMICONDUCTOR DEVICES 9

Construction and Characteristics: PN Junction Diodes – Zener Diodes – BJTs – Field Effect Transistors – MOSFET – Applications: Half-wave and full-wave rectifier – Shunt voltage regulator – CE configuration

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UNIT II CHARACTERISTICS OF OP AMP 9

Ideal characteristics of Op-Amp – Functional blocks of Op-Amp – Inverting and non-inverting amplifiers – Multistage amplifiers – Feedback: Introduction to the concept of feedback – Positive and negative feedback – Properties of feedback – Feedback topologies – DC characteristics – AC characteristics – Differential amplifier

UNIT III APPLICATIONS OF OP AMP 9

V/I and I/V converters – Summer – Differentiator – Integrator – Instrumentation amplifier – First order low pass and high pass active filters – Waveform generators – Clippers – Clampers – Peak detector – Sample and Hold circuit – D/A converters – A/D converters

UNIT IV SPECIAL ICs 9

555 Timer IC – Monostable mode – Astable mode – Applications – 566 Voltage controlled oscillator – 565 Phase lock loop – BQ76PL536-Q1 battery monitoring and protection – Applications

UNIT V VOLTAGE REGULATORS 9

IC voltage regulators – LM78XX, 79XX – Fixed voltage regulators – Low Drop Out (LDO) linear regulator – Switching regulator – SMPS – TPS61170

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Roy Choudhary D. and Sheil B. Jani, "Linear Integrated Circuits", 4th edition, New Age Publisher, 2018
2. Adel S Sedra, Kenneth C Smith and Arun N Chandorkar, "Microelectronic Circuits – Theory and Applications", 7th edition, Oxford University Press, 2017
3. David A. Bell, "Op-amp & Linear ICs", 3rd edition, Oxford University Press, 2013

REFERENCES:

1. Robert F. Coughlin and Fredrick F. Driscoll, "Op-amp and Linear ICs", 6th edition, PHI Learning Pvt. Ltd., New Delhi, 2012
2. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", 4th edition, McGraw Hill, 2016

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER III

U21CSG03	DATA STRUCTURES (Common to AM, BM, CB, EC, EE, IT)	Category: ESC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITE:

- U21CSG01: Problem Solving and C Programming

COURSE OBJECTIVES:

- To understand the concepts of ADT and list operations
- To Learn linear data structures – stacks and queues
- To apply Tree and Graph structures

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the concept of linear and non-linear data structures (Understand)

CO2: Demonstrate stack and queue with suitable applications (Apply)

CO3: Implement various searching, sorting, and hashing techniques (Apply)

CO4: Analyze non-linear data structures – trees (Apply)

CO5: Implement various problems in graph data structures (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	-	-	-	1	2	2	-	3	2	-
CO2	2	2	2	2	-	-	-	1	2	2	-	3	2	-
CO3	3	3	2	2	-	-	-	1	2	2	-	3	2	-
CO4	3	3	2	2	-	-	-	1	2	2	-	3	2	-
CO5	3	3	2	2	-	-	-	1	2	2	-	3	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I LINEAR DATA STRUCTURES – LIST 6

Abstract Data Types (ADTs) – List ADT – Array-based implementation – Linked list-based implementation – Singly linked lists – Circularly linked lists – Doubly-linked lists – Applications of linked list

UNIT II LINEAR DATA STRUCTURES – STACKS, QUEUES 6

Stack ADT – Operations – Applications – Evaluating arithmetic expressions – Conversion of Infix to postfix expression – Queue ADT – Operations – Circular Queue – Priority Queue – DeQueue – Applications of queues

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UNIT III SEARCHING, SORTING, AND HASHING TECHNIQUES 6

Introduction to Searching – Types of search – Linear Search – Binary Search – Sorting – Bubble sort – Selection sort – Insertion sort – Shell sort – Hashing – Hash Functions – Separate Chaining – Open Addressing – Rehashing

UNIT IV NON-LINEAR DATA STRUCTURES - TREES 6

Tree ADT – Tree traversals – Binary Tree ADT – Expression trees – Implementation of expression tree – Applications of trees – Binary search tree ADT – Operations in binary search tree – Introduction to Heap – Properties

UNIT V NON-LINEAR DATA STRUCTURES - GRAPHS 6

Introduction to Graph – Types of graph – Graph traversal – Breadth-first traversal – Depth-first traversal – Topological Sort – Minimum spanning tree algorithms – Shortest path algorithm – Dijkstra's algorithm

LIST OF EXPERIMENTS (INDICATIVE)

1. Write a function program to perform the following operations on a singly linked list
   i. Create a list cube
   ii. Insert an element to the list
   iii. Delete the maximum element from the list
   iv. Arrange the list in a sorted order
   v. Display the elements of the list
2. Write a main method to demonstrate the above functionalities
3. Creation of Array and linked list implementation of Stack and Queue ADTs
4. Implementation of quick, heap, and shell sort
5. Program to sort the elements in ascending order using selection sort and bubble sort
6. Implementation of hashing technique
7. Develop a program to perform a linear and binary search
8. Program to construct an expression tree for a given expression and perform various tree traversal methods.
9. Implement Prim's algorithm with the following functionalities
   i. Read a set of vertices minimum of six from the keyboard
   ii. Get the number of edges and form the graph
   iii. Find the value of each edge by using the distance formula for two points.
   iv. Develop a Minimum Spanning Tree for the graph
   v. Find the total length of all edges. Write a main method to execute the above functionalities
10. Choose an appropriate data structure and create a token system for banking service (withdrawal, deposit, and money transfer)
11. Create a food delivering system that allocates the path for the delivery of food using appropriate data structures
12. Create a book rack allocation system in a library, which allocates appropriate space for the books based on category using appropriate data structures

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Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Reema Thareja, "Data structures using C", 1st Edition, Oxford University Press, 2018
2. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, "Fundamentals of Data Structures in C", 2nd Edition, University Press, 2017

REFERENCES:

1. R. Venkatesan, S. Lovelyn Rose, "Data Structures", 1st Edition, Wiley, 2019.
2. Seymour Lipschutz, "Data structures with C", 4th Edition, McGraw Hill Education, 2017

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th colspan="2" rowspan="2">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (Theory) (100 Marks)</th><th colspan="2">Assessment II (Practical) (100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)</td><td>Test</td><td>Theory Examinations (Examinations will be conducted for 100 Marks)</td><td>Practical Examinations (Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>25</td><td>25</td></tr>
<tr><td colspan="4">50</td><td colspan="2">50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER III

		Category: PCC				
U21EE304	MEASUREMENTS AND INSTRUMENTATION	L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21PH201: Materials Science

COURSE OBJECTIVES:

- To acquire the knowledge on measurements and instrumentation systems
- To understand the working of various electrical and electronic instruments, storage and display devices
- To apply the concept of instrumentation in sensors and transducers

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the functional elements and types of instruments (Understand)

CO2: Summarize the concept of electrical and electronic instruments (understand)

CO3: Apply various comparative methods to measure the electrical parameters (Apply)

CO4: Illustrate the working of various storage and display devices (Understand)

CO5: Infer the concept of sensors and transducers for various applications (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	1	1	-	1	1	1	-	1	2	-
CO2	3	1	1	1	1	-	-	1	1	1	-	1	2	-
CO3	3	1	1	1	1	-	-	1	1	1	-	1	2	-
CO4	3	1	1	1	1	-	-	1	1	1	-	1	2	-
CO5	3	1	1	1	1	-	-	1	1	1	-	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I MEASUREMENT SYSTEMS 6

Functional elements of instrument – Standards of measurements – Static and dynamic characteristics – Errors in measurement – Calibration

UNIT II ELECTRICAL AND ELECTRONIC INSTRUMENTS 6

Construction and working principle of moving coil and moving iron instruments – Dynamometer type wattmeter – Single phase induction type energy meter – Digital voltmeters: Integrating type, successive approximation – Instrument transformer

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UNIT III COMPARATIVE METHOD OF MEASUREMENTS 6

DC potentiometers: Crompton's and Duo Range type – AC potentiometers – DC bridges: Wheatstone, Kelvin's double bridge – AC bridges: Maxwell and Schering bridge

UNIT IV STORAGE AND DISPLAY DEVICES 6

X-Y recorder – Cathode Ray Oscilloscope, Digital Storage Oscilloscope – Data loggers – Hard disk drive – Solid state drive

UNIT V SENSORS AND TRANSDUCERS 6

Hall effect sensors – Proximity sensors – Temperature sensors – Soil and moisture sensors – Classification of transducers – RTD, Strain gauge, LVDT, Piezoelectric, Thermoelectric – Sensor fusions

LIST OF EXPERIMENTS (Indicative)

1. Calibration of single phase energy meter
2. Measurement of low / medium resistance using Kelvin's double bridge / Wheat stone's bridge
3. Measurement of Capacitance and Inductance using AC bridges
4. Measurement of EMF using potentiometer
5. Measurement of temperature using sensors
6. Study of measuring instruments and storage devices

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project – Periods

Total 60 Periods

TEXT BOOKS:

1. Sawhney A.K., "A Course in Electrical and Electronic Measurement and Instrumentation", 18th edition, Dhanpat Rai & Co., 2015
2. Albert D Helfrick and William D Cooper, "Modern Electronic Instrumentation and Measurement Techniques", 1st edition, Pearson India Education, 2016

REFERENCES:

1. Stout M.B., "Basic Electrical Measurements", Revised edition, Prentice Hall of India Pvt Ltd., 2018
2. Gupta J.B., "A Course in Electronics and Electrical Measurements and Instrumentation", 14th edition, S.K.Kataria & Sons, Delhi, 2014
3. Patranabis D., "Sensors and Transducers", 2nd edition, PHI Learning, 2013

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER III

		Category: PCC				
U21EE305	ELECTRICAL MACHINES LABORATORY – I	L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- U21EE203: Electric Circuits Laboratory

COURSE OBJECTIVES:

- To acquire the knowledge on testing various DC machines and transformers
- To understand the working principle of DC motors and transformers
- To test DC machines and transformers under various loading conditions

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Analyze the characteristics of DC shunt and compound generator (Apply)
CO2: Compare the load characteristics of DC shunt, series and compound motor (Apply)
CO3: Estimate the efficiency of DC machines using various methods (Apply)
CO4: Choose the different speed control methods for various applications (Apply)
CO5: Asses the performance characteristics of single-phase transformers and three phase transformer connections (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	1	1	-	1	2	-
CO2	3	2	1	1	1	-	-	-	1	1	-	1	2	-
CO3	3	2	1	1	-	-	-	-	1	1	-	1	2	-
CO4	3	2	1	1	-	-	-	1	1	1	-	1	2	-
CO5	3	2	1	1	1	-	-	-	1	1	-	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

LIST OF EXPERIMENTS

1. Open circuit and load characteristics of DC shunt generator
2. Load characteristics of DC compound generator
3. Load test on DC shunt and compound motor
4. Load test on DC series motor
5. Swinburne's test
6. Speed control of DC motor
7. Load test on single phase transformer
8. Open circuit and short circuit tests on single phase transformer
9. Separation of losses in single phase transformers
10. Connections of three phase transformers

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Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project – Periods

Total 60 Periods

EVALUATION PATTERN:

Continuous Internal Assessments		End Semester Examinations
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test	
75	25	
100		100
60		40
100		

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SEMESTER III

		Category: PCC				
U21EE306	ANALOG ELECTRONICS AND APPLICATIONS LABORATORY	L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- U21PH201: Materials Science, U21EE202: Digital Electronics and Applications

COURSE OBJECTIVES:

- To acquire knowledge on linear ICs
- To implement the design procedure for analog circuits
- To apply the simplification techniques for analog circuits

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Construct the rectifiers and voltage regulators using suitable semiconductor devices (Apply)

CO2: Demonstrate the various characteristics of transistors (Apply)

CO3: Design and Implement the various multi vibrators using IC555 timer (Apply)

CO4: Apply the concepts of operational amplifiers for various applications (Apply)

CO5: Develop the power supply unit for real time applications (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	-	-	1	1	1	-	2	2	-
CO2	3	2	2	2	1	-	-	1	1	1	-	2	2	-
CO3	3	2	2	2	1	-	-	1	1	1	-	2	2	-
CO4	3	2	2	2	1	-	-	1	1	1	-	2	2	-
CO5	3	2	2	2	1	-	-	1	1	1	-	2	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

LIST OF EXPERIMENTS

1. Half wave and Full wave rectifier with and without filter
2. Zener Diode characteristics and Zener as voltage regulator
3. Input and Output characteristics of various transistor configuration
4. Astable and Monostable multivibrators using NE555 timer
5. PLL characteristics and frequency multiplier using PLL
6. DC power supply using LM317 and LM723
7. Inverting, Non-inverting and Differential Amplifiers
8. Pulse generation using operational amplifier

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9. Wave shaping circuits
10. Study of SMPS

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project: – Periods

Total: 60 Periods

EVALUATION PATTERN:

Continuous Internal Assessments		End Semester Examinations
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test	
75	25	
100		100
60		40
100		

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SEMESTER IV

		Category: BSC				
U21MA404	STATISTICS AND NUMERICAL METHODS (Common to EE, ME & MI)	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the concepts of probability and statistics in the field of engineering
- To understand the concepts of testing the hypothesis for large and small samples
- To understand the concepts in design of experiments in the field of engineering

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply probability axioms and the moments of discrete and continuous random variables to core engineering problems (Apply)

CO2: Analyze large and small sample tests and perform small sample tests based on Chi-square, t and F distributions (Understand)

CO3: Design an experiment with proper observations and measurement to get a valid result using various design methods (Understand)

CO4: Identify the basic concepts of solving algebraic and transcendental equations (Understand)

CO5: Solve initial value problems of ordinary differential equations using numerical techniques (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	1	1	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	1	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	1	-
CO4	2	2	-	-	-	-	-	-	-	-	-	-	1	-
CO5	2	2	-	-	-	-	-	-	-	-	-	-	1	-

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I PROBABILITY 9

Probability – Axioms of probability – Conditional probability – Total probability – Baye's Theorem – Discrete and continuous random variable

UNIT II TESTING OF HYPOTHESIS 9

Large sample test for single mean and difference of means – Small sample test: t distribution – Chi square distribution – F distribution

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UNIT III DESIGN OF EXPERIMENTS 9

One way and two way classifications – Completely randomized design – Randomized block Design – Latin square design

UNIT IV SYSTEM OF EQUATIONS 9

Newton Raphson method – Gauss elimination method – Gauss Jordon method – Iterative methods of Gauss Jacobi and Gauss Seidel

UNIT V NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS 9

Taylor's series method – Euler method – Modified Euler method – Fourth order Runge kutta method for solving first order differential equations

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total: 45 Periods

TEXT BOOKS:

1. Johnson R A, Miller I, Freund J, Miller and Freund's, "Probability and Statistics for Engineers", 8th edition, Pearson Education, Asia,2015
2. Grewell B S, "Numerical methods in Science and Engineering", 9th edition, Khanna Publishers, 2015
3. Gupta S C and Kapoor V K, "Fundamentals of Mathematical Statistics", 10th edition, Sultan Chand Publishers, 2014

REFERENCES:

1. Bali N P and Manish Goyal "A textbook of Engineering Mathematics", 12th edition, Laxmi Publishers, 2016

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Seminar / MCQ	Written Test	*Individual Assignment / Seminar / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER IV

		Category: PCC				
U21EE401	ELECTRICAL MACHINES – II	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21EE302: Electrical Machines - I

COURSE OBJECTIVES:

- To acquire the knowledge on construction and operating principles of various AC machines
- To understand the starting and speed control of AC motors
- To apply AC motors, generators and special electrical machines for various applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Interpret the constructional details, principle and performance of alternators (Understand)
CO2: Acquire the knowledge of synchronous motors and its applications (Understand)
CO3: Infer the operation and performance of three phase induction motors (Understand)
CO4: Analyze the performance characteristics of AC motors by various testing methods (Apply)
CO5: Explain the construction and operating principles of single phase induction motors and special machines (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	1	1	-	-	-	-	1	2	-
CO2	3	2	1	1	1	-	-	-	-	-	-	1	2	-
CO3	3	2	1	1	1	1	-	-	-	-	-	1	2	-
CO4	3	2	1	-	1	-	-	1	-	-	-	1	2	-
CO5	3	2	1	-	1	-	1	-	-	-	-	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I SYNCHRONOUS GENERATOR 9

Construction and types – EMF equation – Armature reaction – Voltage regulation – EMF and MMF methods – Parallel operation – Two reaction theory for salient pole alternator – Slip test

UNIT II SYNCHRONOUS MOTOR 9

Principle of operation – Starting methods – Torque equation – Effect of varying field current and load – V and Inverted V curves – Synchronous condenser – Hunting – Damper winding

UNIT III THREE PHASE INDUCTION MOTOR 9

Construction – Types – Principle of operation – Slip – Torque Equation – Torque-Slip characteristics – Cogging and crawling – Equivalent circuit – Power flow diagram – Losses and efficiency – No load and blocked rotor tests – Double cage induction motors – Induction generator – Submersible motor

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UNIT IV STARTING AND SPEED CONTROL OF INDUCTION MOTOR 9

Starters – Types – DOL, star-delta, auto transformer and rotor resistance starter – Soft starters – Speed control – Number of poles, cascaded connection and V/f Control – Slip power recovery scheme – Braking

UNIT V SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES 9

Construction – Double field revolving theory – Starting methods – Capacitor start – Capacitor run induction motor – Shaded pole induction motor – Equivalent circuit – Servo motor – Stepper motor – Linear induction motor – Applications

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Stephen J Chapman, "Electric Machinery Fundamentals", 4th edition, McGraw - Hill Education Pvt. Ltd, 2010
2. Kothari D P and Nagrath I J, "Electric Machines", 5th edition, McGraw - Hill Publishing Company Ltd, 2017

REFERENCES:

1. Gupta B R, "Fundamental of Electric Machines" 3rd edition, New Age International Publishers, Reprint 2015.
2. Bimbhra P S, "Electrical Machinery", 2nd edition, Khanna Publishers, 2017
3. Gupta J B, "Theory and Performance of Electrical Machines", 2nd edition, S K Kataria & Sons Publishers, 2016

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / MiniProject / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER IV

		Category: PCC				
U21EE402	CONTROL SYSTEMS	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21MA102: Calculus and Linear Algebra, U21EE201: Electric Circuit Analysis

COURSE OBJECTIVES:

- To impart knowledge on system modeling and response
- To understand the behavior of the system in time domain and frequency domain
- To design controllers and compensators for closed loop systems

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Determine the transfer function of electrical and mechanical system (Understand)

CO2: Solve the Linear Time Invariant (LTI)systems in time domain (Apply)

CO3: Analyze frequency response of the LTI systems using different types of plots (Apply)

CO4: Interpret the stability of LTI systems using Routh Hurwitz criterion, Root locus and Nyquist stability criterion (Apply)

CO5: Implement the controllers and compensators for closed loop systems (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	-	-	1	1	1	-	1	2	-
CO2	3	2	2	1	1	-	-	1	1	1	-	1	2	-
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CO4	3	2	2	1	1	-	-	1	1	1	-	1	2	-
CO5	3	2	2	1	1	-	-	1	1	1	-	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I SYSTEM MODELING 9

Elements – open and closed loop systems – Transfer function – Electrical systems – Mechanical systems: Translational and rotational system – Electrical analogy – Block diagram reduction – Signal flow graph

UNIT II TIME RESPONSE ANALYSIS 9

Time response - Standard test signals – order and type – Time response of first order systems – Step response of second order system – Time domain specifications – Steady state errors – Error constants

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UNIT III FREQUENCY RESPONSE ANALYSIS 9

Frequency Response – Bode plot – Polar plot – Determination of closed loop response from open loop response – Frequency domain specifications – Correlation between time and frequency domain specification

UNIT IV STABILITY ANALYSIS 9

Stability – Characteristics equation – necessary and sufficient conditions for stability – BIBO stability – Routh Hurwitz's criterion – Construction of root locus – Effect of pole-zero addition on the root locus – Relative stability – Nyquist stability criterion

UNIT V COMPENSATOR DESIGN AND CONTROLLER 9

Need for compensator and controllers – Design procedure – Lag network and lead network using bode plot – Controller – P, PI, PID controller

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Nagrath, I J., & Gopal, M, "Control Systems Engineering", 6th edition, New Age International Publishers, 2017
2. Ogata, K. "Modern Control Engineering", 5th edition, Upper Saddle River, NJ: Prentice Hall, 2015

REFERENCES:

1. Richard C. Dorf & Bishop, R H "Modern Control Systems", 13th edition, Pearson Prentice Hall, 2017
2. Nise, N S "Control Systems Engineering", 8th edition, John Wiley & Sons, 2018
3. Golnaraghi, F., & Kuo, B, "Automatic Control Systems", 1st edition, McGraw-Hill Education, 2018

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / MiniProject / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER IV

		Category: ESC				
U21CSG04	JAVA PROGRAMMING (Common to AM, BM, CB, CS, EC, EE, IT)	L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21CSG01: Problem Solving and C programming

COURSE OBJECTIVES:

- To describe object-oriented programming paradigm and its principles
- To implement programs with Core Java features and API
- To develop applications with Java Collections

COURSE OUTCOMES:

Upon completion of the course- the student will be able to

CO1: Describe the object-oriented programming concepts to develop simple java programs (Understand)

CO2: Develop Java programs using Inheritance principle (Apply)

CO3: Apply exception handling techniques in Java programs (Apply)

CO4: Develop Java programs with Input Output classes and multithreading (Apply)

CO5: Implement Java programs with Collections (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	2	-	-	-	1	2	2	-	2	1	-
CO2	3	2	2	2	-	-	-	1	2	2	-	2	1	-
CO3	3	2	2	2	-	-	-	1	2	2	-	2	1	-
CO4	3	2	2	2	-	-	-	1	2	2	-	2	1	-
CO5	3	2	2	2	-	-	-	1	2	2	-	2	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I OBJECT ORIENTED DEVELOPMENT AND JAVA BASICS 6

Object Oriented Programming – Concepts – Abstraction – Encapsulation – Comparison with function oriented programming – Characteristics of Java – Java Environment – JVM and JDK – Classes – Constructors – Methods – Static members – Comments – Data Types – Variables – Operators – Control Flow

UNIT II PACKAGES AND INHERITANCE 6

Defining a Package – Importing Packages – Inheritance – Creating super classes and sub classes – Access modifiers – Constructors in sub classes – Polymorphism – Method overloading – Method overriding – Abstract classes and abstract methods – Interfaces – Defining an interface – Implementing interface – Extending interfaces – Object class

UNIT III EXCEPTION HANDLING 6

Exceptions – Throwing and catching exceptions – Checked and unchecked exceptions – Exception hierarchy – Built in exceptions – Creating own exception – Chained exceptions – Stack Trace Elements

UNIT IV I/O STREAMS AND MULTITHREADING 6

Input / Output Basics – Scanner class – Streams – Byte streams and Character streams comparison – Reading from and Writing to Console and Files – Multithreaded Programming – The Java Thread Model – Creating multiple threads – Thread class – Runnable Interface

UNIT V COLLECTIONS 6

Collections Framework Overview – Basics of List – Set – Queue – Programs using Array list – HashMap and HashSet – Hashcode and equals methods

LIST OF EXPERIMENTS (Indicative)

1. Write a Java program to create a class Student with private data members and public methods to implement encapsulation and abstraction.
2. Develop a Java program to implement constructor overloading and method overloading.
3. Develop a Java program to implement run-time polymorphism with inheritance.
4. Develop a Java program to implement inheritance using Interfaces and Abstract classes. Use packages.
5. Develop a Java program to demonstrate exception handling
6. Develop a multithreaded java program using a Thread class and Runnable interface
7. Develop a Java program to implement basic console IO and File IO.
8. Develop a Java program to store multiple objects in an Array List and to implement search and sort operations.

Contact Periods:

Lecture: 30 Periods	Tutorial: – Periods	Practical: 30 Periods	Project:	– Periods
			Total:	60 Periods

TEXT BOOKS:

1. Herbert Schildt, "Java: The Complete Reference", 11th edition, McGraw Hill Education, 2018
2. Cay.S.Horstmann and Gary Cornell, "Core Java 2, Vol 1, Fundamentals", 11th edition, Pearson Education, 2020

REFERENCES:

1. J.Nino and F.A. Hosch , "An Introduction to Programming and OO Design using Java", 1st edition, John wiley & Sons,2018
2. Paul Deitel, Harvey Deitel, "Java SE 8 for programmers", 3rd edition, Pearson, 2015
3. E Balagurusamy, "Programming with Java",6th edition, McGraw Hill Education,2019

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER IV

		Category: PCC				
U21EE403	TRANSMISSION AND DISTRIBUTION	L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21EE301: Electromagnetic Theory

COURSE OBJECTIVES:

- To acquire the knowledge on electrical supply systems and performance of transmission lines
- To understand the concept of insulators, cables and performance parameters
- To apply the concepts of electrical and mechanical design for overhead lines

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Interpret the structure of electric supply and distribution system (Understand)
CO2: Determine the line parameters in overhead transmission lines (Apply)
CO3: Identify the performance of short and medium transmission lines (Apply)
CO4: Solve sag and tension of overhead line for different weather conditions (Apply)
CO5: Summarize the types of insulators and cables (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	1	1	1	1	1	-	1	-	2
CO2	3	2	1	1	1	-	-	1	1	1	-	1	-	2
CO3	3	2	1	1	1	-	-	1	1	1	-	1	-	2
CO4	3	2	1	1	1	1	1	1	1	1	-	1	-	2
CO5	3	2	1	1	1	-	1	1	1	1	-	1	-	2
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)			3: Substantial (High)								

SYLLABUS:

UNIT I ELECTRICAL SUPPLY SYSTEM 6

Structure of power system – Operating level voltages – Generation, transmission and distribution – AC and DC distributors – Indian grids – Electricity de-regulation – DISCOMs

UNIT II ELECTRICAL DESIGN OF OVERHEAD LINES 6

Parameters of single and three phase transmission lines with single and double circuits – Resistance, Inductance and Capacitance of solid, stranded and bundled conductors – Symmetrical and unsymmetrical spacing – Skin and proximity effect

UNIT III PERFORMANCE OF TRANSMISSION LINES 6

Performance of transmission lines – Short line and medium line – Equivalent circuits, Phasor diagram, voltage regulation and transmission efficiency – Surge impedance loading, Ferranti effect

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UNIT IV MECHANICAL DESIGN OF OVERHEAD LINES 6

Line supports – Dampers – Spacers – Types of towers, tower spotting and conductor types – Corona – Critical voltages – Stress and sag calculation – Effects of wind and ice loading

UNIT V INSULATORS AND CABLES 6

Types of insulators – String efficiency – Construction of cables – Power factor and heating of cables – DC cables – Fault identification

LIST OF EXPERIMENTS (Indicative)

1. AC and DC distribution calculations – Different topology
2. Compute inductance and capacitance of a three phase transmission line parameters
3. Modeling of short and medium transmission line
4. Calculation of sag in overhead transmission line
5. Calculation of potential distribution over string insulator

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Kothari D.P. and Nagarath I.J., "Power System Engineering", 3rd edition, McGraw-Hill Publishing Company Ltd., New Delhi, 2019
2. Mehta V.K. and Rohit Mehta, "Principles of Power System", 6th edition, S.Chand, New Delhi, 2014

REFERENCES:

1. Gupta B.R., "Power System Analysis and Design", 7th revised edition, S. Chand, New Delhi, 2014
2. Gupta J.B., "Transmission and Distribution", 10th edition, S.K. Kataria & Sons, New Delhi, 2015
3. Singh S.N., "Electric Power Generation, Transmission and Distribution" 2nd edition, PHI Learning, Pvt., Ltd., 2011

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th colspan="2" rowspan="2">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (Theory) (100 Marks)</th><th colspan="2">Assessment II (Practical) (100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)</td><td>Test</td><td rowspan="2">Theory Examinations (Examinations will be conducted for 100 Marks)</td><td rowspan="2">Practical Examinations (Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>25</td><td>25</td></tr>
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<tr><td colspan="6">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER IV

U21SSG01	SOFT SKILLS – I (Common to all programmes)	Category: HSMC				
		L	T	P	J	C
		0	0	2	0	1

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To inculcate potential skills and to work as a team effectively.
- To develop confidence and enhance interpersonal skills.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Enhance decision making and negotiation skills (Analyze)

CO2: Maintain open, effective, and Professional Communication (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	3	-	2	-	-
CO2	-	-	-	-	-	-	-	-	2	3	-	1	-	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

UNIT I VERBAL COMPETENCE **10**

Verbal Analogy – Spotting Errors – Ordering of Sentences – Cloze Test – Effective Listening – Reading Comprehension

UNIT II EFFECTIVE COMMUNICATION **10**

Overcoming Communication Barriers – Body Language and its Etiquettes – Contextual Communication – 7C's of Communication – Listening to Documentaries

UNIT III INTERPERSONAL SKILLS **10**

Group Decision Making – Paralanguage – Negotiation Skills – Preparation & Planning, Bargaining & Problem Solving –Self Grooming – SWOT Analysis

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical 30 Periods Project: – Periods

Total: 30 Periods

TEXT BOOKS:

1. Prashant Sharma,"Soft Skills: Personality Development for Life Success",1st edition, BPB Publications,2022
2. Suresh Kumar E, Sreehari P and Savithri J, "Communication Skills and Soft Skills: An Integrated Approach", 1st edition, Dorling Kindersley, 2011.

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REFERENCES:

1. Jeff Butterfield, "Problem Solving and Decision Making", 2nd edition, Course Technology, 2010.
2. Wushow Bill Chou, "Fast-Tracking your Career: Soft Skills for Engineering and IT Professionals", 1st edition, IEEE Press, 2013.

EVALUATION PATTERN:

Continuous Internal Assessments	Marks
Test – I	50
Test – II	50
Total	100

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SEMESTER IV

U21EE404	ELECTRICAL MACHINES LABORATORY – II	Category: PCC				
		L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- U21EE305: Electrical Machines Laboratory – I

COURSE OBJECTIVES:

- To acquire the knowledge on performance characteristics of various AC machines
- To understand the various losses in AC machines
- To analyze the equivalent circuit parameters of AC machines

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply the indirect testing methods to determine the voltage regulation of three phase alternator (Apply)

CO2: Develop the positive, negative and zero sequence impedance of alternators (Apply)

CO3: Analyze the performance of synchronous motor on infinite bus for various excitation (Apply)

CO4: Experiment with single phase and three phase induction motor by direct and indirect test Methods (Apply)

CO5: Identify the performance characteristics of various AC machines using simulation tools (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	1	-	1	2	1	-	1	2	-
CO2	3	2	1	1	1	-	-	1	2	1	-	1	2	-
CO3	3	2	1	1	1	-	-	1	2	1	1	1	2	-
CO4	3	2	1	1	1	-	-	1	2	1	-	1	2	-
CO5	3	2	1	1	1	1	1	1	2	1	-	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

LIST OF EXPERIMENTS

1. Regulation of three phase alternator by EMF and MMF method
2. Regulation of three phase alternator by slip test
3. V and Inverted V curve of three phase synchronous Motor
4. Load test on three-phase induction motor
5. No load and blocked rotor test on three-phase induction motor
6. Separation of No-load losses of three-phase induction motor
7. Load test on single-phase induction motor
8. No load and blocked rotor test on single-phase induction motor

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9. Parallel operation of alternators

10. Simulation on performance characteristics of AC machines

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project: – Periods

Total: 60 Periods

EVALUATION PATTERN:

Continuous Internal Assessments		**End Semester Examinations**
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test	
75	25	
100		100
60		40
Total: 100		

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SEMESTER IV

		Category: PCC				
U21EE405	CONTROL SYSTEMS LABORATORY	L	T	P	J	C
		0	0	4	2	3

PRE–REQUISITES:

- U21EE302: Electrical Machines – I, U21EE401: Electrical Machines – II

COURSE OBJECTIVES:

- To acquire the knowledge in system modeling
- To understand the system performance using time domain analysis and frequency domain analysis
- To design various controllers and compensators to improve system performance

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Determine the transfer function of electro-mechanical systems (Apply)

CO2: Apply various time domain techniques to assess the system performance (Apply)

CO3: Apply various frequency domain techniques to assess the system performance (Apply)

CO4: Apply different types of stability analysis techniques to assess the system performance (Apply)

CO5: Select a suitable controller and/or a compensator for a specific application to improve the system performance (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	-	-	1	2	2	1	1	2	-
CO2	3	2	1	1	1	-	-	1	2	2	1	1	2	-
CO3	3	2	1	1	1	-	-	1	2	2	1	1	2	-
CO4	3	2	1	1	1	-	-	1	2	2	1	1	2	-
CO5	3	2	1	1	1	-	-	1	2	2	1	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

LIST OF EXPERIMENTS

1. Determination of transfer function parameters of armature controlled DC motor
2. Determination of transfer function parameters of field controlled DC motor
3. Determination of transfer function parameters of DC generator
4. Determination of transfer function parameters of an AC servomotor
5. DC and AC position control systems
6. Simulation of first order and second order systems – Time domain analysis
7. Stability analysis (Bode plot and Root locus) of linear time invariant system

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8. Design of lag compensator and lead compensator for the given system
9. Effect of P, PI, PID Controller
10. Simulation of closed loop temperature control system

Project:

Controller / Compensator design for real world applications using simulation tools.

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Project: 30 Periods

Total: 60 Periods

EVALUATION PATTERN:

<table>
<tr><th colspan="5">Continuous Internal Assessments</th><th>End Semester Examinations</th></tr>
<tr><td colspan="2">Assessment I
(Practical)
(100 Marks)</td><td colspan="3">Assessment II
(Project)
(100 Marks)</td><td rowspan="2">Practical Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>Evaluation of Laboratory Observation, Record
(Rubrics Based Assessments)</td><td>Test</td><td>Review I</td><td>Review II</td><td>Review III</td></tr>
<tr><td>75</td><td>25</td><td>15</td><td>25</td><td>60</td><td></td></tr>
<tr><td colspan="2">25</td><td colspan="3">25</td><td>50</td></tr>
<tr><td colspan="5">50</td><td>50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

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SEMESTER V

		Category: PCC				
U21EE501	**POWER SYSTEM ANALYSIS**	L	T	P	J	C
		2	1	0	0	3

PRE–REQUISITES:

- U21EE403: Transmission and Distribution

COURSE OBJECTIVES:

- To acquire the knowledge on power systems components, power flow analysis and faults
- To understand the concept of various faults and stability analysis
- To apply the concept of fault and stability analysis for power system structures

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Model the single line diagram with per unit quantities (Understand)

CO2: Illustrate the load flow analysis using numerical methods (Understand)

CO3: Calculate the fault current in the power system under balanced condition (Apply)

CO4: Determine the fault current in the power system under unbalanced condition (Apply)

CO5: Outline the power system stability using swing equation and equal area criteria (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	1	-	-	-	-	-	1	-	3
CO2	3	2	2	2	1	1	-	-	-	-	-	1	-	3
CO3	3	2	2	2	1	1	-	-	-	-	-	1	-	3
CO4	3	2	2	2	1	1	1	-	-	-	-	1	-	3
CO5	3	2	2	2	1	1	1	-	-	-	-	1	-	3
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I MODELING OF POWER SYSTEMS **6 + 3**

Need for system planning and operational studies – Power system components – per unit quantities – p.u. impedance and reactance diagram – Primitive parameters – Construction of Y-bus and Z-bus using inspection method – Case studies

UNIT II POWER FLOW ANALYSIS **6 + 3**

Classification of buses – Development of power flow model – Newton-Raphson and Gauss-Seidel load flow methods – Q-limit check for voltage-controlled buses

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UNIT III SYMMETRICAL FAULT ANALYSIS **6 + 3**

Importance of short circuit analysis – Assumptions in fault analysis – Analysis using Thevenin's theorem – Z- bus building algorithm – Fault analysis using Z-bus – Analysis using simulation tools

UNIT IV UNSYMMETRICAL FAULT ANALYSIS **6 + 3**

Symmetrical components – Sequence impedances – Sequence networks analysis of single line to ground, line to line and double line to ground faults using Thevenin's theorem and Z-bus matrix – Analysis using simulation tools

UNIT V STABILITY ANALYSIS **6 + 3**

Classification of power system stability – Swing equation – Swing curve – Power angle equation – Equal area criterion – Critical clearing angle and time – Classical step-by-step solution of swing equation

Contact Periods:

Lecture: 30 Periods Tutorial: 15 Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Nagarath I.J and Kothari D.P., "Modern Power System Analysis", 4th edition, Tata McGraw-Hill Education, 2011
2. John J. Grainger and Stevenson Jr. W.D., "Power System Analysis", 6th reprint, McGraw-Hill Education, 2010

REFERENCES:

1. Hadi Saadat, "Power System Analysis", 21st reprint, Tata McGraw-Hill Education, 2010
2. Kundur P., "Power System Stability and Control", 10th reprint, Tata McGraw-Hill Education, 2010
3. Murty P.S.R., "Power System Analysis", 2nd edition, BSP Books Pvt. Ltd, Elsevier, 2017

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER V

		Category: PCC				
U21EE502	POWER ELECTRONICS AND DRIVES	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21EE303: Analog Electronics and applications, U21EE401 - Electrical Machines – II

COURSE OBJECTIVES:

- To acquire the knowledge of power semiconductor switches and its characteristics
- To understand the concept of control and working of various power converters
- To acquire the knowledge in the characteristics of electric motor drives

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Describe the construction of switching devices and its characteristics (Understand)

CO2: Explain the concept of AC-DC and DC-DC power conversion techniques (Understand)

CO3: Explain the operation of inverter and AC – AC conversion techniques (Understand)

CO4: Analyze the operation of the converter/chopper fed dc drive (Understand)

CO5: Analyze the operation and performance of AC drives (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	1	-	-	-	1	1	-	1	3	-
CO2	3	2	2	-	2	1	1	-	1	1	-	1	3	-
CO3	3	2	1	-	2	-	-	-	1	1	-	1	3	-
CO4	3	2	1	-	-	-	-	-	-	-	-	1	3	-
CO5	3	2	1	-	-	-	-	-	-	-	-	1	3	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I POWER SEMI-CONDUCTOR DEVICES 9

Semiconductor devices: SCR, TRIAC, BJT, MOSFET, IGBT – Construction and characteristics – GaN-SiC devices – Triggering – Commutation circuits – Snubber circuit

UNIT II PHASE-CONTROLLED CONVERTERS AND DC TO DC CONVERTERS 9

Single phase and three phase half and fully controlled converters – Dual converters – Choppers – Control strategy – Four quadrant operation – Buck-Boost converter – Resonant Converters

UNIT III INVERTERS AND AC TO AC CONVERTERS 9

Single phase and three phase voltage source inverters (120° and 180° mode) – PWM techniques – Current source inverter – Multilevel inverters – Phase shifting transformer – Single phase AC voltage controllers and cycloconverters

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UNIT IV DC DRIVES 9

Electric drives – Equations governing motor load dynamics – Selection of motor – Single and three phase converter fed separately excited DC motor drive – Four quadrant operation of drives

UNIT V AC DRIVES 9

Stator voltage control – V/f control – Rotor resistance control – Static Scherbius drive – Self-control of synchronous motor – V3F drives – Applications

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Rashid M.H., "Power Electronics: Circuits, Devices and Applications", 4th edition, Pearson Education, New Delhi, 2017
2. Gopal K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, 2018
3. Bimal K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, 2015

REFERENCES:

1. Singh M.D. and Khanchandani K.B., "Power Electronics", 2nd edition, McGraw Hill India, 2013
2. Bimbhra P.S., "Power Electronics", 6th reprint edition, Khanna Publishers, 2018
3. John Hindmarsh and Alasdain Renfrew, "Electrical Machines and Drives System", Elsevier, 2012
4. Shaahin Felizadeh, "Electric Machines and Drives", CRC Press (Taylor and Francis), 2013

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER V

		Category: PCC				
U21EE503	**MICROPROCESSOR, MICROCONTROLLER AND APPLICATIONS**	L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21EE303 – Analog Electronics and Applications

COURSE OBJECTIVES:

- To acquire the knowledge on digital processor 8085 and controller 8051
- To understand the assembly language programming, memory and peripheral interfacing with processors and controllers
- To apply the controllers and processors for various practical applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Describe the architecture, memory organization, interrupts and timing diagram of 8085 microprocessor (Understand)

CO2: Develop the assembly language program using mnemonics of 8085 microprocessor (Apply)

CO3: Illustrate the interfacing of 8085 with various peripheral devices (Apply)

CO4: Explain the architecture, memory organization of 8051 microcontroller (Understand)

CO5: Utilize 8051 microcontroller for real time applications (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	-	-	-	-	2	2	-	-	2	-
CO2	3	2	2	1	-	-	-	-	2	2	-	1	2	-
CO3	3	2	2	1	-	-	-	-	2	2	-	1	2	-
CO4	3	2	2	1	-	-	-	-	2	2	-	1	2	-
CO5	3	2	2	1	-	-	-	-	2	2	-	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I 8085 PROCESSOR **6**

Evolution – Architecture of 8085 – Pin details – I/O and memory mapping – Interrupts – Machine cycles and Timing diagrams

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UNIT II PROGRAMMING WITH 8085 PROCESSOR 6

Addressing modes – Instruction format – Instruction set – Assembly Language Programs – Applications

UNIT III PERIPHERAL INTERFACING OF 8085 MICROPROCESSOR 6

Architecture, Pin configuration and interfacing of ICs: 8255, 8259, 8254, 8279, A/D and D/A converters with 8085 microprocessor

UNIT IV 8051 MICROCONTROLLER 6

Architecture of 8051 – Pin details – Memory Organization – I/O Ports – Timers – Serial Port – Interrupts – Timing diagrams

UNIT V PROGRAMMING WITH 8051 CONTROLLER 6

Addressing modes – Instruction set – Assembly Language Programming – Interfacing of Relay and Sensors – KEIL IDE

LIST OF EXPERIMENTS (Indicative)

1. Assembly Language Programs using 8085
2. ADC and DAC interfacing with 8085
3. Assembly Language Programs using 8051
4. Stepper Motor Control using 8051
5. Assembly Language Programs – KEIL IDE

Contact Periods:

Lecture: 30 Periods	Tutorial: – Periods	Practical: 15 Periods	Project: – Periods
			Total: 45 Periods

TEXT BOOKS:

1. Ramesh S. Gaonkar, "Microprocessor Architecture: Programming and Applications with the 8085", 6th edition, Penram International Publishing, Prentice Hall of India, New Delhi, 2011
2. Muhammed Ali Mazidi, Janice Gillispie Mazidi and Rolin D. Mckinlay, "The 8051 Microcontroller and Embedded Systems", 2nd edition, Pearson Education India, New Delhi, 2011

REFERENCES:

1. Douglas V Hall, "Microprocessors and Interfacing: Programming and Hardware", 2nd edition, Tata McGraw Hill, New Delhi, 2010
2. Subrata Ghoshal, "8051 Microcontroller: Internals, Instructions, Programming and Interfacing", 2nd edition, Pearson Education India, New Delhi, 2014
3. Kenneth J Ayala, "The 8051 Microcontroller Architecture Programming and Application ", 3rd edition, Penram International Publishers

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER V

		Category: HSMC				
U21SSG02	SOFT SKILLS – II (Common to all programmes)	L	T	P	J	C
		0	0	2	0	1

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the importance of communication and enhance self confidence
- To acquire employability skills

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Actively participate in Group Discussion (Analyze)
CO2: Enhance interview skills and make effective Presentation (Apply)

CO-PO MAPPING:

POs / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	2	3	-	-	-	-
CO2	-	-	-	-	-	-	-	-	2	3	-	-	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I PRESENTATION SKILLS **10**

Presentation Techniques – Time Management Techniques – Body language – Managerial Skills – Making Effective Presentation

UNIT II GROUP DISCUSSION AND PUBLIC SPEAKING **10**

Introduction to Group Discussion – Understanding Group Dynamics – Group Discussion Strategies– Activities to Improve GD Skills – Public Speaking Techniques – Public Speaking Activiti

UNIT III INTERVIEW SKILLS **10**

Listening to Interviews – Preparation for the Interview – Interview Techniques and Etiquettes – Handling Stress Interview – Mock Interview – Online Interview Techniques

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 30 Periods

TEXT BOOKS:

1. Prashant Sharma, "Soft Skills: Personality Development for Life Success", BPB Publications,1st edition,2022.
2. Leader Interpersonal and Influence Skills: The Soft Skills of Leadership." Routledge Publications, 2014.

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REFERENCES:

1. Ghosh B N, "Managing Soft Skills for Personality Development", 1st edition, Tata McGraw-Hill, 2012
2. Nitin Bhatnagar and Mamta Bhatnagar, "Effective Communication and Soft Skills Strategies for Success", 1st edition, Pearson Education, 2012.

EVALUATION PATTERN:

Continuous Internal Assessments	Marks
Test – I	50
Test – II	50
Total	100

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SEMESTER V

U21EE504	POWER ELECTRONICS AND DRIVES LABORATORY	Category: PCC				
		L	T	P	J	C
		0	0	4	2	3

PRE–REQUISITES:

- U21EE303: Analog Electronics and applications

COURSE OBJECTIVES:

- To acquire the knowledge on semiconductor devices and characteristics
- To understand the topologies of power converters for electric drives
- To apply the power converters for industrial applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Analyze the static and dynamic characteristics of power semiconductor devices (Appy)

CO2: Demonstrate the working of power converters (Understand)

CO3: Examine the performance of converter fed DC and AC drives (Understand)

CO4: Analyze the performance of converter fed Switched Reluctance and Brushless DC motor drives (Apply)

CO5: Simulate the topologies of converter fed electric drives for various applications (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	-	-	1	2	2	1	1	3	-
CO2	3	2	2	1	1	-	-	1	2	2	1	1	3	-
CO3	3	2	2	2	1	-	-	1	2	2	1	1	3	-
CO4	3	2	2	2	1	-	-	1	2	2	1	1	3	-
CO5	3	2	2	2	1	-	-	1	2	2	1	1	3	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

LIST OF EXPERIMENTS

1. Characteristics of SCR, TRIAC, MOSFET and IGBT
2. Single phase and three phase-controlled rectifiers
3. DC-DC converters
4. DC-AC converters
5. AC voltage controllers and cycloconverters
6. DSP based control of induction motor drives
7. DSP based control of switched reluctance and DC motor drives

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Project:

Simulation of Power Electronic Circuits using MATLAB Simulink

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Project: 30 Periods

Total: 60 Periods

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (Practical) (100 Marks)		Assessment II (Project) (100 Marks)			Practical Examinations (Examinations will be conducted for 100 Marks)
Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test	Review I	Review II	Review III	
75	25	15	25	60	
25		25			50
50					50
Total: 100					

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SEMESTER V

U21EE505	POWER ENGINEERING LABORATORY	Category: PCC				
		L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- U21EE403: Transmission and distribution, U21EE501: Power System Analysis

COURSE OBJECTIVES:

- To provide better understanding of power system analysis through digital simulation
- To compute the transmission line parameter and model them
- To analyze the load flow and fault in transmission network

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Calculate transmission line parameters (Apply)

CO2: Model power transmission lines (Apply)

CO3: Acquire knowledge on formation of bus admittance and impedance matrices and solution of networks (Understand)

CO4: Analyze the power flow using GS and NR method (Analyze)

CO5: Analyze Symmetrical and Unsymmetrical fault (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	-	-	1	2	2	-	1	-	3
CO2	3	2	1	1	1	-	-	1	2	2	-	1	-	3
CO3	3	2	1	1	1	-	-	1	2	2	-	1	-	3
CO4	3	2	1	1	1	-	-	1	2	2	-	1	-	3
CO5	3	2	1	1	1	-	-	1	2	2	-	1	-	3
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

LIST OF EXPERIMENTS

1. Calculation of transmission line parameters
2. Modelling of short and medium transmission lines
3. Formation of Y-bus by the method of inspection
4. Formation of Z-bus by bus building algorithm
5. Load flow analysis by Gauss-Seidel method
6. Load flow analysis by Newton Raphson method
7. Symmetric and unsymmetrical fault analysis
8. Stability analysis of single machine infinite bus system

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Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project: – Periods

Total: 60 Periods

EVALUATION PATTERN:

Continuous Internal Assessments		End Semester Examinations
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test	
75	25	
100		100
60		40
100		

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SEMESTER VI

		Category: PCC				
U21EE601	PROTECTION AND SWITCHGEAR	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21EE403: Transmission and Distribution

COURSE OBJECTIVES:

- To acquire the characteristics and functions of protective devices
- To understand the protection of apparatus using relays and circuit breakers
- To illustrate the types of relays and circuit breakers for power system protection

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Illustrate the protection schemes and its standards (Understand)

CO2: Classify the types of protective relays (Understand)

CO3: Select different types of protective schemes for alternator, transformer, bus bar, substation and motor protection (Apply)

CO4: Explain the theory of arc interruption (Apply)

CO5: Outline the circuit breaker for various applications (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	1	-	-	-	-	-	1	-	3
CO2	3	1	1	-	1	1	1	-	-	-	-	1	-	3
CO3	3	2	1	-	1	1	1	-	-	-	-	1	-	3
CO4	3	2	1	-	-	1	-	-	-	-	-	1	-	3
CO5	3	1	1	-	-	1	1	-	-	-	-	1	-	3
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I PROTECTION SCHEMES AND STANDARDS 9

Principles and need for protective schemes – Nature, causes and types of faults – Zones of protection – Primary and backup protection – Essential qualities of protection – Classification of protection schemes – Introduction to IEC standards for earthing (TT, TN, IT) – IEC standards for MCB and MCCB

UNIT II PROTECTIVE RELAYS 9

Requirement of relays – Universal relay – Torque equation – Electromagnetic relays: Over current, Directional, Differential, Distance, Negative sequence and Frequency relays – Earth fault relays – Static and Numerical relays

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UNIT III APPARATUS AND LINE PROTECTION 9

Alternator, Transformer, Bus bar, Transmission line and Motor protection schemes – Static protection of EHV lines

UNIT IV THEORY OF CIRCUIT INTERRUPTION AND INSULATION COORDINATION 9

Principles of arc extinction – Arc control devices – DC and AC Circuit breaking – Recovery voltage and restriking voltage – Current chopping – Capacitance current breaking – Arc suppression coil – Insulation coordination – Determination of line insulation – Insulation levels of substation

UNIT V CIRCUIT BREAKERS 9

Circuit breakers : Oil, Air break, Air blast, Sulphur hexafluoride, Vacuum – Fuses – Types – Selection – Discrimination – HVDC breakers – Rating – Testing of circuit breakers

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Sunil S. Rao, "Switchgear and Protection", 13th edition, Khanna Publishers, New Delhi, 2014
2. Anderson P.M., "Power System Protection", 1st edition, A John Wiley and Sons Inc., Publication, 2014

REFERENCES:

1. Badri Ram and Vishwakarma B.H., "Power System Protection and Switchgear", 2nd edition, New Age International Pvt. Ltd., 2011
2. Paithankar Y.G. and Bhide S.R., "Fundamentals of power system protection", 2nd edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2010
3. Wadhwa C.L., "Electrical Power Systems", 6th edition, New Age International Pvt. Ltd., 2010
4. https://archive.nptel.ac.in/courses/108/107/108107167/

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course

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LEARN BEYOND

SEMESTER VI

		Category: PCC				
U21EE602	EMBEDDED SYSTEM DESIGN	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21EE503: Microprocessor, Microcontroller and Applications

COURSE OBJECTIVES:

- To acquire knowledge on the building blocks of embedded systems and ARM Processor
- To understand the bus communication protocols in embedded systems
- To apply embedded systems concepts for real time applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Describe the functional blocks of embedded systems (Understand)

CO2: Explain the bus communication involved in processors and input/output interfacing (Understand)

CO3: Summarize the various RTOS concepts and processor scheduling algorithms implemented in embedded system (Understand)

CO4: Develop the assembly language programs using ARM instruction set (Apply)

CO5: Utilize ARM processor for real time applications (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	-	-	-	1	2	-
CO2	3	2	1	1	-	-	-	-	-	-	-	1	2	-
CO3	3	2	1	1	-	-	-	-	-	-	-	1	2	-
CO4	3	2	2	1	-	-	-	-	-	-	-	1	2	-
CO5	3	2	2	1	-	-	-	-	-	-	-	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I INTRODUCTION TO EMBEDDED SYSTEMS 9

Characteristics of embedded system - Structural units - Selection of processor and memory devices - DMA - Timer and counting devices - Watchdog timer - Real time clock - In circuit emulator - Target hardware debugging

UNIT II EMBEDDED NETWORKING 9

I/O devices – Ports and buses – Serial bus communication protocols – RS 232 standard – RS 422 and RS 485 – CAN bus – Serial peripheral interface – I^2C bus – LIN bus

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UNIT III EMBEDDED NETWORKING 9

Task, Process and threads – Interrupt routine in RTOS – Multiprocessing and multitasking – Pre-emptive and Non-primitive scheduling algorithm – Task communication – Shared memory – Message passing – Inter process communication – Semaphores

UNIT IV ARM.PROCESSOR AND PERIPHERALS 9

ARM Architecture – Block diagram of ARM 7 – Instruction set – Stacks and subroutine – Peripherals – Timer unit – Pulse Width Modulation unit – UART

UNIT V APPLICATIONS 9

Washing machine – Automotive: Anti-locking brake system – Smart card system – ATM machine – Elevator control

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Rajkamal, "Embedded System - Architecture, Programming and Design", 2nd edition, McGraw Hill, 2013
2. James K. Peckol, "Embedded System Design", 2nd edition, John Wiley and Sons, 2010

REFERENCES:

1. Sriram J., Iyer V. and Pankaj Gupta: "Embedded Real-time Systems Programming", 1st edition, Tata McGraw-Hill, New Delhi, 2017
2. David E.Simon, "An Embedded Software Primer", 17th edition, Pearson Education India, New Delhi, 2014
3. Elicia White, "Making Embedded Systems", 3rd edition, O Reilly Series SPD, 2012
4. https://archive.nptel.ac.in/courses/108/102/108102045/

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th rowspan="3">Total Internal Assessments</th><th rowspan="3">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
<tr><th>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</th><th>Written Test</th><th>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</th><th>Written Test</th></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>200</td><td>100</td></tr>
<tr><td colspan="4" rowspan="2">Total</td><td>40</td><td>60</td></tr>
<tr><td colspan="2">100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER VI

		Category: PCC				
U21AMG02	MACHINE LEARNING (For EE Department)	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge on data regression, data classification and transformation, deep neural networks.
- To understand the concept of data regression, classification, clustering and transformation and deep neural networks.
- To implement the data regressive and classification concept for electrical engineering applications.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Infer the various types of data and various types of learning. (Understand)

CO2: Explain the linear models and association rule. (Understand)

CO3: Apply the data classification concept for electrical fault grouping problem. (Apply)

CO4: Apply the data clustering and transformation concept for electricity usage problem. (Apply)

CO5: Implement the deep neural network model for lane and vehicle detection. (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	1	-	-	-	-	-	-	-	-	1	1	-
CO2	3	2	2	-	-	-	-	-	-	-	-	1	1	-
CO3	3	2	2	1	-	-	-	-	-	-	-	1	1	-
CO4	3	2	2	1	-	-	-	-	-	-	-	1	1	-
CO5	3	2	2	1	-	-	-	-	-	-	-	1	1	-
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)					3: Substantial (High)						

SYLLABUS:

UNIT I INTRODUCTION TO MACHINE LEARNING 9

Machine Learning Overview – Machine Learning Model Lifecycle – Machine Learning Tools – Supervised vs Unsupervised Learning – Classification – Regression – Evaluating Machine Learning Models

UNIT II LINEAR MODELS AND ASSOCIATION RULE 9

Linear basis function models – Bayesian linear regression – Association rule mining – Market basket analysis – Case studies: Electricity consumption, weather forecasting

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UNIT III DATA CLASSIFICATION 9

Perceptron algorithm – Linear maximal margin classifier – Linear soft margin classifier – Non-linear classifier – Regression by SVM – Variants of SVM techniques – Decision tree – Classification – Measures of impurity – ID3, C4.5, CART – ID3, C4.5 – Case study: Fault classifier

UNIT IV DATA CLUSTERING AND TRANSFORMATION 9

Unsupervised learning – Clustering Methods – K-Means Clustering – EM algorithm – Data transformation – Entropy based method for attribute discretization – PCA for attribute reduction – Case study: Clustering electricity usage

UNIT V DEEP LEARNING 9

Introduction – Neuron models – Networks: Single and multilevel Perceptron, Radial bias function – Back propagation algorithm – Case studies: Lane detection, Vehicle detection

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Ethem Alpaydin, "Introduction to Machine Learning", 4th Edition, Prentice Hall India, 2020.
2. Kevin P. Murphy, "Probabilistic Machine Learning: An Introduction", 1st Edition, MIT Press, 2022.
3. Stephen Marsland, "Machine Learning- An Algorithmic Perspective", 2nd Edition, CRC Press, 2015.

REFERENCES:

1. Shai Shalev-Shwartz, Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", 1st Edition, Cambridge University Press, 2015.
2. John Mueller and Luca Massaron, "Machine Learning for Dummies", 2nd Edition, John Wiley & Sons, 2021.
3. Gopal M, "Applied Machine Learning", 1st Edition, Tata McGraw Hill LLC, 2019.

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th rowspan="2">Total Internal Assessments</th><th rowspan="3">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td></td></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>200</td><td>100</td></tr>
<tr><td colspan="4" rowspan="2">Total</td><td>40</td><td>60</td></tr>
<tr><td colspan="2">100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER VI

		Category: HSMC				
		L	T	P	J	C
U21SSG03	SOFT SKILLS – III (Common to all programmes)	0	0	2	0	1

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To improve language adeptness and to enhance fluency in language.
- To Gain emotional intelligence and to manage stress.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Write reports and make reasoning and assertions (Apply)
CO2: Overcome stress and attain work-life balance (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	1	3	-	-	-	-
CO2	-	-	-	-	-	-	-	1	-	3	-	2	-	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

UNIT I LANGUAGE ADEPTNESS **10**

Sentence Completion – Report Writing – Logical Reasoning – Cause and Effect – Assertion and Reasoning – Digital Profiling – Creative Resume

UNIT II STRESS MANAGEMENT **10**

Factors Causing Stress – Positive and Negative Stress – Effects of Stress – Stress Overcoming Techniques – Context Based Tasks

UNIT III EMOTIONAL INTELLIGENCE **10**

Leadership effectiveness – Self-awareness – Self-management – Self-motivation – Empathy and Social Skills

Contact Periods:

Lecture: – Periods Tutorial: –Periods Practical: 30 Periods Project – Periods
Total 30 Periods

TEXT BOOKS:

1. Daniel Goleman, "Emotional Intelligence: Why it Can Matter More Than IQ", 1st edition, Bloomsbury, 2009.
2. Alan Barker, "Improve Your Communication Skills : Present with Confidence; Write with Style; Learn Skills of Persuasion",1st edition, Kogan Page, 2010.

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REFERENCES:

1. Jeremy Stranks, "Stress at Work: Management and Prevention", 1st edition, Butterworth- Heinemann, 2005.
2. Edward J Watson, "Emotional Intelligence: A Practical Guide on How to Control Your Emotions and Achieve Lifelong Social Success", 1st edition, Amazon Digital Services LLC, 2016.

EVALUATION PATTERN:

Continuous Internal Assessments	Marks
Test – I	50
Test – II	50
Total	100

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SEMESTER VI

U21EE603	EMBEDDED SYSTEM DESIGN LABORATORY	Category: PCC				
		L	T	P	J	C
		0	0	4	2	3

PRE–REQUISITES:

- U21EE503: Microprocessor, Microcontroller and Applications

COURSE OBJECTIVES:

- To develop assembly language program using ARM instruction set
- To understand the interfacing devices with ARM board
- To configure ARM Board and transmit data to PC

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain ARM instruction set and gain the knowledge how assembly language works (Understand)
CO2: Develop and implement the program written in ARM assembly language instructions (Apply)
CO3: Acquire knowledge about devices and buses used in embedded systems (Understand)
CO4: Understand the functioning of hardware devices and interfacing them with ARM board (Understand)
CO5: Conduct and test on STM32 evaluation board using software tool/compiler (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	-	-	1	2	2	-	1	2	-
CO2	3	2	1	1	1	-	-	1	2	2	-	1	2	-
CO3	3	2	1	1	1	-	-	1	2	2	-	1	2	-
CO4	3	2	1	1	1	-	-	1	2	2	-	1	2	-
CO5	3	2	1	1	1	-	-	1	2	2	-	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

LIST OF EXPERIMENTS

1. Installation of software for embedded development, troubleshooting issues, installing packages
2. STM32 GPIO peripheral programming
   a. LEDs, Buttons
   b. Using GPIO interrupts to respond to user button press
3. Configuration of clock system to generate different peripheral and system frequency
4. Configuration of UART in polling method to send data from STM32 MCU to PC

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5. Interface audio sensor to STM32 board using ADC
6. Design of a coherent sensor signal sampling methodology to implement a data logger

Project:
Implementation of Embedded processor/controller for real time application

Contact Period:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Project: 30 Periods

Total: 60 Periods

EVALUATION PATTERN:

<table>
<tr><th colspan="5">Continuous Internal Assessments</th><th>End Semester Examinations</th></tr>
<tr><td colspan="2">Assessment I (Practical) (100 Marks)</td><td colspan="3">Assessment II (Project) (100 Marks)</td><td rowspan="2">Practical Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>Evaluation of Laboratory Observation, Record
(Rubrics Based Assessments)</td><td>Test</td><td>Review I</td><td>Review II</td><td>Review III</td></tr>
<tr><td>75</td><td>25</td><td>15</td><td>25</td><td>60</td><td></td></tr>
<tr><td colspan="2">25</td><td colspan="3">25</td><td>50</td></tr>
<tr><td colspan="5">50</td><td>50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

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SEMESTER VI

U21AMG03	MACHINE LEARNING LABORATORY (For EE Department)	Category: PCC				
		L	T	P	J	C
		0	0	2	0	1

PRE–REQUISITES:

- U21CSG02 : Python Programming

COURSE OBJECTIVES:

- To impart knowledge on decision trees, regression trees and data sets
- To model the supervised and unsupervised learning algorithms in machine learning
- To apply machine learning algorithms for electrical engineering applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Articulate the knowledge on decision trees and regression trees (Understand)

CO2: Classify the information using K-means and Naive Bayesian classifier (Apply)

CO3: Model the supervised learning algorithm using machine learning algorithm (Apply)

CO4: Model the unsupervised learning algorithm using machine learning algorithm (Apply)

CO5: Implement the machine learning algorithm for electrical engineering application (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	-	-	1	1	1	-	1	1	-
CO2	3	3	2	2	2	-	-	1	1	1	-	1	1	-
CO3	3	3	2	2	2	-	-	1	1	1	-	1	1	-
CO4	3	3	2	2	2	-	-	1	1	1	-	1	1	-
CO5	3	3	2	2	2	-	-	1	1	1	-	1	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

LIST OF EXPERIMENTS

1. Working with default and user defined datasets (.xls and .csv)
2. Implement SVM algorithm using given datasets (.xls and .csv)
3. Data and Text clustering using K-means algorithm
4. Naïve Bayesian classifier for a sample training data set stored as a .CSV file.
5. Back propagation algorithm and test the same using appropriate data sets.
6. Object Detection using machine learning algorithm.
7. Clustering of electricity consumer using K-means.

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Project – Periods

Total 30 Periods

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REFERENCES:

1. Oliver Theobald, "Machine Learning for Absolute Beginners", 3rd Edition, 2021.
2. Sebastian Raschka. "Python Machine Learning" 2nd Edition, Packt Publishing, 2015.

EVALUATION PATTERN:

Continuous Internal Assessments		End Semester Examinations
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test	
75	25	
100		100
60		40
100		

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SEMESTER VII

		Category: HSMC				
U21EE701	PRINCIPLES OF MANAGEMENT	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To summarize the principles of management and illustrate the role of managers
- To interpret the nature and purpose of planning and to gain knowledge about decision making
- To illustrate the need for human resource management and compare various motivation theories

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Illustrate the role of managers and relate it to the strategies of international business (Understand)

CO2: Interpret the nature and purpose of planning and to gain knowledge about decision-making (Understand)

CO3: Illustrate the need for human resource management which can be used for management Effectiveness (Understand)

CO4: Compare various motivation theories and relate it to leadership and innovation (Understand)

CO5: Explain the controlling techniques and apply it for cost control operation management (Understand)

CO-PO MAPPING:

POs / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	2	-	1	1	1	2	1	-	-
CO2	-	-	-	-	-	2	-	1	1	1	2	1	-	-
CO3	-	-	-	-	-	2	-	1	1	1	2	1	-	-
CO4	-	-	-	-	-	2	-	1	1	1	2	1	-	-
CO5	-	-	-	-	-	2	-	1	1	1	2	1	-	-
Correlation levels:	1: Slight (Low)					2: Moderate (Medium)					3: Substantial (High)			

SYLLABUS:

UNIT I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9

Introduction to management – Manager Vs Entrepreneur – Kinds of managers – Managerial roles and skills – Evolution of management: Taylor Principles, Fayol, Elton Mayo – Scientific, human relations, system and contingency approaches – Types of business organization – Sole proprietorship – Public and private sector enterprises – Current trends and issues in management.

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UNIT II PLANNING 9

Definition – Benefits and pitfalls of planning – Planning process – Types of planning – Objectives – Setting objectives – Policies – Planning premises – Strategic management – Planning tools and techniques – Decision making steps and process.

UNIT III ORGANISING 9

Nature and purpose – Formal and informal organization – Organization chart – Intra nd inter organizational process – Types – Line and staff authority – Departmentalization – Delegation of authority – Human Resource Management (HRM) – Career planning and management.

UNIT IV DIRECTING 9

Foundations of individual and group behaviour – Motivation theories, motivational techniques – Job satisfaction – Job enrichment – Leadership – Types and theories of leadership – Fiedler's contingency theory, path goal theory– Normative decision theory – Leadership styles – Communication – Process of communication – Barrier in communication – Effective communication.

UNIT V CONTROLLING 9

Innovation and learning perspective of control – Audit – Budgetary and cost control techniques – Use of computers and IT in management control – Productivity problems and management – Control and performance – Direct and preventive control – Challenges in control.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods
Total: 45 Periods

TEXT BOOKS:

1. Stephen P. Robbins and Mary Coulter, 'Management', 14th edition, Pearson Education, 2017
2. Harold Koontz, Heinz Welhrich and Ramachandra Aryasri, 2nd edition, 'Principles of Management', McGraw-Hill Education Pvt. Ltd, 2015

REFERENCES:

1. J.K.Mitra, 'Principles of Management', 1st edition, Oxford University Press, 2017
2. Stephen A. Robbins, David A. Decenzo and Mary Coulter, 'Fundamentals of Management', 7th edition, Pearson Education,2011
3. P.C.Tripathi and P.N.Reddy, 'Principles of Management', 6th edition, McGraw-Hill Education Pvt. Ltd, 2017
4. James A F. Stoner,Edward Freeman and Gilbert, 'Management',8th edition, Prentice Hall of India Pvt. Ltd,2011

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER VII

		Category: PCC				
U21EE702	ELECTRICAL APPLICATION LABORATORY	L	T	P	J	C
		0	0	2	2	2

PRE–REQUISITES:

- U21EE501: Power System Analysis, U21EE502: Power Electronics and Drives,

COURSE OBJECTIVES:

- To acquire the essential knowledge on electric drives and various controllers
- To compute the performance assessment of the renewable energy sources
- To solve the real-world problem with aids of internet technology

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Develop the electric drive model using MATLAB software (Apply)

CO2: Integrate the electric drive with dSPACE controller for speed control application (Apply)

CO3: Integrate the electric drive for speed control applications using FPGA/PLC (Apply)

CO4: Compute the performance Assessment of wind and solar PV system (Apply)

CO5: Model the real-world problem using internet technology (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	1	1	2	3	3	1	1	2	-
CO2	3	3	3	3	3	1	1	2	3	3	1	1	2	-
CO3	3	3	3	3	3	1	1	2	3	3	1	1	2	-
CO4	3	3	3	3	3	1	1	2	3	3	1	1	-	2
CO5	3	3	3	3	3	1	1	2	3	3	1	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

List of Experiments

1. Model of electric drive systems using MATLAB software
2. Control of variable speed drive using dSPACE controller
3. V/Hz control of electric drive system using PLC
4. Speed control of BLDC motor drive using dSPIC / FPGA Controller
5. Performance assessment of micro wind energy generator
6. Performance assessment of 1 kWp solar PV system
7. Monitoring and control of sensor data via Cloud

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Project:

Modelling / Simulation of Electrical Drives and Applications of Renewable Energy System

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Project: 30 Periods

Total: 60 Periods

EVALUATION PATTERN:

<table>
<tr><th colspan="5">Continuous Internal Assessments</th><th>End Semester Examinations</th></tr>
<tr><td colspan="2">Assessment I (Practical) (100 Marks)</td><td colspan="3">Assessment II (Project) (100 Marks)</td><td rowspan="2">Practical Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>Evaluation of Laboratory Observation, Record
(Rubrics Based Assessments)</td><td>Test</td><td>Review I</td><td>Review II</td><td>Review III</td></tr>
<tr><td>75</td><td>25</td><td>15</td><td>25</td><td>60</td><td></td></tr>
<tr><td colspan="2">25</td><td colspan="3">25</td><td>50</td></tr>
<tr><td colspan="5">50</td><td>50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

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SEMESTER VII

U21EE703	PROJECT WORK PHASE - I	Category: EEC					
		L	T	P	J	C	
		0	0	0	4	2	

PRE–REQUISITES:

Nil

COURSE OBJECTIVES:

- To develop the ability to identify and solve the specific problem in the field of electrical and electronics engineering
- To develop collaborative work and communication skills
- To acquire skills to utilize the modern tools effectively for report preparation

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify, formulate, design, interpret, analyze and provide solutions to complex problem by applying knowledge gained on basics of science and engineering (Apply)

CO2: Demonstrate a technical skills of their selected project topics by exploring suitable engineering and IT tools (Apply)

CO3: Build the team work to solve problems with ethics and commitment towards sustainable development (Apply)

CO4: Use the modern tools for report preparation and communicate orally in review and viva voce (Apply)

CO5: Acquire the technology advancements in the selected topics and engage in lifelong learning (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	-	-	-	-	-	-	-	2	2
CO2	-	-	-	2	2	-	-	-	-	-	-	-	2	2
CO3	-	-	-	-	-	2	2	2	2	2	2	2	2	2
CO4	-	-	-	-	2	-	-	-	-	3	2	2	2	2
CO5	-	-	-	-	2	-	-	-	-	-	-	2	2	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

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STRATEGY

To identify a project topic of interest in consultation with supervisor. The progress of the project work is evaluated based on a reviews and the review committee may be constituted by the Head of the Department. A project report is required at the end of the semester.

Contact Periods:

Lecture:	- Periods	Tutorial: – Periods	Practical: – Periods	Project	60 Periods
				Total	60 Periods

EVALUATION PATTERN:

Internal Assessments (60 Marks)			End Semester Examinations (40 Marks)			
Review I	Review II	Review III	Project Report		Viva - Voce	
			Supervisor	External	Internal	External
10	15	30	10	10	10	10
60			40			
Total			100			

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SEMESTER VIII

		Category: EEC				
		L	T	P	J	C
U21EE801	PROJECT WORK PHASE - II	0	0	0	20	10

PRE–REQUISITES:

Nil

COURSE OBJECTIVES:

- To develop the ability to identify and solve the specific problem in the field of electrical and electronics engineering
- To develop collaborative work and communication skills
- To acquire skills to utilize the modern tools effectively for report preparation

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify, formulate, design, interpret, analyze and provide solutions to complex problems by applying the knowledge gained on the basics of science and engineering (Apply)

CO2: Demonstrate the technical skills of their selected project topics by exploring suitable engineering and IT tools (Apply)

CO3: Build the team work to solve problems with ethics and commitment towards sustainable development (Apply)

CO4: Use the modern tools for report preparation and communicate orally in review and viva voce (Apply)

CO5: Adapt to technology advancements in the selected topics and engage in lifelong learning (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	-	-	-	-	-	-	3	3
CO2	-	-	-	3	3	-	-	-	-	-	-	-	3	3
CO3	-	-	-	-	-	2	2	3	3	3	2	2	3	3
CO4	-	-	-	-	3	-	-	-	-	3	2	3	3	3
CO5	-	-	-	-	3	-	-	-	-	-	-	3	3	3
Correlation levels:	1: Slight (Low)				2: Moderate (Medium)						3: Substantial (High)			

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STRATEGY

To identify a project topic of interest in consultation with supervisor. The progress of the project work is evaluated based on a reviews and the review committee may be constituted by the Head of the Department. A project report is required at the end of the semester.

Contact Periods:

Lecture: - Periods Tutorial: – Periods Practical: – Periods Project 300 Periods

Total 300 Periods

EVALUATION PATTERN:

Internal Assessments (60 Marks)			End Semester Examinations (40 Marks)			
Review I	Review II	Review III	Project Report		Viva - Voce	
10	15	30	Supervisor	External	Internal	External
			10	10	10	10
60			40			
Total			100			

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		Category: PEC				
		L	T	P	J	C
U21EEP01	POWER SYSTEM OPERATION AND CONTROL	3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge on operation of power systems and its control methods
- To understand the concept of reactive power control in power systems
- To summarize the computer control methods of power systems

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Make use of load dispatching concepts and plan load forecasting technique (Understand)

CO2: Identify the concept of load frequency control in power systems (Apply)

CO3: Plan the principle of reactive power control in power systems (Apply)

CO4: Outline the economic operation of power systems (Understand)

CO5: Extend the knowledge on computer control of power systems (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	-	-	-	-	-	2
CO2	3	2	1	1	1	-	-	-	-	-	-	1	-	2
CO3	3	2	1	1	1	-	-	-	-	-	-	1	-	2
CO4	3	2	1	1	-	-	-	-	-	-	-	-	-	2
CO5	2	1	-	-	-	-	-	-	-	-	-	-	-	2
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)				3: Substantial (High)							

SYLLABUS:

UNIT I ECONOMIC ASPECTS 9

Power scenario in Indian grid – National and regional load dispatching centers – Requirements of good power system – Necessity of voltage and frequency regulation – System load variation – Load curves – Load forecasting – Economic load dispatch – Regulation of two generators in parallel

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UNIT II LOAD FREQUENCY CONTROL 9

Speed governing mechanism and modeling of thermal and hydro systems – Speed load characteristics – Parallel operation of generators – Load frequency control of single area and multi-area system – Simulation of single area and multi-area system

UNIT III REACTIVE POWER CONTROL 9

Generation and absorption of reactive power – Basics of reactive power control – Automatic voltage regulator – Static and dynamic analysis of AVR loop – Methods of reactive power control – Necessity of voltage control – Methods of voltage control – Simulation of AVR system

UNIT IV ECONOMIC OPERATION OF POWER SYSTEMS 9

Input and output characteristics of thermal plant – Incremental cost curve – Optimal operation of thermal units without and with transmission losses – Unit commitment (UC) problem – Constraints on UC problem – Solution of UC problem using priority list

UNIT V COMPUTER CONTROL OF POWER SYSTEMS 9

Need of computer control – Energy control centers and its functions – Phasor measurement unit – Data acquisition and controls – System hardware configurations – SCADA – Energy management system and its functions – Various operating states – State estimation problem

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Olle I. Elgerd, "Electric Energy Systems Theory – An Introduction", 34th reprint, McGraw Hill Education Pvt. Ltd., New Delhi, 2010
2. Abhijit Chakrabarti and Sunita Halder, "Power System Analysis Operation and Control",3rd edition, PHI learning Pvt. Ltd., New Delhi, 2010

REFERENCES:

1. Wadhwa C.L., "Electrical Power Systems", 7th edition, New Academic Science Limited, 2016
2. Allen J. Wood and Bruce F. Wollen berg, "Power Generation, Operation and Control", 3rd edition, John Wiley & Sons, Inc., 2013
3. Kundur P., "Power System Stability and Control", 10th reprint, McGraw Hill Education Pvt. Ltd., New Delhi, 2010

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP02	HIGH VOLTAGE ENGINEERING	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge on electric fields and breakdown mechanisms in dielectrics
- To understand the various generation, measurement techniques in high voltage and high current
- To apply the various testing techniques and simulation of high voltage equipment

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the electric fields and various breakdown mechanisms in dielectrics (Understand)

CO2: Illustrate the generation methods of high voltage and high current (Understand)

CO3: Interpret the high voltage and high current measurement techniques (Understand)

CO4: Outline the various testing methods for high voltage equipment (Understand)

CO5: Design of insulators and bushings using simulation tool (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	2
CO2	2	2	-	1	1	-	-	-	-	-	-	1	-	2
CO3	2	1	-	-	-	-	-	-	-	-	-	1	-	2
CO4	2	2	-	-	-	2	-	-	-	-	-	1	-	2
CO5	2	2	2	2	2	-	-	-	-	-	-	1	-	2
Correlation levels:	1: Slight (Low)				2: Moderate (Medium)						3: Substantial (High)			

SYLLABUS:

UNIT I ELECTRIC BREAKDOWN IN DIELECTRICS **9**

Uniform and non-uniform electric fields – Breakdown mechanism in gaseous, vacuum, liquid, solids and composite dielectrics

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UNIT II GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS 9

Generation of high DC and AC voltages – Generation of impulse voltages and impulse currents – Tripping and control of impulse generators

UNIT III MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS 9

Measurement of high DC and AC voltages – High DC and AC currents – High impulse voltages and impulse currents

UNIT IV HIGH VOLTAGE TESTING 9

Definitions and terms – IEEE and IEC standards - Partial discharge measurement – Testing of insulators, bushings, circuit breakers, transformers and surge diverters

UNIT V SIMULATION OF HIGH VOLTAGE APPARATUS 9

Finite Element Analysis (FEA): Basis of FEA, procedure, elements, boundary conditions – Simulation environment: Modelling procedure, pre and post processing – Design of insulators and bushings

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Naidu M.S. and Kamaraju V., "High Voltage Engineering", 6th edition, Tata McGraw Hill Ltd., 2020
2. Ravindra Arora, Wolfgang Mosch, "High Voltage and Electrical Insulation Engineering", 2nd edition, Jon & Wiley Son Limited, 2022

REFERENCES:

1. Farouk A.M. Rizk, Giao N. Trinh, "High Voltage Engineering", CRC Press, 2018
2. Sivaji Chakravorti, "Electric Field Analysis", CRC Press, 2017
3. "José Roberto Cardoso", Electromagnetics Through the Finite Element Method - A Simplified Approach Using Maxwell's Equations, CRC Press, 2016

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP03	MICROGRID	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge of microgrid technology, types and its issues
- To understand the control and operational strategies of microgrid
- To outline the communication infrastructure, operation and protection of microgrid

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the concepts of microgrid technologies (Understand)

CO2: Illustrate the characteristics and selection of power electronics interfaces (Understand)

CO3: Choose the converters, inverters for microgrid (Understand)

CO4: Demonstrate the communication protocols and infrastructure (Understand)

CO5: Interpret the operation of microgrid and its protection schemes (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	-	-	-	-	-	-	-	-	1	-	2
CO2	2	1	1	-	-	-	-	-	-	-	-	1	-	2
CO3	2	1	1	-	-	-	-	-	-	-	-	1	-	2
CO4	2	1	1	-	-	-	-	-	-	-	-	1	-	2
CO5	2	1	1	-	-	-	-	-	-	-	-	1	-	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I MICROGRID STRUCTURE 9

Typical structure and configuration – Significance – Sources – Types: AC, DC and hybrid microgrid – Technical implications and social fall out – Market models and business cases for microgrid

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UNIT II MICROGRID SOURCES AND POWER ELECTRONIC INTERFACES 9

Review of microgrid sources – Basic characteristics and selection – Power electronics interface – Design for microgrid – DC and AC sources – Protection and co-ordination – Power quality issues and solutions

UNIT III CONTROL AND DESIGN OF POWER ELECTRONIC INTERFACES 9

Microgrid control architecture – Control strategies: Centralized and decentralized control – Multi-agent system-based control – Power relations and power control – Control of DC-DC converters and inverter – Microgrid challenges – Energy management in microgrid

UNIT IV COMMUNICATION INFRASTRUCTURE 9

Requirement of communication system in microgrid – Communication protocols and standards – Selection of communication protocols for microgrid – Event triggered system and Time triggered system – Unicast and multicast communication – Impact of time latencies on operation

UNIT V OPERATION AND PROTECTION OF MICROGRID 9

Grid connected and islanding mode of operation – Challenges for microgrid protection – Adaptive protection – Fault current source for effective protection in islanded operation – Fault current limitation in microgrids

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Nikos Hatziargyriou, "Microgrids: Architectures and Control", Wiley-IEEE Press, 2013
2. Sharkh S.M., Abu-Sara M.A., Orfanoudakis G.I. and Hussain B., "Power Electronic Converters for Microgrids", Wiley – IEEE Press, 2014

REFERENCES:

1. Naser Mahdavi Tabatabaei, Ersan Kabalci, Nicu Bizon, "Microgrid Architectures, Control and Protection Method", Springer, 2020
2. Magdi S. Mahmoud, "Microgrid Advanced Control Methods and Renewable Energy System Integration", Elsevier, 2017
3. Li Fusheng, Li Ruisheng, Zhou Fengquan, "Microgrid Technology and Engineering Application", Elsevier, 2016

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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KPRIET LEARN BEYOND

U21EEP04	COMPUTER AIDED POWER SYSTEM ANALYSIS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge on power flow analysis in power system networks
- To understand the various types of faults occurring in power system
- To apply the algorithms for obtaining security and stability performance of power system

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Solve the power flow problems using algorithms (Apply)

CO2: Outline the simultaneous linear equations using sparse matrix techniques (Understand)

CO3: Identify the symmetrical and asymmetrical faults in power systems (Apply)

CO4: Interpret the contingency analysis in power systems (Understand)

CO5: Summarize the stability analysis of synchronous and multi-machine systems (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	-	-	-	-	-	-	2	-	2
CO2	3	2	2	1	1	-	-	-	-	-	-	2	-	2
CO3	3	2	2	1	1	-	-	-	-	-	-	2	-	2
CO4	3	2	2	-	-	-	-	-	-	-	-	2	-	2
CO5	3	2	2	-	-	-	-	-	-	-	-	2	-	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I POWER FLOW STUDIES 9

Modeling of power system components – Power flow equations – Formation of Y bus matrix – Power flow solution algorithms: Newton Raphson, Fast decoupled and DC load flow analysis – Sequential and simultaneous solution algorithms – Newton Raphson load flow study using MATLAB

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UNIT II SPARSE MATRICES 9

Sparse matrix techniques for large scale power systems – Sparsity directed optimal ordering schemes – Solution algorithms – LU factorization, bi-factorization and iterative methods

UNIT III FAULT ANALYSIS 9

Symmetrical and asymmetrical faults – Z bus formulation with mutual coupling – Short circuit analysis of large power systems using Z bus – Analysis of open circuit faults – Computer method for fault analysis using Z bus and sequence components

UNIT IV STABILITY ANALYSIS 9

Classification of power system stability – Classical model of synchronous machines and excitation system – Transient stability analysis of multi-machine systems – Eigen analysis of dynamical systems – Small signal stability analysis using digital simulator

UNIT V SECURITY ANALYSIS 9

Basic concepts – Static security analysis at control centers – Contingency analysis – Contingency selection – Cyber security initiatives in India

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. George Kusic, "Computer-Aided Power Systems Analysis", 2nd edition, CRC Press, 2009
2. Kothari D.P. and Nagrath I.J., "Power System Engineering", 3rd edition, Tata McGraw-Hill Education, 2019

REFERENCES:

1. Ranjana Sodhi, "Simulation and Analysis of Modern Power Systems", McGraw Hill Limited, 2021
2. Arrillaga J. and Arnold C.P., "Computer Analysis of Power Systems", John Wiley, 2016
3. Uma Rao K., "Computer Techniques and Models in Power Systems", I.K. International Publishing House Pvt. Limited, 2008

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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KPRIET LEARN BEYOND

U21EEP05	POWER QUALITY	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge on power quality issues
- To understand the types of power quality problems and mitigation techniques
- To interpret the concept of power quality effects and its measuring instruments

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Illustrate the various classes of power quality problems and power quality standards (Understand)

CO2: Explain the sources of voltage sags and its mitigation techniques (Understand)

CO3: Show the various cases of over voltages and its mitigation methods (Understand)

CO4: Relate the harmonic effects in power systems (Understand)

CO5: Outline the knowledge of harmonics measurement techniques (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	-	2
CO2	2	2	1	1	1	-	-	-	-	-	-	1	-	2
CO3	2	1	1	1	1	-	-	-	-	-	-	1	-	2
CO4	2	1	-	-	-	-	-	-	-	-	-	1	-	2
CO5	2	1	1	1	1	-	-	-	-	-	-	1	-	2
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)					3: Substantial (High)						

SYLLABUS:

UNIT I POWER QUALITY AND ITS STANDARDS 9

General classes of power quality problems: Concepts of transients, short duration and long duration voltage variations, voltage imbalance, waveform distortions, frequency variations and voltage fluctuations – Power quality standards: IEEE, IEC, CBEMA and ITI curves

UNIT II VOLTAGE SAGS AND INTERRUPTIONS 9

Sources of sag and interruptions – Estimating voltage sag performance – Analysis and calculation of various fault conditions – Mitigation of voltage sags – Active series compensators – Static transfer and fast transfer switches – Voltage sag study using simulation

UNIT III OVER VOLTAGES AND ITS MITIGATIONS 9

Sources of over voltages – Capacitor switching – Lightning – Mitigation of voltage swells – Surge

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arresters – Power conditioners – Lightning protection – Line arresters – Protection of transformers and cables – Ferro-resonance – Switching transients – Voltage swell study using simulation

UNIT IV HARMONICS AND ITS EFFECTS 9

Harmonic distortion – Voltage and current distortions – Power system quantities under non - sinusoidal conditions – Harmonic indices – Harmonic sources from commercial and industrial loads – System response characteristics – Effect of harmonics – Devices for controlling harmonic distortion

UNIT V POWER QUALITY MEASURING INSTRUMENTS 9

Flicker meters, disturbance analyzer, spectrum and harmonic analyzer, data chart recorders and smart power quality monitors – Basics of computer analysis tools – Intelligent system for power quality monitoring – Case study

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Roger C. Dugan, Mark F. McGranaghan, Surya Santoso and H. Wayne Beaty, "Electrical Power Systems Quality", 3rd edition, Tata McGraw Hill, 2012
2. Bhim Singh, Ambrish Chandra and Kamal Al-Haddad, "Power Quality Problems and Mitigations Techniques", 2nd edition, John Wiley, 2015

REFERENCES:

1. Math H.J.Bollen, "Understanding Power Quality Problems: Voltage Sags and Interruptions", IEEE Press, 2011
2. Arrillaga.J., Watson.N.R. and Chen.S., "Power System Quality Assessment", 3rd edition, John Wiley and Sons Ltd., 2011
3. Beaty H. Wayne, McGranaghan and Mark, "Electrical Power Systems Quality", 3rd edition, 2012
4. https://archive.nptel.ac.in/courses/108/102/108102179/

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP06	POWER SYSTEM SECURITY	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge on factors affecting the power system security
- To understand the concepts of state estimation, assessment and enhancement
- To apply the security assessment techniques for improving power system reliability

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Outline the factors affecting power system security assessment and enhancement (Understand)

CO2: Illustrate the most appropriate state of the power system network through state estimation technique (Understand)

CO3: Relate the network problems to assess the power system security (Understand)

CO4: Interpret the various methods for enhancing the power system security (Understand)

CO5: Compare the various security assessment techniques (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	-	-	-	1	-	2
CO2	2	2	-	-	-	-	-	--	-	-	-	1	-	2
CO3	2	2	-	-	-	-	-	-	-	-	-	1	-	2
CO4	2	2	-	-	-	-	-	-	-	-	-	1	-	2
CO5	2	2	-	-	-	-	-	-	-	-	-	1	-	2
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)					3: Substantial (High)						

SYLLABUS:

UNIT I BASICS OF POWER SYSTEM SECURITY 9

Factors affecting power system security – Decomposition and multilevel approach – State estimation – System monitoring using SCADA – Security assessment and security enhancement

UNIT II POWER SYSTEM STATE ESTIMATION 9

Maximum likelihood weighted least-square estimation – State estimation – Detection and identification of bad measurements – Estimation of quantities – Network observability and pseudo measurements

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UNIT III SECURITY ASSESSMENT 9

Detection of network problems – Network equivalent for external system – Network sensitivity methods – Calculation of network sensitivity factors – Fast contingency algorithms – Contingency ranking – Dynamic security indices – PMU based voltage security assessment

UNIT IV SECURITY ENHANCEMENT 9

Correcting the generator dispatch by sensitivity methods – Compensated factors – Security constrained optimization – Preventive – Emergency and restorative control through NLP and LP methods

UNIT V SECURITY TECHNIQUES 9

Voltage security assessment – Transient security assessment methods – Comparison – Case study – Power system security assessment using neural networks and machine learning techniques – SCADA

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Kothari D.P. and Nagrath I.J., "Power System Engineering", 3rd edition, Tata McGraw-Hill Education, 2019
2. Wood, A.J. and Woolenberg, "Power Generation Operation for Security", John Wiley and Sons, 2010

REFERENCES:

1. Allen J. Wood, Bruce F. Wollenberg and Gerald B. Sheble, "Power Generation, Operation and Control", 3rd edition, John Wiley and Sons, 2013
2. Venkatesh P, Manikandan B.V. and Charles Raja S., "Electrical Power Systems: Analysis, Security and Deregulation", PHI learning Pvt. Ltd., 2012
3. Leonard L. Grigsby, "Power System Stability and Control", 3rd edition, CRC Press, 2012

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP07	EHVAC TRANSMISSION	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge of EHVAC transmission systems and power-frequency voltage control methods
- To outline the basics of corona, electrostatic and magnetic field effect in EHVAC transmission
- To understand the steady state and transient limits

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the concept of EHVAC transmission systems (Understand)

CO2: Illustrate the corona effect in EHVAC transmission systems (Understand)

CO3: Understand the effects of electrostatic and magnetic fields of EHVAC line (Understand)

CO4: Summarize the power-frequency voltage control in EHV systems (Understand)

CO5: Interpret the steady state and transient limits of EHV systems (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	-	-	-	-	-	2
CO2	2	2	1	1	-	-	-	-	-	-	-	1	-	2
CO3	2	2	1	1	-	-	-	-	-	-	-	1	-	2
CO4	2	2	1	1	-	-	-	-	-	-	-	1	-	2
CO5	2	2	1	1	-	-	-	-	-	-	-	1	-	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

SYLLABUS:

UNIT I EHVAC TRANSMISSION SYSTEM 9

Role of EHVAC transmission – Average values of line parameters – Power handling capacity and line loss – Costs of transmission lines and equipment – Resistance of conductors – Properties of bundled conductors – Inductance of EHV line configurations – EHV AC transmission lines in India

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UNIT II CORONA EFFECTS AND RADIO INTERFERENCES 9

Power loss and corona loss – Attenuation of travelling waves due to corona loss – Generation and characteristics of audible noise – Measurement and meter of audible noise – Corona pulses – Limits for radio interference fields – Measurement of RI, RIV, and excitation function

UNIT III ELECTROSTATIC AND MAGNETIC FIELD EFFECTS 9

Electric shock and threshold currents – Calculation of electrostatic field of AC lines – Effect of high electrostatic field – Meters and measurement of electrostatic field – Magnetic field effects in three-phase and six-phase line - IEEE standard for safety levels for human exposure

UNIT IV POWER-FREQUENCY VOLTAGE CONTROL 9

Power-frequency problems – No load voltage conditions and charging currents – Voltage control – Shunt and series compensation – Static VAR compensation

UNIT V STEADY STATE AND TRANSIENT LIMITS 9

Scheme of EHV lines based on steady state and transient limits – Scheme of line insulation – EHV cables and their characteristics – Surge performance of cable systems

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Begamudre R.D., "Extra High Voltage AC Transmission Engineering", New Age International Private Limited, 2011
2. Sanjay Kumar Sharma, "EHV-AC, HVDC Transmission and Distribution Engineering", S.K. Kataria & Sons, 2013

REFERENCES:

1. Subir Ray, "An Introduction to High Voltage Engineering", Prentice Hall of India Private Limited, 2013
2. RD Begamudre, "Extra High Voltage AC Transmission Engineering", New Academic Science Limited, 4th edition, 2011
3. Narain G. Hingorani and Laszlo Gyugyi, "Understanding FACTS Concepts and Technology of Flexible AC Transmission Systems", John Willey and Sons, 2000

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP08	SMART GRID TECHNOLOGIES	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge on smart grid infrastructure and its composition
- To understand the operation of converters and energy storage systems for smart grid
- To apply the computational techniques for optimizing the smart grid

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Interpret the knowledge on smart power grids and its issues (Understand)

CO2: Outline the communication standard and measurement technologies (Understand)

CO3: Apply the optimization and computational intelligence techniques for smart grid design (Apply)

CO4: Illustrate the power electronic converters and energy storage systems (Understand)

CO5: Identify the issues in renewable energy integration and solve the problem using test bench (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	-	-	-	1	-	2
CO2	2	2	-	-	-	-	-	-	-	-	-	1	-	2
CO3	3	2	2	1	2	-	-	-	-	-	-	1	-	2
CO4	2	2	1	1	1	-	-	-	-	-	-	1	-	2
CO5	3	2	2	1	2	-	-	-	-	-	-	1	-	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)		

SYLLABUS:

UNIT I SMART POWER GRID 9

Grid challenges – Evolution – Characteristics and benefits of smart grid – Vision and roadmap for India – Examples of smart grid projects in India, US and Europe effort – Comparison of microgrid and smart grid – Cyber controlled smart power grids - Consumer versus prosumer

UNIT II COMMUNICATION AND MEASUREMENT 9

Functions of smart grid components – Communication and measurement – Monitoring, PMU and smart meters – Demand side integration – Synchrophasor measurement – IEEE Standards, Multi agent systems technology

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UNIT III COMPUTATIONAL TOOLS 9

Decision support tools – Optimization techniques – Heuristic optimization – Evolutionary computational techniques – Adaptive Dynamic Programming (ADP) techniques – Load flow for smart grid design – Hybridizing optimization techniques

UNIT IV POWER ELECTRONICS AND ENERGY STORAGE SYSTEMS 9

Current source and voltage source converters – Shunt and series compensators with energy storage – Energy storage technologies: Batteries, flow battery, fuel cell, flywheels, superconducting magnetic energy storage systems, super capacitors and energy storage for wind power

UNIT V CASE STUDIES AND TESTBEDS 9

Demonstration projects – Advanced metering – Microgrid with renewable energy – ADP for optimal network reconfiguration in distribution automation – Case study of renewable energy integration – Testbeds and benchmark systems – Challenges and benefits of smart transmission

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Salman K. Salman, "Introduction to the Smart Grid Concepts, Technologies and Evolution", The Institution of Engineering and Technology, 2017
2. James Momoh, "Smart Grid - Fundamentals of Design and Analysis", IEEE Press, John Wiley and Sons, 2012

REFERENCES:

1. Takuro Sato, Daniel M. Kammen, Bin Duan, Muhammad Tariq, Zhenyu Zhou, Jun Wu and Solomon Abebe Asfaw, "Smart Grid Standards - Specifications, Requirements, and Technologies", John Willey and Sons, 2015
2. Stuart Borlase, "Smart Grids Advanced Technologies and Solutions", CRC Press, 2nd Edition, 2018
3. Ali Keyhani, "Design of Smart Power Grid Renewable Energy Systems", John Willey and Sons, 3rd Edition, 2019

EVALUATION PATTERN:*

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP09	ADVANCED SEMICONDUCTOR DEVICES	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- NIL

COURSE OBJECTIVES:

- To understand the concepts of advanced power semiconductor switches and characteristics
- To learn the working, steady state and switching characteristics of current controlled and voltage-controlled silicon devices
- To understand the purpose of the gate driver and various protection circuits

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify suitable device for the power application. (Understand)

CO2: Interpret the advantages of Silicon Carbide and Gallium Nitride devices (Understand)

CO3: Understand the principles and characteristics of Silicon, Silicon Carbide and Gallium Nitride devices (Understand)

CO4: Design proper driving circuits and protection circuits (Apply)

CO5: Select a proper thermal protective device for power semiconductor devices (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	1	-	-	-	-	-	-	-	1	2	-
CO2	3	2	-	1	-	-	-	-	-	-	-	1	2	-
CO3	3	2	-	1	-	-	-	-	-	-	-	1	2	-
CO4	3	2	-	1	-	-	-	-	-	-	-	1	2	-
CO5	3	2	-	1	-	-	-	-	-	-	-	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I POWER SEMICONDUCTOR DEVICES **9**

Power switching devices overview – Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability – (SOA); Power diodes - Types, steady state and switching characteristics – rating. Silicon Carbide: Features, Demonstration and Physical Properties - Unipolar and Bipolar Diodes- GaN Technology Overview.

UNIT II CURRENT CONTROLLED DEVICES **9**

Power BJT's – Construction, static and switching characteristics; Negative temperature coefficient and second breakdown; Thyristors: Construction, working, static and transient characteristics, types, series and parallel operation – comparison of BJT and Thyristor – GTO: Construction, static and switching characteristics – Applications - GaN Transistor -Electrical Characteristics

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UNIT III VOLTAGE CONTROLLED DEVICES 9

Principle of voltage controlled devices – Power MOSFETs, IGBTs and IGCT – construction, operation, types, static and switching characteristics– Intelligent power modules- study of modules like APTGT100TL170G, MSCSM70TAM05TPAG. Integrated gate commutated thyristor (IGCT) – Applications

UNIT IV DEVICE SELECTION, DRIVING AND PROTECTING CIRCUITS 9

Device selection strategy – On-state and switching losses – EMI due to switching. Necessity of isolation, pulse transformer, optocoupler – Gate drive integrated circuit: Study of Driver IC – SCR, MOSFET, IGBTs and base driving for power BJT. - Over voltage, over current and gate protections; Design of snubber circuit

UNIT V THERMAL PROTECTION 9

Heat transfer – conduction, convection and radiation; Cooling – liquid cooling, vapors – phase cooling; Guidance for heat sink selection – heat sink types and design – Mounting types –Thermal resistance and impedance – Electrical analogy of thermal components – Switching loss calculation for power device

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Rashid M.H., " Power Electronics Circuits, Devices and Applications ", Pearson, 4th edition, 10th Impression 2021.
2. Ned Mohan, T.M.Undeland and W.P.Robbins, "Power Electronics: converters, Application and design", 3rd edition Wiley, 2007

REFERENCES:

1. Sunenobu Kimoto and James A. Cooper, Fundamentals of Silicon Carbide Technology: Growth, Characterization, Devices, and Applications, 1st edition., 2014 John Wiley & Sons Singapore Pvt Ltd.
2. Alex Lidow, Johan Strydom, Michael de Rooij, David Reusch, GaN Transistors for Efficient Power Conversion, 2nd edition, Wiley, 2015
3. Biswanath Paul, Power Electronics, Universities Press 2019

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP10	SMPS AND UPS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- NIL

COURSE OBJECTIVES:

- To understand the concepts of switching regulators and SMPS converters.
- To understand the concepts of resonant converters and PWM techniques for inverter circuits
- To acquire knowledge on UPS and filters

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Infer the state space model of DC – DC converters (Understand)

CO2: Interpret the operation of switched mode power converters (Understand)

CO3: Describe the importance of resonant converters (Understand)

CO4: Apply the PWM techniques for DC-AC converters (Apply)

CO5: Summarize the operation of UPS and filters (Understand)

CO-PO MAPPING:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	1	1	-	-	-	-	1	2	-
CO2	3	3	2	2	-	1	1	-	-	-	-	1	2	-
CO3	3	3	2	2	-	1	1	-	-	-	-	1	2	-
CO4	3	3	2	2	-	1	1	-	-	-	-	1	2	-
CO5	3	3	2	2	-	1	1	-	-	-	-	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I DC-DC CONVERTERS **9**

Principles of step down and step up converters – Analysis and state space modeling of Buck, Boost, Buck- Boost and Cuk converters

UNIT II SWITCHED MODE POWER CONVERTERS **9**

Analysis of fly back, forward, push pull, Luo, half bridge and full bridge converters - Control circuits and PWM techniques

UNIT III RESONANT CONVERTERS **9**

Resonant switch- Load resonant converters - ZVS, Clamped voltage topologies - DC link inverters with Zero Voltage Switching – ZCS – Series and parallel Resonant inverters - Applications

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UNIT IV DC-AC CONVERTERS 9

Single phase and three phase inverters, Voltage control – Sine PWM, SVPWM and PSPWM techniques – Harmonic elimination techniques - Multilevel inverters - Types: Diode clamped, Flying capacitor and Cascaded – Applications

UNIT V UPS AND FILTERS 9

Power line disturbances - Power conditioners – UPS: offline UPS, Online UPS, Applications – Filters: Voltage filters, Series-parallel resonant filters, filter without series capacitors, filter for PWM VSI, current filter, DC filters

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Simon Ang, Alejandro Oliva," Power-Switching Converters", 3rd edition, CRC Press, 2010
2. Kjeld Thorborg, "Power Electronics – In theory and Practice", Overseas Press, 1st Indian edition, 2005

REFERENCES:

1. Erickson, Robert W, "Fundamentals of Power Electronics", Springer, 2nd edition, 2010
2. M.H. Rashid, "Power Electronics circuits, devices and applications" 3rd edition, Prentice Hall of India, New Delhi, 2007
3. P.S.Bimbra, "Power Electronics", Khanna Publishers, 11th edition, 2003
4. https://archive.nptel.ac.in/courses/108/108/108108036/

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP11	ELECTRICAL MACHINE DESIGN	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- NIL

COURSE OBJECTIVES:

- To interpret the overall dimensions of DC machines and transformers
- To design stator and rotor of induction and synchronous machine
- To evaluate the design problems of special machines

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Evaluate the operating characteristics of DC machines (Apply)

CO2: Estimate the single phase and three phase transformer design (Apply)

CO3: Design stator and rotor circuits of induction motor (Apply)

CO4: Formulate the output equation of synchronous machine (Apply)

CO5: Simulate the special machines design circuits (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	1	1	-	-	-	-	1	2	-
CO2	3	3	2	2	-	1	1	-	-	-	-	1	2	-
CO3	3	3	2	2	-	1	1	-	-	-	-	1	2	-
CO4	3	3	2	2	-	1	1	-	-	-	-	1	2	-
CO5	3	3	2	2	-	1	1	-	-	-	-	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I DESIGN OF DC MACHINES 9

Construction - Output Equations – Main dimensions – Choice of specific loadings – Selection of number of poles – Design of armature – Design of commutator and brushes – Evaluation of operating characteristics from design data

UNIT II DESIGN OF TRANSFORMERS 9

Types of transformer - KVA output for single and three phase transformers – Overall dimensions – design of yoke, core and winding for core and shell type transformers – Estimation of no load current – Temperature rise in transformers – Design of tank and cooling tubes of transformers

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UNIT III DESIGN OF INDUCTION MACHINES 9

Construction - Output equation – Main dimensions – Design of squirrel cage rotor and wound rotor – Magnetic leakage calculations – Operating characteristics: Magnetizing current - Short circuit current – Circle diagram

UNIT IV DESIGN OF SYNCHRONOUS MACHINES 9

Output equations – Choice of specific loadings – Design of salient pole machines – Short circuit ratio – Armature design – Estimation of air gap length – Design of rotor – Design of damper winding – Determination of full load field MMF – Design of field winding – Design of turbo alternators

UNIT V DESIGN OF SPECIAL MACHINES 9

Constructional features: BLDC & PMBLDC motors, PMSM and SRM – Output equation – Main Dimensions – Design of BLDC and permanent magnet brushless DC motor – Design of switched reluctance motor – Design of permanent magnet synchronous motor - Application based control designing and simulation

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Sawhney A.K., "A Course in Electrical Machine Design", Dhanpat Rai & Sons, New Delhi, 1984
2. Deshpande M.V., "Design and Testing of Electrical Machine Design" Wheeler Publications, 2010
3. Sen S.K., "Principles of Electrical Machine Designs with Computer Programmes", Oxford and IBH Publishing Co.Pvt.Ltd, New Delhi, 1987

REFERENCES:

1. M.G.Say, "Performance and Design of Alternating Current Machines" 3rd edition, CBS Publishers, 2002
2. A.Shanmuga Sundaram, G.Gangadharan, R.Palani 'Electrical Machine Design Data Book', New Age International Pvt. Ltd., Reprint, 2007.
3. R.K.Agarwal " Principles of Electrical Machine Design" Esskay Publications, Delhi, 2002.

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP12	HVDC TRANSMISSION	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- NIL

COURSE OBJECTIVES:

- To acquire knowledge on DC power transmission and HVDC converters
- To understand the control of HVDC system and harmonic reduction
- To gain knowledge on the power flow in HVDC system under steady state

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the principles and types of DC transmission systems (Understand)

CO2: Illustrate the concept of HVDC converters (Understand)

CO3: Interpret the control of HVDC systems (Understand)

CO4: Infer the concepts of reactive power management and harmonic control (Understand)

CO5: Interpret the importance of power flow analysis in HVDC system (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	1	-	-	-	-	1	-	2
CO2	3	2	1	-	-	-	1	-	-	-	-	1	2	-
CO3	3	2	1	-	-	-	1	-	-	-	-	1	2	-
CO4	3	2	1	-	-	-	1	-	-	-	-	1	2	-
CO5	3	2	1	-	-	-	1	-	-	-	-	1	-	2

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I DC POWER TRANSMISSION TECHNOLOGY 9

Comparison of AC and DC transmission – DC transmission – Applications and Description – Planning for HVDC transmission – Modern trends in HVDC technology – Types and applications of Multi Terminal DC (MTDC) systems.

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UNIT II HVDC CONVERTERS 9

Line commutated converter – Analysis of Graetz circuit with and without overlap – Pulse number – Choice of converter configuration – Converter bridge characteristics – Analysis of 12 pulse converters – Analysis of VSC topologies and firing schemes.

UNIT III CONTROL OF HVDC SYSTEMS 9

Principles of DC link control – Converter control characteristics – System control hierarchy – Firing angle control – Current and extinction angle control – Starting and stopping of DC link – Power control – Higher level controllers – Control of VSC based HVDC link.

UNIT IV REACTIVE POWER AND HARMONIC CONTROL 9

Reactive power requirements in steady state – Sources of reactive power – SVC and STATCOM – Generation of harmonics – Design of AC and DC filters – Active filters.

UNIT V POWER FLOW ANALYSIS 9

Per unit system for DC quantities – DC system model – Inclusion of constraints – Power flow analysis – Case study.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. K. R. Padiyar, "HVDC Power Transmission System", New Academic Science Limited, New Delhi, 2nd edition, 2017
2. S. Kamakshaiah and V. Kamaraju, "HVDC Transmission", McGraw-Hill Education Private Limited, 2nd edition, 2020

REFERENCES:

1. Dragan Jovcic, "High Voltage Direct Current Transmission: Converters, Systems and DC Grids", John Wiley and Sons, 2nd edition, 2019
2. Chan-Ki Kim, Vijay K. Sood, "HVDC Transmission: Power Conversion Application in Power Systems", John Wiley and Sons, 2009

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

. *Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP13	ADVANCED ELECTRIC MOTORS AND CONTROL	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- NIL

COURSE OBJECTIVES:

- To acquire the knowledge on selection of suitable special machine drive based on the application
- To understand the working of different drives and its controls
- To apply the appropriate control scheme for the specified application

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Interpret the operation of synchronous reluctance motor (Understand)

CO2: Interpret the characteristics and operations of permanent magnet synchronous motor (Understand)

CO3: Summarize the control methods of switched reluctant motor (Understand)

CO4: Explain the concept of BLDC motor and energy efficiency standard (Understand)

CO5: Describe the axial flux topology and control methods (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	1	2	-
CO2	3	3	-	-	-	-	-	-	-	-	-	1	2	-
CO3	3	3	-	-	1	-	-	-	-	-	-	1	2	-
CO4	3	3	-	-	-	-	-	-	-	-	-	1	2	-
CO5	3	3	-	-	1	-	-	-	-	-	-	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I SYNCHRONOUS RELUCTANCE MOTOR 9

Constructional features – Principle of operation – Characteristics – Open loop and closed loop control – Microprocessor based control – Sensor less control – Applications

UNIT II PERMANENT MAGNET SYNCHRONOUS MOTOR 9

Construction – Principle of operation – EMF, power input and torque expressions – Power controllers – Torque speed characteristics – Self-control – Vector control – Current control schemes – Sensor less control

UNIT III SWITCHED RELUCTANCE MOTOR 9

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Constructional features – Modes of excitation – Torque prediction – Characteristics – Steady state performance prediction – Power controllers – Control of SRM drive – Sensor less operation of SRM

UNIT IV BLDC MOTOR 9

PMBLDC: Constructional features – Types – Principle of operation – Drive schemes – Converter topologies – Characteristics

UNIT V AXIAL FLUX MOTOR AND ENERGY EFFICIENCY STANDARD 9

Axial Flux motor – types of axial flux motor – Principle of operation – AFPM control method – Characteristics of PM materials – Control of trapezoidal AFPM – Solid state converter – Standard motor efficiency – Efficiency evaluation technique – Motor efficiency labelling

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Vedam Subramanyam, "Electric Drives - Concepts and Applications", 2nd edition, McGraw Hill, 2010
2. Jacek F. Gieras Rong-Jie Wang Maarten J. Kamper., "Axial Flux Permanent Magnet Brushless Machines",2nd edition, Springer, 2008

REFERENCES:

1. Diane Lobsiger ., "Electrical Control for Machines" 7th edition Cengage Learning, 2015
2. Ned Mohan, "Advanced Electric Drives: Analysis, Control and Modeling using MATLAB / Simulink", Wiley, 2014
3. https://en.nanotec.com/knowledge-base/stepper-motor-animation

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP14	FLEXIBLE AC TRANSMISSION SYSTEMS	Category: PE				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- NIL

COURSE OBJECTIVES:

- To understand the reactive power control techniques
- To acquire knowledge on static VAR compensators and thyristor controlled series capacitors
- To understand STATCOM devices and advanced FACTS controllers

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the power flow control in power systems. (Understand)

CO2: Understand the role of SVC in power systems. (Understand)

CO3: Illustrate the operation of TCSC in power systems. (Understand)

CO4: Understand the working of STATCOM and stability issues in power systems. (Understand)

CO5: Interpret advanced FACTS controllers in power systems. (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	3	1	-	-	-	-	-	-	1	-	2
CO2	3	2	1	2	1	-	-	-	-	-	-	1	-	2
CO3	3	2	1	3	1	-	-	-	-	-	-	1	-	2
CO4	3	2	1	1	1	-	-	-	-	-	-	1	-	2
CO5	3	2	1	3	1	-	-	-	-	-	-	1	-	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

SYLLABUS:

UNIT I INTRODUCTION 9

Real and reactive power control in electrical power transmission lines – Load and system compensation – Uncompensated transmission line – Shunt and series compensation.

UNIT II STATIC VAR COMPESATOR (SVC) AND APPLICATIONS 9

Voltage control by SVC – Advantages of slope in dynamic characteristics – Influence of SVC on system voltage – Design of SVC voltage regulator – Modelling of SVC for power flow and fast transient stability

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UNIT III THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC) AND APPLICATIONS 9

Operation of TCSC – Different modes of operation – Modelling of TCSC – Variable reactance model – Modelling for power flow and stability studies – Applications: Improvement of the system stability limit – Enhancement of system damping.

UNIT IV VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS 9

Static Synchronous Compensator (STATCOM) – Principle of operation – V-I Characteristics – Applications: Steady state power transfer – Enhancement of transient stability – Prevention of voltage instability – SSSC – Operation of SSSC – Control of power flow - Dynamic voltage restorer (DVR).

UNIT V ADVANCED FACTS CONTROLLERS 9

Interline DVR (IDVR) – Unified Power flow controller (UPFC) – Interline power flow controller (IPFC) – Unified power quality conditioner (UPQC).

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Joe H. Chow, Juan J. Sanchez-Gasca, "Power System Modeling, Computation, and Control", Jon Wiley & Sons Ltd., 2020.
2. K.R.Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International(P) Limited, Publishers, New Delhi, 3rd edition, 2021

REFERENCES:

1. V.K.Sood, HVDC and FACTS controllers – Applications of Static Converters in Power System, APRIL 2004 , Kluwer Academic Publishers, 2004.
2. Xiao – Ping Zang, Christian Rehtanz and Bikash Pal, "Flexible AC Transmission System: Modelling and Control" Springer, 2012.

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP15	ANALYSIS OF INVERTERS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- NIL

COURSE OBJECTIVES:

- To understand the concept of single phase and three phase inverters
- To implement the suitable inverters for various applications
- To identify the modern methodologies in the design of Inverters

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the operation of single phase bridge inverters (Understand)

CO2: Classify the modulation techniques for three phase inverters (Understand)

CO3: Select suitable current source inverter for a specific application (Apply)

CO4: Choose the suitable multilevel inverter for a specific load (Apply)

CO5: Summarize the performance characteristics of resonant inverters (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	1	1	-	-	-	-	1	3	-
CO2	3	3	2	2	-	1	1	-	-	-	-	1	3	-
CO3	3	3	2	2	-	1	1	-	-	-	-	1	3	-
CO4	3	3	2	2	-	1	1	-	-	-	-	1	3	-
CO5	3	3	2	2	-	1	1	-	-	-	-	1	3	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I SINGLE PHASE INVERTERS 9

Principle of operation of half and full bridge inverters – Performance parameters – Voltage control of single phase inverters using various PWM techniques – Harmonic elimination techniques – Forced commutated Thyristor inverters

UNIT II THREE PHASE VOLTAGE SOURCE INVERTERS 9

180 degree and 120 degree mode inverters with star and delta connected loads – Voltage control of three phase inverters: single pulse, multi pulse, sinusoidal, space vector modulation techniques

UNIT III CURRENT SOURCE INVERTERS 9

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Operation of six-step thyristor inverter – Operating modes – Load commutated inverters – Auto sequential current source inverter (ASCI) – Current pulsations – Comparison of current source and voltage source inverters

UNIT IV MULTILEVEL INVERTERS **9**

Multilevel concept – Diode clamped – Flying capacitor – Cascade type multilevel inverters - Comparison of multilevel inverters - Application of multilevel inverters

UNIT V RESONANT INVERTERS **9**

Series and parallel resonant inverters - Voltage control of resonant inverters – Class E resonant inverter – Resonant DC link inverters

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Rashid M.H., "Power Electronics Circuits, Devices and Applications", Prentice Hall India, 3rd edition, New Delhi, 2004
2. Jai P. Agrawal, "Power Electronics Systems", Pearson Education, Second Edition, 2002

REFERENCES:

1. Reissland, M.U, "Electrical Measurements: Fundamentals, Concepts, Applications" 1st edition, New Age International (P) Ltd., 2010
2. Bimal K.Bose "Modern Power Electronics and AC Drives", Pearson Education, 2nd edition, 2003
3. P.S.Bimbra, "Power Electronics", Khanna Publishers, 11th edition, 2003
4. https://nptel.ac.in/courses/108102157

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP16	SIMULATION OF POWER CONVERTERS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- NIL

COURSE OBJECTIVES:

- To impart the knowledge on semiconductor switching devices and its performance
- To design and simulate the different types of converts circuits
- To analyze the performance parameters of AC/DC converters

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Examine the switching devices characteristics in simulation tool (Apply)

CO2: Analyze the single phase and three phase converter with different load (Apply)

CO3: Analyze the 120^0 and 180^0 mode operation of inverter in simulation tool (Apply)

CO4: Analyze the different configuration of DC-DC converter in simulation tool (Apply)

CO5: Simulate the AC voltage regulator and cycle converter in simulation tool (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	3	-	-	1	-	-	-	1	2	-
CO2	3	2	1	1	3	-	-	1	-	-	-	1	2	-
CO3	3	2	1	1	3	-	-	1	-	-	-	1	2	-
CO4	3	2	1	1	3	-	-	1	-	-	-	1	2	-
CO5	3	2	1	1	3	-	-	1	-	-	-	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I INTERACTIVE MODELLING 9

Introduction – M-File function – Debugging M-Files – Simulink library browser – Simscape – Circuit elements – DC and AC analysis – Steady state analysis of a linear circuit – Example: RLC, Diode, SCR, MOSFET, IGBT

UNIT II AC TO DC CONVERTER 9

Simulation : single and three phase full wave bridge rectifier using Diode and SCR – R and RLE load analysis – Switching technique using FLC

UNIT III DC TO AC CONVERTER 9

Simulation, Voltage analysis, THD analysis : Three phase 180 degree mode and 120 degree mode Inverter – PWM generation using M.File – Soft switching techniques

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UNIT IV DC TO DC CONVERTER 9

Simulation – Buck converter analysis in CCM and DCM – Boost converter analysis in CCM and DCM – Buck Boost converter analysis in CCM and DCM – SEPIC converter – Luo converter – Switching techniques using soft computing

UNIT V AC TO AC CONVERTER 9

Simulation of three phase three wire AC voltage regulator with star and delta connected load –Single phase and three cyclo converter – Simulation of FLC based cyclo converter

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Narayanaswamy P R Iyer, "Power Electronic converters interactive modelling using Simulink", CRC Press, 2018.
2. L.Ashok kumar, A.kalaiarasi, Y.Uma Maheswari, "Power Electronics with MATLAB", Cambridge University Press, 2018.

REFERENCES:

1. Muhammad H. Rashid, "Power Electronics Devices, Circuits and Applications", 4th edition, Peasrson, 2017.
2. https://in.mathworks.com/solutions/power-electronics-control.html

EVALUATION PATTERN:

Continuous Internal Assessments				Total Internal Assessments	End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)			
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP17	BATTERY MANAGEMENT SYSTEMS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge on energy system in electric vehicles
- To understand the basics of battery management
- To apply the concepts in effective energy management

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Infer the working of various battery technologies (Understand)

CO2: Illustrate the function of battery management system (Understand)

CO3: Summarize the battery state of charge and health estimation (Understand)

CO4: Infer the electric vehicle model using software tool (Apply)

CO5: Interpret the design of BMS using software tool (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	2	-
CO2	3	2	1	-	-	-	-	-	-	-	-	1	2	-
CO3	3	2	1	-	-	-	-	-	-	-	-	1	2	-
CO4	3	2	1	-	1	-	-	-	-	-	-	1	2	-
CO5	3	2	1	-	1	-	-	-	-	-	-	1	2	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

UNIT I BASIC CONCEPTS OF BMS 9

introduction to Battery Management System – Cells & amp – Batteries – Nominal voltage and capacity – C rate – Energy and power – Cells in series – Cells in parallel – Electrochemical and lithium-ion cells – Flow Battery – Rechargeable cell

UNIT II BATTERY MANAGEMENT SYSTEM 9

BMS functionality – Sensing unit – High-voltage contactor control – Isolation sensing and thermal control – Protection and interface – Energy and power estimation

UNIT III SENSING AND CONTROL OF BATTERY MANAGEMENT SYSTEM 9

Battery state of charge estimation (SOC) – Voltage-based method – Model-based state estimation – Battery Health Estimation – Lithium-ion aging: Negative electrode – Positive electrode – Cell balancing – Causes of imbalance – Circuits for balancing

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UNIT IV MODELLING AND SIMULATION 9

Equivalent-circuit models (ECMs) – Physics-based models (PBMs) – Empirical modelling approach – Physics-based modelling approach – Vehicle range calculations – Simulation of battery packs

UNIT V DESIGN PRINCIPLES OF BMS 9

Design principles – Effect of distance – Load and force on battery life – Energy balancing with multi-battery system

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Mehrdad Ehsani, Yimin Gao, Sebastein E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles – Fundamental, Theory and Design", 1st edition, CRC Publication, 2005
2. Shedon S. Williamson, "Energy Management Strategies for Electric and Plugin Hybrid Electric Vehicles", 1st edition, Springer, 2013

REFERENCES:

1. Plett, Gregory L. Battery management systems, Volume I: Battery modeling. Artech House, 2015.
2. Plett, Gregory L. Battery management systems, Volume II: Equivalent-circuit methods. Artech House, 2015.
3. Davide Andrea," Battery Management Systems for Large Lithium-ion Battery Packs" Artech House, 2010

EVALUATION PATTERN:

<table>
<tr><td colspan="4">Continuous Internal Assessments</td><td rowspan="2">Total Internal Assessments</td><td rowspan="3">End Semester Examinations</td></tr>
<tr><td colspan="2">Assessment I (100 Marks)</td><td colspan="2">Assessment II (100 Marks)</td></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td></td></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>200</td><td>100</td></tr>
<tr><td colspan="4" rowspan="2">Total</td><td>40</td><td>60</td></tr>
<tr><td colspan="2">100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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KPRIET

U21EEP18	ELECTRIC VEHICLES AND DYNAMICS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire knowledge on structure and requirements of electric vehicles
- To understand the operation and characteristics of electric vehicles
- To apply the concepts of longitudinal and adaptive cruise control

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Interpret the characteristics and performance of conventional vehicles (Understand)

CO2: Infer the mechanics of electric vehicles (Understand)

CO3: Classify the components of electric vehicles (Understand)

CO4: Explain the concepts of longitudinal motion of the vehicle (Understand)

CO5: Describe the adaptive cruise control mechanism of vehicle (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	2	-
CO2	3	2	1	-	-	-	-	-	-	-	-	1	2	-
CO3	3	2	1	-	-	-	-	-	-	-	-	1	2	-
CO4	3	2	1	-	-	-	-	-	-	-	-	1	2	-
CO5	3	2	1	-	-	-	-	-	-	-	-	1	2	-

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I CONVENTIONAL VEHICLES **9**

Overview – Basics of vehicle performance – Vehicle power source characterization – Transmission characteristics and mathematical models

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UNIT II MECHANICS OF ELECTRIC VEHICLES 9

Fundamentals of vehicle mechanics – Tractive force, power and energy requirements for standard drive cycles of HEVs – Motor torque, Power rating and battery capacity – Power train components and sizing, gears, clutches, transmission and brakes

UNIT III ELECTRIC VEHICLE DRIVE TRAIN 9

Transmission configuration – Components: gears, clutch, brakes, regenerative braking, motor sizing Basic concept of electric traction – Various drive train topologies – Power flow control – Fuel efficiency analysis

UNIT IV DYNAMIC PERFORMANCE OF VEHICLE 9

Dynamic axle loads – Equations of motion – Vehicle performance – Power limited and traction limited acceleration – Braking performance – Brake proportioning – Braking efficiency

UNIT V ADAPTIVE CRUISE CONTROL 9

Introduction – Control architecture – String stability – Autonomous control with constant spacing and time- gap policy – Transitional trajectories – Cruise control – Upper and lower-level cruise control

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Iqbal Hussain, "Electric and Hybrid Vehicles-Design Fundamentals", 2nd edition, CRC Press, 2011
2. Mehrdad Ehsani, Yimin Gao and Ali Emadi, "Modern Electric, Hybrid and Fuel Cell Vehicles: Fundamentals" 5th edition, Prentice Hall India, 2010

REFERENCES:

1. Rajesh Rajamani., "Vehicle Dynamics and Control", 2nd edition, Springer, 2012
2. Davide Andrea, "Battery Management Systems for Large Lithium - Ion Battery Packs", Artech House, 2010
3. Hui Zhang, Dongpu Cao and Haiping Du, "Modeling, Dynamics and Control of Electrified Vehicles", Elsevier Science, 2017

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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KPRIET

U21EEP19	EV STANDARDS AND TESTING	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge on standards of EV, battery and charging systems
- To understand the concepts of wind tunnel, body and wheel of EV
- To apply the testing methods of energy and fuel consumption of EV

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the standards of electric vehicle (Understand)

CO2: Interpret the standards of traction battery and charger (Understand)

CO3: Interpret the various EV standards (Understand)

CO4: Infer the methodologies for energy and fuel consumption testing (Understand)

CO5: Summarize the various government policies (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	2	2	-
CO2	3	2	-	-	-	-	-	-	-	-	-	2	2	-
CO3	3	2	-	-	-	2	-	-	-	-	-	2	2	-
CO4	3	2	-	-	-	2	-	-	-	-	-	2	2	-
CO5	3	2	-	-	-	2	-	-	-	-	-	2	2	-
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)				3: Substantial (High)							

SYLLABUS:

UNIT I EV STANDARDS 9

Electric power train vehicles – Construction and functional safety requirements – Measurement of electrical energy consumption – Measurement of range – Measurement of net power and maximum 30-minute power – Central Motor Vehicle Rules (CMVR) type approval for electric power train vehicles

UNIT II BATTERY TRACTION AND CHARGING STANDARDS 9

Battery operated vehicles – Safety requirements of traction batteries – Charger standards – Electric vehicle conductive AC and DC charging system – Public EV charging standards – Charging for high voltage EVs – Home charging standards

UNIT III EV REGULATIONS 9

EV ecosystem – Vehicle safety standard : AIS 038 – Battery safety standard : AIS 408 – M & N category standard : AIS 038 – L category standard : AIS156

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UNIT IV VEHICLE TESTING 9

Energy consumption by engine cooling fan, air conditioning and brake compressors – Hydraulic pumps power consumption, ABS energy consumption – Test route selection – Vehicle speed test – Cargo, weight and driver selection – Tested data, findings and calculations – Test on rough terrain – Pot hole with laden and unladen conditions

UNIT V GOVERNMENT POLICIES 9

National Electric Mobility Mission Plan 2020 (NEMMP2020) – Faster Adoption and Manufacture of Hybrid and Electric Vehicles – FAME, Niti Aayog Report on Transforming Mobility

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. John G. Hayes and G. Abas Goodarzi, "Electric Power Train: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles", Wiley, 2018
2. Course W.H. and Anglin D.L., "Automotive Mechanics", TMG publishing company, 2017

REFERENCES:

1. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals", 2nd edition, CRC press, 2010
2. Automotive Handbook, Bosch - Website: www.mainindia.com/Draft, AIS standards.asp
3. DHI Centre of Excellence for E-Mobility, Standards - Website: https://emobility.araiindia.com/standards.

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP20	HYBRID ELECTRIC VEHICLES	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the fundamental knowledge of hybrid electric vehicles
- To understand the operational behaviour of various components of hybrid electric vehicle
- To apply the concept for modelling of hybrid electric vehicles

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the fundamentals and characteristics of traction system in vehicle (Understand)

CO2: Interpret the various architectures of hybrid electric vehicle with their control strategies (Understand)

CO3: Describe the operation and control of propulsion system (Understand)

CO4: Explain the energy management system in HEV (Understand)

CO5: Infer the various test for hybrid electric vehicles (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO3	3	2	1	-	-	-	-	-	-	-	-	1	2	-
CO4	3	2	-	1	-	-	-	-	-	-	-	1	2	-
CO5	3	2	1	1	1	-	-	-	-	-	-	1	2	-

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I FUNDAMENTALS OF VEHICLES 9

Vehicle movement – Vehicle resistance – Dynamic equation – Power train tractive effort and vehicle speed – Characteristics: vehicle power plant and transmission – Vehicle performance

UNIT II ARCHITECTURES HYBRID ELECTRIC VEHICLE 9

Classification of HEV – Concept of hybrid electric drive trains – Architectures of HEV's drive train – Operation pattern – Control strategies

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UNIT III ELECTRIC PROPULSION SYSTEM 9

Induction Motor: Voltage/frequency control, field-oriented control – Permanent Magnet Brushless DC Motor: Sensor less techniques – Sensor controlled techniques – Switched Reluctance Motor drive: Sensor less Control

UNIT IV HEV MODELLING 9

Modelling for energy analysis – Vehicle level energy analysis: equations of motions, vehicle energy balance, driving cycles – Power train components

UNIT V TEST FOR HYBRID ELECTRIC VEHICLES 9

Hybrid Electric Vehicle Test (M and N category), Test for Hybrid Electric System Intended for Retro-fitment on Vehicles of M and N Category (GVW < 3500 kg)

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Mehrdad Ehsani, Yimin Gao, Sebastein E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles - Fundamental, Theory and Design", 1st edition, CRC Publication, 2005
2. Chris Mi and Abul Masrur M., "Hybrid Electric Vehicle Principles and Applications with Practical Perspectives", 1st edition, Wiley and Sons, 2018

REFERENCES:

1. Simona Onori, Lorenzo Serrao and Giorgio Rizzoni, "Hybrid Electric Vehicles - Energy Management Strategies", 1st edition, Springer, 2016
2. R. Krishnan, "Electric Motor Drives Modeling, Analysis and Control", 1st edition, Prentice Hall, 2001
3. Narayanaswamy P. and Iyer R., "Power Electronic Converters Interactive Modelling using Simulink", CRC Press, 2018

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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KPRIET

U21EEP21	ELECTRIC VEHICLES IN SMART GRID	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge in vehicle electrification and impact of charging strategies
- To understand the concept of influence of EVs on power system
- To apply the frequency control and voltage reserve from EVs

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Interpret the grid connected electric vehicle charging technology (Understand)

CO2: Infer the influence of EVs on power system (Understand)

CO3: Exemplify the frequency control and voltage support from EV (Understand)

CO4: Infer the ICT solution in EV charging and communication technology (Understand)

CO5: Explain the EV charging plan with micro grid (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO3	3	2	2	-	-	-	-	-	-	-	-	-	2	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I IMPACT OF CHARGING SYSTEM 9

EV charging options and infrastructure – Impact of charging strategies – Energy, economic and environmental considerations – Effect of EV charging on generation and load profile – Smart charging technologies – Impact on investment

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UNIT II INFLUENCE OF EVS ON POWER SYSTEM 9

Identification of EV demand – EV penetration level for different scenarios – Classification based on penetration level – EV impacts on system demand: dumb charging, multiple tariff charging, smart charging

UNIT III FREQUENCY CONTROL RESERVES & VOLTAGE SUPPORT FROM EVS 9

Power system ancillary services – Electric vehicles to support wind power integration – Electric vehicle as frequency control reserves and tertiary reserves – Voltage support and electric vehicle integration – Properties of frequency regulation reserves – Control strategies for EVs to support frequency regulation

UNIT IV ICT SOLUTIONS TO SUPPORT EV DEPLOYMENT 9

Architecture and model of smart grid – ICT role in smart grid – Smart metering, information and communication models – Functional and logical models – Technology and solution for smart grid: interoperability – Communication technologies

UNIT V EV CHARGING FACILITY PLANNING 9

Energy generation scheduling – Different power sources – Fluctuant electricity – Centralized charging schemes – Decentralized charging schemes – Energy storage integration into Microgrid – Design of V2G Aggregator

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Sumedha Rajakaruna, Farhad Shahnia, Arindam Ghosh, "Plug In Electric Vehicles in Smart Grids", 2nd edition Springer Nature, 2015.
2. Junwei Lu, Jahangir Hossain, "Vehicle-to-Grid: Linking electric vehicles to the smart grid", Institution of Engineering and Technology, 2015.

REFERENCES:

1. Wanrong Tang , Ying Jun (Angela) Zhang, " Optimal Charging Control of Electric Vehicles in Smart Grids ", Springer Nature, 2017.
2. Crouse W.H, Anglin D.L, "Automotive Transmission and Power Train construction", McGraw Hill, 2000.
3. Harald Naunheimer , Bernd Bertsche , Joachim Ryborz , Wolfgang Novak "Automotive Transmission: Fundamentals, Selection, Design and Application", 2nd Edition, Springer, 2011

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP22	AUTOMOTIVE TRANSMISSION	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

Nil

COURSE OBJECTIVES:

- To acquire the knowledge in the construction and principle of clutch and gearbox
- To understand the hydrodynamic and hydrostatic transmission systems
- To apply the concepts of automotive transmission systems

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Interpret the fundamentals of automotive transmission (Understand)

CO2: Infer the construction, working principle of clutch and gearbox (Understand)

CO3: Exemplify the construction, principle and performance characteristics of hydrodynamic transmission (Understand)

CO4: Interpret the principle, construction and performance characteristics of hydrostatic transmission (Understand)

CO5: Exemplify the automotive transmission principles to electric vehicles (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	2	-
CO2	3	2	1	-	-	-	-	-	-	-	1	1	2	-
CO3	3	2	1	-	-	-	-	-	-	-	1	1	2	-
CO4	3	2	1	-	-	-	-	-	-	-	1	1	2	-
CO5	3	2	2	-	-	-	-	-	-	-	1	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)							3: Substantial (High)			

SYLLABUS:

UNIT I FUNDAMENTALS OF TRANSMISSION 9

Tractive effort – Resistance to motion of a vehicle – Requirements – Classification – Single, two and four-wheel drive systems – Multi axle drives, chain, shaft and electric drives – Different transmissions in car, and transport vehicles

UNIT II CLUTCH AND GEAR BOX 9

Requirement of Transmission system – Different types of clutches: Principle – construction and operation of friction clutches – Performance of automobile – Tractive effort and acceleration – Determination of gear ratios – Three speed and four speed gear boxes

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UNIT III HYDRODYNAMIC TRANSMISSION 9

Fluid coupling – Principle and constructional details – Torque capacity – Performance characteristics – Reduction of drag torque in fluid coupling – Torque converter – Principle and constructional details – Performance characteristics – Multistage torque converters and polyphase torque converters

UNIT IV HYDROSTATIC TRANSMISSION 9

Principle, types, advantages, limitations – Comparison of hydrostatic drive with hydrodynamic drive – Construction and working of typical Janny hydrostatic drive – Performance Characteristics

UNIT V APPLICATIONS OF AUTOMOTIVE TRANSMISSION 9

Chevrolet turbo glide transmission – Four speed longitudinally mounted automatic transmission – Power glide transmission – Continuously Variable Transmission – Toyota "ECT-i" automatic transmission with intelligent electronic control system – Hydraulic actuation system, Electrified Transmission Technology for HEVs/PHEVs/EVs

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Devaradjane G. and Kumaresan M., "Automobile Engineering", AMK Publishers, 2013
2. Gill P.S., "Automobile Engineering", S K Kataria & Sons, 2014

REFERENCES:

1. Kirk T. Van Gelder, CDX Automotive, "Fundamentals of Automotive Technology: Principles and Practice", Jones & Bartlett Publishers, 2013
2. Chau, K. T., "Electric Vehicle Machines and Drives: Design, Analysis and Application", Wiley-IEEE, 2015
3. Heinz Heisler, "Advance Vehicle Technology", Butterworth-Heinemann, 2002

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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KPRIET LEARN BEYOND

U21EEP23	ENERGY STORAGE SYSTEMS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire knowledge about electric vehicle architecture and power train components
- To understand the concept of energy storage systems
- To apply IoT paradigms for EV applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Recognize various issues related to energy market, growth and its structural implications in India (Understand)

CO2: Infer the performance of different battery storage systems (Understand)

CO3: Explain different thermoelectric measurement techniques appropriately (Understand)

CO4: Interpret the applications of super capacitors for appropriate storage systems (Understand)

CO5: Understand and differentiate different types of fuel cells. (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	3	3	-	-	-	-	-	-	-	-	1	3	-
CO2	-	3	3	-	-	-	-	-	-	-	-	1	3	-
CO3	-	3	3	1	-	-	-	-	-	-	-	1	3	-
CO4	-	3	3	1	-	-	-	-	-	-	-	1	3	-
CO5	-	3	3	1	-	-	-	-	-	-	-	1	3	-

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I INTRODUCTION TO ENERGY STORAGE 9

Prospect for both traditional and renewable energy sources – Detailed analysis of Indian energy market and future need – Energy, economic growth and the environment – Implications of Kyoto Protocol – Structural change in electricity supply industry

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UNIT II STORAGE SYSTEMS 9

Batteries – Performance – charging and discharging – storage density – energy density and safety issues – classical batteries: Lead Acid – Nickel-Cadmium – Zinc Manganese dioxide and modern batteries – Zinc – Air – Nickel Hydride – Lithium Battery – Fuel cell – Fly wheel

UNIT III THERMOELECTRIC BATTERY 9

Thermoelectric –Eelectron conductor and phonon glass – Classical thermoelectric materials – Probe resistivity measurement – Seebeck coefficient measurement, and thermal conductivity measurement

UNIT IV SUPER CAPACITORS 9

Super capacitors – Types of electrodes and electrolytes – Electrode materials – High surface area activated carbons – Metal oxide – Conductive polymers – Electrolyte – Aqueous – Applications transport vehicles – private vehicles and consumer electronics – energy density – power density and market

UNIT V FUEL CELLS 9

Fuel cells – Direct energy conversion – Maximum intrinsic efficiency of an electrochemical converter, Physical interpretation – Carnot efficiency factor in electrochemical energy convertors – Types of fuel cells – Hydrogen oxygen cells – Hydrogen air cell – Aalkaline fuel cell – Phosphoric fuel cell

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Tetsuya Osaka, Madhav Datta, 'Energy Storage Systems in Electronics', Gordon and Breach,2000
2. A.G.Ter-Gazarian, "Energy Storage for Power Systems", Second Edition, The Institution of Engineering and Technology (IET) Publication, UK, 2011.

REFERENCES:

1. D.M. Rowe, 'Thermoelectrics Handbook: Macro to Nano', CRC Press, 2006
2. James M. Eyer, Joseph J. Iannucci and Garth P. Corey ", "Energy Storage Benefits and Market Analysis", Sandia National Laboratories, 2004.
3. Jim Eyer, Garth Corey", Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide, Report, Sandia National Laboratories, Feb 2010.

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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KPRIET
LEARN BEYOND

U21EEP24	IoT IN EV APPLICATIONS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge about electric vehicle architecture
- To understand the concept of impact of IoT in EV
- To apply IoT paradigms for EV applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Describe the basic concepts of IoT (Understand)

CO2: Summarize the drive-train topologies and propulsion techniques (Understand)

CO3: Explain the fundamentals of vehicle mechanics (Understand)

CO4: Understand hybrid energy storage methodologies (Understand)

CO5: Infer the various IoT applications (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	3	-
CO2	3	2	1	-	-	-	-	-	-	-	-	1	3	-
CO3	3	2	1	-	-	-	-	-	-	-	-	1	3	-
CO4	3	2	2	1	-	-	-	-	-	-	-	1	3	-
CO5	3	2	2	1	-	-	-	-	-	-	-	1	3	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I PHYSICAL DESIGN OF IoT 9

IoT System – Characteristics – Logical design – IoT protocols – IoT levels and deployment templates – Need for IoT system management – Network operator requirements – Differences and similarities between M2M and IoT

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UNIT II ELECTRIC VEHICLE ARCHITECTURE AND POWER TRAIN COMPONENTS 9

Evolution of Electric Vehicles – Impact of modern drive trains on energy supplies – Architecture of Electric vehicles and hybrid electric vehicles – Plug-in hybrid electric vehicles – Power train components and sizing, gears, clutches, transmission and brakes

UNIT III MECHANICS OF ELECTRIC VEHICLES 9

Fundamentals of vehicle mechanics – Tractive force, power and energy requirements for standard drive cycles of HEVs – Motor torque, Power rating and battery capacity – Range-extended electric vehicles: classification and configurations, fuel cell electric vehicles, solar electric vehicles, electric bi-cycles and their propulsion systems, vehicle-to-grid, vehicle-to-home concepts

UNIT IV ENERGY STORAGE SYSTEMS 9

Storage requirements – Battery – Fuel cell – Super Capacitor – Power pack management systems – Cell balancing techniques – Flywheel based energy storage and its analysis – Hybridization of different energy storage devices – Compressed air storage systems – Super conducting magnetic storage systems

UNIT V IoT APPLICATIONS 9

Case Study – Autonomous electric vehicles – Connected vehicles – Electric vehicle charging

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Ali Emadi, "Advanced Electric Drive Vehicles", CRC Press, Taylor & Francis Group, 2015
2. Husain I., "Electric and Hybrid Vehicles", Boca Raton, CRC Press, 2010

REFERENCES:

1. Sheldon S. Williamson, "Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles", Springer, 2013
2. Arshdeep Bahga and Vijay Madisetti, "Internet of Things - A Hands on Approach", Universities Press, 2015
3. Jack Erjave C. and Jeff Arias, "Alternate Fuel Technology - Electric, Hybrid and Fuel Cell Vehicles", Cengage, 2012

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP25	ARTIFICIAL INTELLIGENCE APPLICATIONS TO POWER SYSTEMS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge of different soft computing techniques
- To understand the principle of ANN, fuzzy logic and genetic algorithm
- To impart the knowledge on soft computing techniques for solving power system problems of resonance and coupled circuits

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Elucidate the basic concept of ANN, Fuzzy and GA (Understand)

CO2: Illustrate the architecture of artificial neural networks (Understand)

CO3: Understand the concepts of fuzzy logic system (Understand)

CO4: Understand the principle of genetic algorithm for real time applications (Understand)

CO5: Apply ANN, Fuzzy and GA in power system applications (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	1	2	-
CO2	3	2	1	-	1	-	-	-	-	-	-	1	2	-
CO3	3	2	1	-	1	-	-	-	-	-	-	1	2	-
CO4	3	2	2	-	1	-	-	-	-	-	-	1	2	-
CO5	3	2	2	1	1	1	1	-	-	-	-	1	-	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

SYLLABUS:

UNIT I SOFT COMPUTING TECHNIQUES **9**

Definition of AI – Difference between soft computing and hard computing techniques – Expert systems – Brief history of ANN, Fuzzy and GA – Basic concepts of Neural Networks, human brain, model of artificial neuron – Difference between GA and traditional methods

UNIT II NEURAL NETWORKS **9**

Neural Network architectures – Single layer and multi-layer feed forward network, recurrent networks – Characteristics of NN, Learning Methods Perceptron – ADALINE networks – Back Propagation Network (BPN) – Nonlinear activation operators – Selection of parameters in BPN.

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UNIT III FUZZY LOGIC SYSTEM 9

Comparison between fuzzy and crisp logic, fuzzy sets, membership function, basic fuzzy set – Operations, properties of fuzzy set, fuzzy relations, fuzzy interference system, mamdani, sugeno, fuzzy rule-based system, defuzzification methods – Type 2 fuzzy sets –Interval type 2 fuzzy set

UNIT IV GENETIC ALGORITHM 9

Principles – Encoding – fitness function – Inheritance operators – Types of GA operators: Cross over, Mutation and Reproduction – GA's for constrained and unconstrained optimization.

UNIT V APPLICATION OF AI TO POWER SYSTEM 9

Applications of ANN, Fuzzy logic and GA in power system - load forecasting, Voltage stability – Economic load dispatch.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Rajasekaran S. and VijayalakshmiPai G.A., "Neural Networks, Fuzzy logic and Genetic Algorithms", PHI publication, 2017
2. Kalyanmoy Deb, "Optimization for Engineering Design", PHI publication, 2012

REFERENCES:

1. Kalyanmoy Deb, "Multi-objective Optimization using Evolutionary Algorithms", Wiley Publication, 2010
2. Ross T.J., "Fuzzy logic with Fuzzy Applications", McGraw Hill Inc, 2008
3. Simon Haykins, "Neural Networks: A comprehensive Foundation", Pearson Edition, 2003

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP26	DATA SCIENCE FOR ELECTRICAL ENGINEERS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge in of data science and statistical inference.
- To understand the data mining and data streams concepts
- To understand the concept of data pre-processing and feature selection algorithms.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the basics of data science and big data analytics. (Understand)

CO2: Apply the statics techniques for data descriptive analysis (Apply)

CO3: Apply the machine learning techniques for electrical load forecasting and fault classifier. (Apply)

CO4: Apply the concepts of data mining streams for real time applications. (Apply)

CO5: Implement the data science application using python (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	2	-	-	-	-	-	-	1	2	-
CO2	3	2	-	-	2	-	-	-	-	-	-	1	2	-
CO3	3	2	1	-	2	-	-	-	-	-	-	1	2	-
CO4	3	2	1	-	2	-	-	-	-	-	-	1	2	-
CO5	3	2	1	-	2	-	-	-	-	-	-	1	2	-
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)				3: Substantial (High)							

SYLLABUS:

UNIT I INTRODUCTION TO DATA SCIENCE 9

Data Science – Big Data and Data Science – Fundamentals and components – Data scientist – Terminologies used in big data environments – Types of digital data – Classification of digital data – Big data: Evolution, Characteristics, analytics, Classification, challenges facing big data.

UNIT II DESCRIPTIVE ANALYTICS USING STATISTICS 9

Types of data - Mean, median and model – Standard deviation and variants – Probability Density function – Types of data distribution – Percentiles and moments – Correlation and covariance – Conditional probability – Baye's theorem – Univariate, bivariate and multivariate analysis – Dimensionality reduction using principal component analysis.

UNIT III PREDICTIVE MODELING AND MACHINE LEARNING 9

Linear regression – Polynomial regression – Multivariate regression – Multilevel models – Bias/ variance trade off – K fold cross validation – Data cleaning and normalization – Cleaning web log data – Feature selection algorithms – Detecting outliers – Introduction to supervised and unsupervised learning – Reinforcement learning – Case studies: Electrical load forecasting, Fault classifier

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UNIT IV MINING DATA STREAMS 9

Stream data model and architecture – Stream computing, Sampling data in a stream – Filtering streams – Counting distinct elements in a stream – Estimating moments – Counting oneness in a window – Decaying window – Real Time Analytics Platform (RTAP) applications – Case studies: Temperature estimation

UNIT V DATA SCIENCE USING PYTHON 9

Essential data science packages: Numpy, Scipy, Jupyter, Statsmodels and Pandas package – Data munging: Data pipeline and Machine learning in Python – Data visualization using Matplotlib – Interactive visualization in Python

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Michael Berthold and David J. Hand, "Intelligent Data Analysis", Springer, 2007
2. Seema Acharya and Subhashini Chellapan, "Big Data Analytics", Wiley, 2015

REFERENCES:

1. Alberto Boschetti and Luca Massaron, "Python Data Science Essentials", 2nd edition, Packt Publications, 2016
2. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers, 2014
3. Foster Provost and Tom Fawcet, "Data Science for Business", O'Reilly Publishers, 2013

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP27	FUNDAMENTALS OF AR AND VR	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge on augmented reality (AR) and virtual reality (VR).
- To understand the design procedure of AR and VR.
- To apply the concept of AR and VR for real-time applications.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the basics of VR systems (Understand)

CO2: Understand the architecture and modeling of the VR system (Understand)

CO3: Explore the basic concepts of AR (Understand)

CO4: Use computer vision concepts for AR and AR techniques (Understand)

CO5: Implement the VR/AR applications for real-time applications (Apply)

CO-PO MAPPING:

Cos \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	1	-	-	-	-	-	-	1	2	-
CO2	3	2	-	-	1	-	-	-	-	-	-	1	2	-
CO3	3	2	-	-	1	-	-	-	-	-	-	1	2	-
CO4	3	2	-	-	1	-	-	-	-	-	-	1	2	-
CO5	3	2	-	-	1	-	-	-	-	-	-	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I OVERVIEW OF VIRTUAL REALITY 9

Introduction – The three I's of virtual reality – Early commercial VR – Five classic components of VR system – Three-Dimensional position trackers – Navigation and Manipulation Interfaces – Gesture Interface. Output Devices: Graphics display – Sound display – Haptic feedback.

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UNIT II COMPUTING ARCHITECTURE AND MODELING 9

PC graphics Architecture – Workstation-based architecture – Distributed VR architecture – Geometric modeling – Kinematic modeling – Physical modeling – Behavior modeling.

UNIT III AGUMENTED REALITY ENVIRONMENT 9

Introduction to augmented reality – History of augmented reality – Multimodal display – Visual perception – Requirements and characteristics – Spatial display model – Visual displays.

UNIT IV TRACKING AND COMPUTER VISION FOR AR 9

Coordinate system – Characteristics of tracking technology – Degrees of freedom – Marker tracking – Multiple camera infrared tracking – Natural feature tracking by detection – Incremental tracking – Simultaneous localization and mapping – Outdoor tracking.

UNIT V APPLICATIONS OF VR AND AR 9

Introduction – VR applications in manufacturing – Military VR application – Engineering – Architecture – Medicine – Entertainment – Science – Training.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Grigore C Burdea, Philippe Coiffet, "Virtual Reality Technology", 2nd Edition, Willey, 2017.
2. Dieter Schmaslstieg, Tobias Hollerer, "Augmented Reality: Principles and Practice" Pearson Education, 2016.
3.

REFERENCES:

1. Alan Craig, William Sherman, Jeffrey Will, "Developing Virtual Reality Applications, Foundations of Effective Design", Morgan Kaufmann, 2009.
2. Alan B. Craig, "Understanding Augmented Reality, Concepts and Applications", Morgan Kaufmann, 2013.

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP28	ARTIFICIAL NEURAL NETWORKS AND APPLICATIONS	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- **Nil**

COURSE OBJECTIVES:

- To understand the basic concepts of single and multi-layer neural networks
- To acquire the knowledge on special neural networks
- To apply the neural network for real-time applications.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the biological neural network and artificial neural networks (Understand)
CO2: Compare the single layer and multi-layer neural network (Understand)
CO3: Understand the feedback and feed forward neural networks (Understand)
CO4: Apply the special neural network models for character recognitions (Apply)
CO5: Apply the suitable neural network models for real-time applications (Apply)

CO-PO MAPPING:

POs / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	2	-	-	-	-	-	1	1	2	-
CO2	3	2	1	-	2	-	-	-	-	-	1	1	2	-
CO3	3	2	1	-	2	-	-	-	-	-	1	1	2	-
CO4	3	2	1	-	2	-	-	-	-	-	1	1	2	-
CO5	3	2	1	1	2	-	-	-	-	-	1	1	2	-
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

SYLLABUS:

UNIT I FUNDAMENTALS OF NEURAL NETWORKS 9

Introduction – Artificial neural networks – Biological neural networks – Basic building blocks of ANNs – ANN Terminologies – McCulloch-Pits neuron model – Learning rules – Hebb net.

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UNIT II PERCEPTRON AND ASSOCIATIVE MEMORY NETWORKS 9

Single layer perceptron – Multilayer perceptron – Adaline – Madaline – Associative memory networks – Hetero Associate memory neural networks – Auto associative memory networks.

UNIT III FEEDBACK AND FEED FORWARD NETWORKS 9

Discrete Hopfield net – Continuous Hopfield net – Back propagation network – Radial basis function network – Full counter propagation network – Forward counter propagation network – Self organizing feature map.

UNIT IV SPECIAL NETWORKS 9

Probabilistic neural network – Cognitron – Neocognitron – Boltzman machine – Gaussian machine – Support vector machines – Character recognition

UNIT V APPLICATIONS OF NEURAL NETWORKS 9

Bioinformatics – Forecasting – Healthcare – Communication – Robotics – Image processing and compression.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Sivanandam S.N., Sumathi and Deepa S.N., "Introduction to Neural Networks Using MATLAB 6.0", Tata McGraw – Hill Education, 2016
2. Rajasekaran S. and Pai G.A.V., "Neural Networks, Fuzzy Logic and Genetic Algorithm Synthesis and applications", PHI, New Delhi, 2017

REFERENCES:

1. Laurene Fausett, "Fundamentals of Neural Networks: Architectures, Algorithms and Applications", Pearson Education India, 2006
2. Simon Haykin, "Neural Networks- A comprehensive foundation", Pearson Education, 2003.
3. Sivanandam S.N.and Deepa S.N., "Principles of Soft Computing Techniques", Wiley,2018

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP29	FUZZY LOGIC CONTROL	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To impart the knowledge on fuzzy sets and classical sets
- To analyze the data using fuzzy logic techniques
- To provide comprehensive knowledge to solve electrical engineering problems

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Interpret fuzzy set theory and uncertainty concepts (Understand)

CO2: Solve the electrical engineering problems using fuzzy conversion techniques (Apply)

CO3: Understand the fundamentals of fuzzy data analysis (Understand)

CO4: Apply fuzzy rules for decision making in expert systems (Apply)

CO5: Apply the fuzzy logic control for electrical engineering applications (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	1	2	-
CO2	3	2	2	1	-	-	-	-	-	-	-	1	2	-
CO3	3	2	2	1	-	-	-	-	-	-	-	1	2	-
CO4	3	2	2	-	-	-	-	-	-	-	-	1	2	-
CO5	3	2	2	1	2	-	-	-	-	-	-	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I FUZZY SYSTEMS **9**

Crisp set – Vagueness – Uncertainty and imprecision – Fuzziness – Basic definitions – Fuzzy set theory – Classical set Vs Fuzzy set – Properties of fuzzy sets – Fuzzy operation – Fuzzy arithmetic – Fuzzy relation – Fuzzy relational equations – Fuzzy Cartesian product and composition

UNIT II FUZZY MODELS AND CONVERSION **9**

Introduction to Fuzzy model – Structure of fuzzy logic control – Fuzzification models – Knowledge base – Rule base – Inference engine – Fuzzy to crisp conversion – Lambda cuts for fuzzy sets and relations – Defuzzification methods

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UNIT III FUZZY DATA ANALYSIS 9

Methods for Fuzzy Data Analysis – Algorithmic Approaches – Knowledge based Approaches – Tools for Fuzzy Data Analysis – Applications of FDA

UNIT IV ADVANCED FUZZY LOGIC CONTROL 9

Fuzzy logic controllers –adaptive fuzzy systems – Fuzzy decision making – Multi-objective decision making – Fuzzy classification – Means clustering – Fuzzy pattern recognition – Image processing applications – Syntactic recognition

UNIT V APPLICATION OF FUZZY SYSTEMS 9

Fuzzy logic control: Home heating system – Liquid level control –PID control –Motor control– Energy management – Buck-Boost Converter

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", 4th edition, Wiley, 2016
2. H.J. Zimmermann, "Fuzzy Set Theory and its Applications", Springer Netherlands, 2nd Edition, Illustrated, 2014

REFERENCES:

1. Rajasekaran S. and Pai G.A.V., "Neural Networks, Fuzzy Logic and Genetic Algorithm Synthesis and applications", PHI, New Delhi, 2017
2. John Yen and Reza Langari, "Fuzzy Logic – Intelligence Control & Information", Pearson Education, New Delhi, 2003
3. Sivanandam S N, Sumathi S, Deepa S N, "Introduction to Fuzzy Logic using MATLAB", Springer-Verlag, Berlin Heidelberg, 2010.

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP30	DEEP LEARNING FOR ELECTRICAL ENGINEERING	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the basic knowledge on deep feed forward networks, convolutional neural networks, recurrent and recursive nets.
- To understand the concept of deep neural networks architecture
- To implement the deep neural network models for electrical engineering applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the basic concepts of deep learning technique (Understand)

CO2: Apply the deep feed forward networks for electrical load forecasting (Apply)

CO3: Understand the concept of regularization and optimization for deep models (Understand)

CO4: Understand the architecture of different types of convolutional neural network models (Apply)

CO5: Implement the pre-trained model for solar and wind power forecasting (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	2	-
CO2	3	2	1	1	1	-	-	-	-	-	1	1	2	-
CO3	3	2	1	-	-	-	-	-	-	-	-	1	2	-
CO4	3	2	1	1	1	-	-	-	-	-	1	1	2	-
CO5	3	2	1	1	1	-	-	-	-	-	1	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I INTRODUCTION **9**

Review of concepts from Linear Algebra and Vector Calculus – Learning algorithms: supervised and unsupervised – Capacity, over fitting and under fitting – Hyper parameters and validation sets – Estimators, bias and variance – Maximum likelihood estimation

UNIT II DEEP FEED FORWARD NETWORKS **9**

XOR function – Gradient based learning – Hidden units – Architecture design – Back propagation algorithm – Case studies: load forecasting.

UNIT III REGULARIZATION AND OPTIMIZATION FOR DEEP MODELS **9**

Norm penalties – Regularization – Dataset augmentation – Noise robustness – Early stopping – Parameter tying and parameter sharing – Bagging and ensemble methods – Dropout – Batch and mini batch algorithms – Basic algorithms

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UNIT IV CONVOLUTIONAL NEURAL NETWORKS 9

Convolution operation – Motivation – Pooling – Convolution and pooling as an infinitely strong prior – Variants of the basic convolution function – Structured outputs – Data type – Unsupervised features- Case studies: AlexNet, ZFNet, VGG, C3D, Google Net

UNIT V RECURRENT AND RECURSIVE NETS 9

Recurrent neural networks – Encoder – decoder sequence to sequence architectures – Deep Recurrent networks – Recursive neural networks – Echo state networks – Leaky units and other strategies for multiple time scales – LSTM – Case studies: forecasting of wind and solar power.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Bengio, Yoshua, Ian J. Goodfellow and Aaron Courville, "Deep Learning", MIT Press, 2015
2. Francois Chollet, "Deep Learning with Python", Manning Publications Co., 2017

REFERENCES:

1. Eugene Charniak, "Introduction to Deep Learning", MIT Press, 2018
2. Charu C. Aggarwal, "Neural Networks and Deep Learning", Springer, 2018
3. Josh Patterson and Adam Gibson, "Deep Learning A Practitioner's Approach", O'Reilly media Inc., 2017

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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LEARN BEYOND

U21EEP31	TENSOR FLOW FOR ENGINEERING APPLICATIONS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the basic knowledge of TensorFlow implementation
- To apply the convolution and recurrent neural network for real time application
- To understand the various applications using Tensorflow networks

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Implement neural networks in TensorFlow for solving problems (Apply)

CO2: Understand the concept of convolution neural networks using TensorFlow (Understand)

CO3: Apply the concept to develop RNN, LSTM and GRU model for real-time applications (Apply)

CO4: Understand the building block of deep learning models using Keras and Tflearn (Understand)

CO5: Apply the concept of CNN and RNN to solve real time problems (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	-	-	-	-	-	1	1	2	-
CO2	3	2	1	-	1	-	-	-	-	-	1	1	2	-
CO3	3	2	1	1	1	-	-	-	-	-	1	1	2	-
CO4	3	2	1	-	1	-	-	-	-	-	1	1	2	-
CO5	3	2	1	1	1	-	-	-	-	-	1	1	2	-

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I IMPLEMENTING NEURAL NETWORKS IN TENSORFLOW 9

Introduction to TensorFlow: Computational graph – Key highlights – Creating a graph – Regression example – Gradient descent – tensor board, modularity – Sharing variables – Managing models over the CPU and GPU – Specifying the logistic regression model in TensorFlow – Logging and training the logistic regression model

UNIT II CONVOLUTIONAL NEURAL NETWORKS 9

Introduction to convolution neural networks – CNN architecture – Convolution operation – Padding and stride – Transfer learning – Fine-tuning – Applications of convolution neural networks

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UNIT III RECURRENT NEURAL NETWORKS 9

Fundamentals of recurrent neural network – Modelling sequencing– Types of RNNs – Long short–term memory – Gated recurrent unit – Recursive neural tensor network theory - recurrent neural network applications

UNIT IV KERAS AND TFLEARN 9

Introduction of Keras – Keras model building blocks – Different compositional layers – Process based use cases' implementations – Introduction of TFlearn – TFlearn model building blocks–Different compositional layers– Cases implementations

UNIT V APPLICATIONS 9

Image classification – Image segmentation and instance segmentation – Object detection – Natural Language Processing – Sentiment analysis and data set – Solar and Wind energy forecasting – Load forecasting, Electric Vehicle charging management

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola. "Dive into Deep Learning", Release 0.15.1, 2020
2. Goodfellow I., Bengio, Y., and Courville, A., "Deep Learning", MIT Press, 2016

REFERENCES:

1. Golub G.H. and Van Loan C.F., "Matrix Computations", JHU Press, 2013
2. Nikhil Buduma and Nicholas Locascio, "Fundamentals of Deep Learning: Designing Next Generation Machine Intelligence Algorithms", O'Reilly Media, 2017
3. Josh Patterson and Adam Gibson, "Deep Learning: A Practitioner's Approach", O'Reilly, 2017

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP32	FUNDAMENTALS OF NATURAL LANGUAGE PROCESSING	Category: BSC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Python Programming

COURSE OBJECTIVES:

- To understand the fundamental of NLP and the use of CFG and PCFG in NLP
- To understand the role of semantics of sentences and pragmatics
- To apply the NLP techniques to IR applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand a tag of given text with basic language features (Understand)

CO2: Understand the word level analysis application using NLP components (Understand)

CO3: Implement a rule based system to tackle morphology/syntax of a language (Apply)

CO4: Understand a tag set of statistical processing for real-time applications (Understand)

CO5: Compare and contrast the use of different statistical approaches of NLP applications. (Understand)

CO-PO MAPPING:

POs / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-	2	-
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)					3: Substantial (High)						

SYLLABUS:

UNIT I INTRODUCTION 9

Origins and challenges of NLP – Language Modeling: Grammar-based LM, Statistical LM - Regular Expressions, Finite-State Automata – English Morphology, Transducers for lexicon and rules, Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance

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UNIT II WORD LEVEL ANALYSIS 9

Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models

UNIT III SYNTACTIC ANALYSIS 9

Context-Free Grammars, Grammar rules for English, Treebanks, Normal Forms for grammar – Dependency Grammar – Syntactic Parsing, Ambiguity, Dynamic Programming parsing – Shallow parsing – Probabilistic CFG, Probabilistic CYK.

UNIT IV SEMANTICS AND PRAGMATICS 9

Requirements for representation, First-Order Logic, Description Logics – Syntax-Driven Semantic analysis, Semantic attachments – Word Senses, Relations between Senses, Thematic Roles, selectional restrictions – Word Sense Disambiguation, WSD using Supervised, Dictionary & Thesaurus,

UNIT V DISCOURSE ANALYSIS AND LEXICAL RESOURCES 9

Discourse segmentation, Coherence – Reference Phenomena, Anaphora Resolution using Hobbs and Centering Algorithm – Coreference Resolution – Resources: Porter Stemmer, Lemmatizer, Penn Treebank, Brill's Tagger, WordNet, PropBank, FrameNet, Brown Corpus, British National Corpus (BNC)

Contact Periods:

Lecture: 45 Periods Tutorial: - – Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Daniel Jurafsky, James H. Martin—Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, Pearson Publication, 2014.
2. Steven Bird, Ewan Klein and Edward Loper, —Natural Language Processing with Pythonll, First Edition, O_Reilly Media, 2009.

REFERENCES:

1. Tanveer Siddiqui, U.S. Tiwary, —Natural Language Processing and Information Retrievalll, Oxford University Press, 2008.
2. Richard M Reese, —Natural Language Processing with Javall, O_Reilly Media, 2015
3. Nitin Indurkhya and Fred J. Damerau, —Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010.

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP33	SMART SENSORS AND APPLICATIONS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge in physical parameters using smart sensors
- To understand different types of sensors and its characteristics
- To choose smart sensors in real time applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Infer the characteristics and calibration techniques of sensors (Understand)

CO2: Describe the operating principle of optical, pressure and radiation sensors (Understand)

CO3: Understand the operating principle of motion and range sensors (Understand)

CO4: Elucidate the sensor for automotive applications (Understand)

CO5: Illustrate the applications of sensors in energy harvesting (Understand)

CO–PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	-	-	-	-	-	-	-	-	-	2	-
CO2	2	2	1	-	-	-	-	-	-	-	-	-	2	-
CO3	2	2	1	-	-	-	-	-	-	-	-	-	2	-
CO4	2	2	1	-	-	-	-	-	-	-	-	-	2	-
CO5	2	2	1	-	1	1	1	-	-	-	-	-	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I SENSOR CHARACTERISTICS **9**

Characteristics – Classification – Calibration of smart sensor – Output signal types – Properties – Dynamic models of sensor elements

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UNIT II OPTICAL, PRESSURE AND TEMPERATURE SENSORS 9

LDR – Fiber optic sensors – Pressure sensors – Piezoelectric sensors – Acoustic sensors – Radiation sensors – LASER sensors – MEMS and Nano sensors

UNIT III MOTION AND RANGE SENSORS 9

Motion sensors – Encoders – Optical, Magnetic, Inductive and Capacitive type – Accelerometer – Range sensors – Radar – Flex ray – RF beacons – LIDAR

UNIT IV SENSORS FOR AUTOMOTIVE INDUSTRY 9

Air mass sensors – Wheel speed sensors – Suspension sensors – Impact sensors – Oil sensors – Brake sensors – Battery sensor – Parking sensors – Lane control sensors

UNIT V SENSOR INTERFACE AND APPLICATIONS 9

Battery monitoring sensors – Smart building sensors – Smoke and occupancy sensors – Smart wind sensors – Applications: Vibration and motion energy harvesting – Thermoelectric energy harvesting

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Jon S. Wilson, "Sensor Technology Handbook", 1st edition, Elsevier, 2011
2. Jacob Fraden, "Hand Book of Modern Sensors: Physics, Designs and Applications", 3rd edition, Springer, 2015

REFERENCES:

1. Patranabis D., "Sensors and Transducers", 2nd edition, PHI, New Delhi, 2010
2. John G. Webster, "Measurement, Instrumentation and Sensor Handbook", 2nd edition, CRC Press, 2017
3. Richard Zurawski, "Industrial Communication Technology Handbook", 2nd edition, CRC Press, 2015

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I(100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / MiniProject / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP34	MEMS AND ITS APPLICATIONS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire knowledge in the design and modeling of electrostatic sensors and actuators
- To understand the properties of materials, microstructure and fabrication methods
- To select MEMS sensors in automotive systems

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the products of micro system devices and its mechanical behavior (Understand)

CO2: Illustrate the fabrication process of micro systems and micro machining (Understand)

CO3: Explain the working principles of various sensors and actuators (Understand)

CO4: Identify the sensor type and required packaging methods (Understand)

CO5: Choose the appropriate MEMS for automotive applications (Understand)

CO–PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	-	-	-	-	-	-	-	-	-	2	-
CO2	2	2	1	-	-	-	-	-	-	-	-	-	2	-
CO3	2	2	1	-	-	-	-	-	-	-	-	-	2	-
CO4	2	2	1	-	-	-	-	-	-	-	-	-	2	-
CO5	2	2	1	-	-	-	-	-	-	-	-	-	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)							3: Substantial (High)			

SYLLABUS:

UNIT I MEMS AND MICROFABRICATION **9**

Need for miniaturization – MEMS and microsystems – Microsystem products – Micro gears, micro turbines, micro motors, micro – optical devices – Micro fabrication – Microelectronic fabrication process – Silicon based MEMS process – Stress and strain analysis – Flexural beam bending – Torsional deflections – Intrinsic stress

UNIT II MICROMACHINING **9**

Photolithography – Ion implantation – Diffusion – Oxidation – Thermal oxidation – Oxidation by chemical vapour deposition – Physical vapour deposition – Sputtering – Etching – Chemical, plasma, LIGA process – Micromachining – Bulk micromachining, surface micromachining, hard and soft micromachining.

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UNIT III SENSING AND ACTUATION 9

Electrostatic sensor – Parallel plate capacitors – Design and fabrication – Interdigitated finger capacitor – Comb drive devices – Micro Grippers – Micro Motors – Thermal sensor – Design and fabrication – Thermocouples – Thermal resistors – Thermal bimorph

UNIT IV MECHANICAL SENSORS AND PACKAGING 9

Mechanical transduction techniques – Piezo resistivity – Piezo electricity – Capacitive, optical, resonant actuation techniques – Pressure sensors – Force and torque sensors – Inertial sensors – Flow sensors – Tactile sensor; Standard IC packaging – Packaging process – MEMS mechanical sensors packing

UNIT V AUTOMOTIVE APPLICATIONS 9

MEMS for passenger safety – Vehicle stability control – Automotive tire pressure monitoring systems – Pressure and flow sensors for engine management system – RF MEMS and its application – MEMS for passenger comfort in vehicles

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Chang Liu, "Foundations of MEMS", 2nd edition, Pearson Education India, 2014
2. Michael Kraft and Neil M. White, "MEMS for Automotive and Aerospace Applications", Woodhead Publishing Limited, Oxford, 2013

REFERENCES:

1. Vinoy K.J., Ananthasuresh G.K. and Rudra Pratap, "Micro and Smart Devices and Systems", Springer India, 2014
2. Stephen Beeby, Graham Ensell, Michael Kraft and Neil White, "MEMS Mechanical Sensors", Artech House, Inc., Boston, London, 2004
3. Thomas M. Adams and Richard A. Layton, "Introductory MEMS: Fabrication and Applications", Springer, 2010

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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		Category: PEC			
U21EEP35	DISCRETE TIME SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the mathematical operations performed on the signals.
- Impart the knowledge on Z Transforms, DFT and FFT and its computation
- Acquire knowledge of DSP processor computational building blocks and its architecture.

COURSE OUTCOMES:

- **Upon completion of the course, the student will be able to**
- CO1: Identify the different types of signals and systems (Understand)
- CO2: Analyze the discrete time system using Z-transform (Apply)
- CO3: Apply DFT and FFT techniques to analyze the digital signals and systems (Apply)
- CO4: Design of FIR and IIR filter for the given specifications (Apply)
- CO5: Understand the functional blocks of DSP processor and its operation (Understand)

CO–PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	2	-
CO2	3	2	1	-	-	-	-	-	-	-	-	1	2	-
CO3	3	2	1	-	-	-	-	-	-	-	-	1	2	-
CO4	3	2	1	-	-	-	-	-	-	-	-	1	2	-
CO5	3	2	1	-	-	-	-	-	-	-	-	1	2	-
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

SYLLABUS:

UNIT I INTRODUCTION 9

Classification of systems: Continuous, discrete, linear, causal, stability, dynamic, recursive, time variance – Classification of signals: continuous and discrete, energy and power – Mathematical representation of signals – Sampling techniques – Quantization – Quantization error – Nyquist rate – Aliasing effect.

UNIT II DISCRETE TIME SYSTEM ANALYSIS 9

Z-transform and its properties – Inverse z-transforms – Difference equation – Solution by z transform - Stability analysis – Convolution

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UNIT III DISCRETE FOURIER TRANSFORM & COMPUTATION 9

Discrete Fourier Transform – Properties, magnitude and phase representation – Computation of DFT using FFT algorithm – DIT &DIF using radix 2 FFT – Butterfly structure

UNIT IV DESIGN OF DIGITAL FILTERS 9

FIR & IIR filter realization – Parallel & cascade forms – FIR design: Windowing Techniques – Need and choice of windows – Analog filter design – Butterworth and Chebyshev approximations – IIR Filters, digital design using impulse invariant and bilinear transformation – Warping, pre warping.

UNIT V DIGITAL SIGNAL PROCESSORS 9

Introduction – Architecture – Features – Addressing Formats – Introduction to Commercial Digital Signal Processors

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. S.K. Mitra, 'Digital Signal Processing – A Computer Based Approach', McGraw Hill Edu, 2013.
2. Lonnie C. Ludeman , "Fundamentals of Digital Signal Processing",Wiley,2013

REFERENCES:

1. Robert Schilling & Sandra L.Harris, Introduction to Digital Signal Processing using Matlab", Cengage Learning,2014

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP36	REAL TIME OPERATING SYSTEMS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the concepts of real time operating systems
- To understand the basics of process management and process synchronization
- To understand about real time kernel

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Describe **the** operating system structures and its types. (Understand)

CO2: Explain about task, process and its scheduling (Understand)

CO3: Illustrate knowledge on various RTOS support modelling (Understand)

CO4: Explain about real time kernel (Understand)

CO5: Illustrate the implementation of RTOS in real time application (Understand)

CO–PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	-	1	-	-	-	-	-	-	1	2	-
CO2	2	2	1	-	1	-	-	-	-	-	-	1	2	-
CO3	2	2	1	-	1	-	-	-	-	-	-	1	2	-
CO4	2	2	1	-	1	-	-	-	-	-	-	1	2	-
CO5	2	2	1	-	1	-	-	-	-	-	-	1	2	-
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

SYLLABUS:

UNIT I REVIEW OF OPERATING SYSTEMS 9

Basic principles – Operating system structures – System calls – Files – Processes – Design and Implementation of processes – Communication between processes

UNIT II OVERVIEW OF RTOS 9

RTOS Task and Task state – Multithreaded preemptive scheduler – Process synchronization– Message queues – Mail boxes -pipes – Critical section – Semaphores – Classical synchronization problem – Deadlocks

UNIT III REALTIME MODELS AND LANGUAGES 9

Event Based – Process Based and Graph based Models – Real Time Languages – RTOS Tasks – RT scheduling – Interrupt processing – Synchronization

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UNIT IV REALTIME KERNEL 9

Principles – Design issues – Polled Loop Systems – RTOS Porting to a Target – Comparison and Basic study of various RTOS like – VX works – Linux supportive RTOS

UNIT V APPLICATION DEVELOPMENT 9

Discussions on Basics of Linux supportive RTOS – uCOS-C Executive for development of RTOS Application – Case study

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Raj Kamal, "Embedded Systems- Architecture, Programming and Design" Tata McGraw Hill,2006.
2. Charles Crowley, "Operating Systems-A Design Oriented approach" McGraw Hill,1997.

REFERENCES:

1. Silberschatz,Galvin,Gagne" Operating System Concepts,6th edition,John Wiley,2003.
2. Karim Yaghmour,Building Embedded Linux System",O'reilly Pub,2003.
3. MukeshSighal and N G Shi "Advanced Concepts in Operating System", McGraw Hill,2000.

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP37	COMPUTER NETWORKS FOR ELECTRICAL ENGINEERS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the protocol layering and physical level communication.
- To analyze the performance of a network.
- To understand the various components required to build different networks

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Elucidate the basic layers and its functions in computer networks (Understand)

CO2: Explain the performance of a networks (Understand)

CO3: Describe various network layer protocols like IPV4 and IPV6 (Understand)

CO4: Explain the various transport layer protocols (Understand)

CO5: Summarize the working of various application layer protocols (Understand)

CO–PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO3	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO4	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO5	3	2	1	-	-	-	-	-	-	-	-	-	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I PHYSICAL LAYER 9

Networks – Network Types – Protocol Layering – TCP/IP Protocol suite – OSI Model – Physical Layer: Performance – Transmission media – Switching – Circuit–switched Networks – Packet Switching.

UNIT II DATA–LINK LAYER AND MEDIA ACCESS 9

Introduction – Link-Layer Addressing – DLC Services – Data-Link Layer Protocols – HDLC – PPP – Media Access Control – Wired LANs: Ethernet – Wireless LANs – Introduction – IEEE 802.11, Bluetooth – Connecting Devices.

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UNIT III NETWORK LAYER 9

Network Layer Services – Packet switching – Performance – IPV4 Addresses – Forwarding of IP Packets – Network Layer Protocols: IP, ICMP v4 – Unicast Routing Algorithms – Protocols – Multicasting Basics – IPV6 Addressing – IPV6 Protocol

UNIT IV TRANSPORT LAYER 9

Introduction – Transport Layer Protocols – Services – Port Numbers – User Datagram Protocol – Transmission Control Protocol – SCTP.

UNIT V APPLICATION LAYER 9

WWW and HTTP – FTP – Email –Telnet –SSH – DNS – SNMP

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Behrouz A. Forouzan, Data Communications and Networking, Fourth Edition TMH, 2017
2. Kalyanmoy Deb, "Optimization for Engineering Design", PHI publication, 2012

REFERENCES:

1. Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach, Fifth Edition, Morgan Kaufmann Publishers Inc., 2012.
2. William Stallings, Data and Computer Communications, Tenth Edition, Pearson Education, 2013
3. Nader F. Mir, Computer and Communication Networks, Second Edition, Prentice Hall, 2014.

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I(100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / MiniProject / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP38	SOFTWARE FOR EMBEDDED SYSTEMS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge in basics concepts of Embedded C
- To develop assembly language program with Embedded C
- To acquire the knowledge of interfacing of 8051 with peripherals

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the data types, control structures and functions in embedded C (Understand)

CO2: Outline the process of hardware delays, loop timeouts (Understand)

CO3: Explain the programming of 8051 in C (Understand)

CO4: Develop serial communication, interrupt programming of 8051 using C (Apply)

CO5: Demonstrate the interfacing of peripherals with 8051 using C(Understand)

CO–PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	1	-	-	-	-	-	-	-	2	-
CO2	2	2	-	-	1	-	-	-	-	-	-	-	2	-
CO3	2	2	-	-	1	-	-	-	-	-	-	-	2	-
CO4	2	2	-	-	1	-	-	-	-	-	-	-	2	-
CO5	2	2	-	-	1	-	-	-	-	-	-	-	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I BASIC C PROGRAMMING **9**

Introduction to C programming - Structured program development in C - Data types and operators - C program control - C functions - Introduction to arrays.

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UNIT II EMBEDDED C 9

Object oriented programming with C – Header files for project and port – Meeting Real time constraints: Creating hardware delays – Need for timeout mechanism – Creating loop timeouts – Creating hardware timeouts

UNIT III 8051 PROGRAMMING IN C 9

Data types and time delay in 8051 – I/O programming in 8051 – Logic operations in 8051 – Data conversion program in 8051 – Accessing code ROM space in 8051 – Data serialization using 8051

UNIT IV 8051 SERIAL PORT AND INTERRUPT PROGRAMMING IN C 9

Basics of serial communication – 8051 interface to RS232 – serial port programming in 8051 – 8051 interrupts and programming – Programming for timer configuration

UNIT V 8051 INTERFACING 9

8051: ADC interfacing – DAC interfacing – Sensor interfacing – LCD interfacing – Stepper motor interfacing

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Paul Deitel and Harvey Deitel, "C How to Program", 9th Edition, Pearson Education Limited, 2022, 1st edition.
2. Michael J Pont, "Embedded C", Addison-Wesley, An imprint of Pearson Education, 2002.

REFERENCES:

1. William von Hagen, "The Definitive Guide to GCC", 2nd Edition, Apress Inc., 2006.
2. Gowrishankar S and Veena A, "Introduction to Python Programming", CRC Press, Taylor & Francis Group, 2019.

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I(100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / MiniProject / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP39	IoT SYSTEM DESIGN AND SECURITY	Category: PEC			
		L	T	P	C
		3	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the fundamental knowledge on Internet of Things
- To understand the concept of IoT architecture, protocols, communications and security
- To develop an IoT model for real time problem

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the fundamentals of Internet of Things (Understand)

CO2: Describe the various IoT protocols (Understand)

CO3: Explain the IoT Architecture for real time problems (Understand)

CO4: Elucidate the MQTT services for a real time application (Understand)

CO5: Illustrate the real–world applications using IoT concepts (Understand)

CO–PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	-	1	-	-	-	-	-	-	1	2	-
CO2	2	1	1	-	1	-	-	-	-	-	-	1	2	-
CO3	2	1	1	-	1	-	-	-	-	-	-	1	2	-
CO4	2	1	1	-	1	-	-	-	-	-	-	1	2	-
CO5	2	1	1	-	1	-	-	-	-	-	-	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I FUNDAMENTALS OF IoT **9**

Evolution of IoT – Fog, Edge and Cloud in IoT – Simplified IoT architecture and Core IoT functional stack – Functional blocks of an IoT ecosystem – Sensors, Actuators – Smart Objects and connecting smart objects

UNIT II IoT DATA LINK PROTOCOLS **9**

Protocol Standardization for IoT – IEEE802.15.4, IEEE 802.11 AH, LTE–A, M2M and WSN Protocols –SCADA and RFID Protocols – Issues with IoT standardization – Zigbee – network layer – Application Layer Protocols: CoAP and MQTT

UNIT III IoT ARCHITECTURE **9**

IoT open–source architecture – OIC architecture and design principles – IoT devices and deployment models – System on Chip – IoTivity: An open source IoT stack overview

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UNIT IV COMMUNICATION AND SERVICE DISCOVERY 9

IoT application development – Application protocols: Communication protocols based on the exchange of messages (MQTT), – Service oriented protocols (COAP) – Data processing for IoT – Organization of data processing for Internet of Things

UNIT V IoT Security and Application 9

IoT Security, System security – Security issues in Zigbee – IoT application: smart and connected cities layered architecture, smart healthcare, smart parking architecture and smart traffic control

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Jamil Y. Khan and Mehmet R. Yuce, "Internet of Things Systems and Application", Jenny Stanford 2019
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things", Cisco Press, 2017

REFERENCES:

1. Dimitrios Serpanos, Marilyn Wolf, "Internet–of–Things (IoT) Systems: Architectures, Algorithms, Methodologies", Springer International Publication, 2018
2. Alvaro Vives, Marco Zennaro, "Internet of Thing", Taylore & Francis Group, 2018
3. https://www.cse.wustl.edu/~jain/cse570–15/ftp/iot_prot/index.html

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP40	ADVANCED INDUSTRIAL AUTOMATION	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge in various industrial applications of Programmable Logic Controller
- To understand the problems related to I/O module, data acquisition system and communication networks using standard devices
- To apply the general structure of automated process using SCADA

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the internal architecture and operations of Programmable Logic Controller (Understand)

CO2: Understand the basic programming concepts and various logical instructions (Understand)

CO3: Compute the extent and nature of electronic circuitry (Apply)

CO4: Infer the general structure of SCADA for real time industrial applications (Understand)

CO5: Apply the advanced automation technology for various applications (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	1	-	-	-	-	-	-	-	2	-
CO2	3	2	2	-	1	-	-	-	-	-	-	-	2	-
CO3	3	2	2	-	1	-	-	-	-	-	-	-	2	-
CO4	3	2	2	-	1	-	-	-	-	-	-	-	2	-
CO5	3	2	2	-	1	-	-	-	-	-	-	-	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)							3: Substantial (High)			

SYLLABUS:

UNIT I PROGRAMMABLE LOGIC CONTROLLERS **9**

Evolution – Types – Unitary, modular, small, medium, large – Functional Block diagram – Input/Output (I/O) section, processor, power supply, memory – Central processing unit – Processor software / executive software – Multi tasking – Languages – Ladder language

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B.E. – EE – R2021 – CBCS

UNIT II LOGICAL INSTRUCTIONS AND PROGRAMMING 9

Bit logic instructions – Input and output contact program symbols, numbering system of inputs and outputs, program format – Equivalent ladder diagram of gates, equivalent ladder diagram – Comparison instructions – PLC timers: ON and OFF delay, retentive and non-retentive – Format of timer instruction – PLC Counter – Count up and count down

UNIT III INPUT / OUTPUT MODULES 9

Classification – practical I/O systems and its mapping – I/O expansion - I/O systems – Direct, parallel, serial – Sinking and sourcing – Discrete input module – Rectifier with filter, threshold detection, isolation, logic section, specifications – Analog input module – Types – Analog output module – I/O modules in hazardous locations – Power supply configuration – Case Study: PLC in– Cement and Paper industry

UNIT IV SCADA 9

Generalized architecture – Communication requirements – SCADA system architecture – Monolithic – Distributed – Networked architecture

UNIT V APPLICATIONS OF SCADA 9

SCADA systems in operation and control of interconnected power system – Power system automation, petroleum refining process, sugar and cogeneration plant – Plant wide control – Cloud based automation – Object Linking and Embedding for process control

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Madhuchhanda Mitra and Samarjit Sen Gupta, "PLC and Industrial Automation: An Introduction", 2nd edition, Penram International Publishing (India) Pvt. Ltd., 2017
2. Ronald L. Krutz, "Securing SCADA Systems", 4th edition, John Wiley and Sons, 2015

REFERENCES:

1. Rajesh Mehra and Vikrant Vij, "PLCs & SCADA: Theory and Practice", 1st edition, University Science press, 2011
2. Kunal Chakraborty, Palash De and Indranil Roy, "Industrial Applications of Programmable Logic Controllers and SCADA", Anchor Academic Publishing, 2016
3. Stuart A Boyer, "SCADA: Supervisory Control and Data Acquisition", 4th edition, Inscribe Digital, 2016

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP41	POWER PLANT TECHNOLOGY	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge of various power station methods and parameters
- To understand the boiler and furnace control in power plants
- To apply the concepts in energy and economic monitoring

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the various power generation methods (Understand)

CO2: Identify the important parameters to monitor and controlled (Understand)

CO3: Illustrate the various furnace control methods (Understand)

CO4: Describe the various boiler controls of power plant (Understand)

CO5: Calculate the energy in economical way and environmental impact (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	1	1	-	-	-	1	-	2
CO2	3	2	2	-	-	-	1	1	-	-	-	1	-	2
CO3	3	2	2	-	-	-	1	1	-	-	-	1	-	2
CO4	3	2	2	-	-	-	1	1	-	-	-	1	-	2
CO5	3	2	2	-	-	-	1	1	-	-	-	1	-	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I POWER GENERATION METHODS 9

Brief survey of methods of power generation: hydro, thermal, nuclear, solar, and wind power – importance of instrumentation in power generation – thermal power plants: building blocks, details of boiler processes P&I diagram of boiler – cogeneration

UNIT II MEASUREMENTS IN POWER PLANTS 9

Electrical measurements: current, voltage, power, frequency, power factor – Nonelectrical parameters: Flow of feed water, fuel, air, steam pressure, and steam temperature – Smoke density measurement – Flue gas oxygen analyzer – Pollution monitoring instruments.

UNIT III FURNACE CONTROL 9

Coal handling: Pulverizes – Furnace Draught: natural draught, forced draught, induced draught, power requirements for draught systems – Combustion control: Fuel/Air ratio, combustion efficiency, excess air, parallel and cross limited combustion control

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UNIT IV BOILER CONTROL 9

Boiler metal temperature measurement, pressure measuring devices – Boiler feed water processing and control – Drum level measurement methods – Steam temperature control: main steam and reheat steam temperature control, Superheater control, Deaerator control – interlocks in boiler operation.

UNIT V ENERGY, ECONOMICS, AND ENVIRONMENTAL ISSUESS 9

Power tariff types – Load distribution parameters – Load curve – Comparison of site selection – Capital & Operating cost of different power plants. Pollution control technologies – Waste Disposal of coal and nuclear power plant

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXTBOOKS:

1. R.K Hedge, "Power Plant Engineering", Pearson Education India, 2015
2. Krishnaswamy KM, Bala P, Bala MP, "Power Plant Instrumentation," Prentice Hall, 2013

REFERENCES:

1. Jain R.K., Mechanical and industrial Measurements, Khanna Publishers, New Delhi, 2008
2. Harry Taplin, "The control of boilers" ,3rd Edition, River Publishers, 2014

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP42	FUEL CELL TECHNOLOGY	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire knowledge of fundamental principles and processes of fuel cells
- To understand the process of electrochemical reaction
- To identify the fuel cell modeling and characterization techniques
- To understand the fuel cell power plants operation

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the fundamentals of various types of fuel cell systems, their components, and characterization (Understand)

CO2: Describe the fuel cell reaction kinetics (Understand)

CO3: Analyze the characteristic of fuel cells (Understand)

CO4: Acquire the knowledge of hydrogen production, and analysis of the life cycle of fuel cells (Understand)

CO5: Summarize the concept of hydrogen storage and applications (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	1	1	-	-	-	1	-	2
CO2	3	2	2	-	-	-	1	1	-	-	-	1	-	2
CO3	3	2	2	-	-	-	1	1	-	-	-	1	-	2
CO4	3	2	2	-	-	-	1	1	-	-	-	1	-	2
CO5	3	2	2	-	-	-	1	1	-	-	-	1	-	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I BASICS OF FUEL CELLS **9**

Fuel Cells: History, Design, Principle, and Working – Types - Fuel cell performances- Batteries and fuel cells comparison – Fuel cell thermodynamics

UNIT II FUEL CELL REACTION KINETICS **9**

Electrode kinetics and overvoltage – Butler- Volmer: Nernst and Tafel equation – Charge transfer reaction – Electrocatalysis design and activation kinetics – Fuel cell charge and mass transport - Flow field, transport in electrode and electrolyte

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UNIT III FUEL CELL CHARACTERIZATION 9

Fuel cell properties - Fuel cell test station – Testing condition - In situ analysis: CV, EIS and equivalent circuit model, Current interrupt analysis - Ex situ techniques: Porosity, Surface area, Structure, Gas permeability, Chemical analysis

UNIT IV HYDROGEN PRODUCTION METHODS 9

H_2 production from fossil fuel – Source of fuels – Electrolysis – Thermal decomposition – Photochemical and photocatalytic methods – safety issues – Cost of hydrogen production – Life cycle analysis of fuel cell

UNIT V HYDROGEN STORAGE METHODS AND APPLICATIONS 9

Metal hydrides – Metallic alloy hydrides – Carbon nanotubes – Sea as source of deuterium -Fuel processor – Fuel cell Power section in fuel cell stack – Automotive application – Power conditioner – Portable devices

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXTBOOKS:

1. John Wiley and Sons., "Fuel cell fundamentals", Willey 2016
2. O'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, Fuel Cell Fundamentals, Wiley, NY 2006

REFERENCES:

1. Bard, A. J., L. R., Faulkner, Electrochemical Methods, Wiley, N.Y. 2004
2. Basu, S. (Ed) Fuel Cell Science and Technology, Springer, N.Y. 2007

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designers can choose any one / two components based on the nature of the course.

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U21EEP43	SOLAR ENERGY TECHNOLOGY	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To introduce the concept of solar power
- To identify the technologies involved in harnessing solar power
- To familiarize with the applications of solar energy

COURSE OUTCOMES

Upon completion of the course, the student will be able to

CO1: Describe the principles of solar radiation and able to solve the solar energy potential (Understand)

CO2: Discover solutions to improve the efficiency of flat plate collectors by evaluating their performance theoretically and experimentally (Understand)

CO3: Identify the solutions to improve the efficiency of concentrating collectors by evaluating its performance (Understand)

CO4: Describe the recent developments of PV and evaluate its performance (Understand)

CO5: Construct and demonstrate various solar thermal systems (understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	1	-	-	-	-	1	-	3
CO2	3	2	1	-	-	-	1	-	-	-	-	1	-	3
CO3	3	2	1	-	-	-	1	-	-	-	-	1	-	3
CO4	3	2	1	-	-	-	1	-	-	-	-	1	-	3
CO5	3	2	1	-	-	-	1	-	-	-	-	1	-	3
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I SOLAR RADIATION 9

Source of radiation – Sun earth relationship – Extra-terrestrial radiation – Atmospheric attenuation - Solar constant – Monthly average daily global radiation and diffuse radiations – Radiation Measurement instruments

UNIT II SOLAR FLAT PLATE COLLECTORS 9

Design considerations – classification – Flat plate collectors – air heating collector's liquid heating - Temperature distributions – Heat removal rate – Useful energy gain – Losses in the collectors – Testing of flat plate collectors.

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UNIT III SOLAR COLLECTORS 9

Solar collectors: Types, Materials, Construction and operation – Cylindrical, Parabolic collector, Compound parabolic collector: orientation and tracking modes – Geometry – Tracking requirements.

UNIT IV PHOTOVOLTAIC SYSTEMS 9

Conversion of Solar energy into Electricity – Photovoltaic Effect, Photovoltaic material – Solar Cell Module – Silicon solar cell and types – Efficiency of solar cells – PV Systems, Photovoltaic applications.

UNIT V APPLICATIONS 9

Solar thermal power plant – Solar desalination – Solar dryer – Solar water heating – Solar air heating – Solar cookers – Solar air conditioning – Solar pumps.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Soteris Kalogirou, "Solar Energy Engineering: Processes and Systems", 2nd Edition, Academic Press, 2013.
2. Duffie JA and Beckman WA, "Solar Engineering of Thermal Processes", 4th Edition, Wiley, 2013
3. Solanki, "Solar Photovoltaics: fundamentals, technologies and applications" 2nd Edition, PHI Learning, 2011

REFERENCES:

1. Sukhatme SP, "Solar Energy", Tata McGraw-Hill Education, 3rd Edition, 2008.
2. Garg HP and Prakash J, "Solar Energy - Fundamentals & Applications", Tata McGrawHill, 2000.

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP44	BIO ENERGY TECHNOLOGY	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To create awareness about bio energy in Indian scenario
- To understand the process involved in bio methanation and gasification
- To identify the mechanism of combustion process, pyrolysis and carbonization

COURSE OUTCOMES

Upon completion of the course, the student will be able to

CO1: Understand the status of Bio Energy in the Indian scenario (Understand)

CO2: Observe the process involved in the process of Bio methanation (Apply)

CO3: Understand the various mechanism in the combustion process (Understand)

CO4: Identify the types of gasification, economics and characteristics (Apply)

CO5: Understand the process involved in pyrolysis and carbonization (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	1	-	-	-	-	1	-	3
CO2	3	2	1	-	-	-	1	-	-	-	-	1	-	3
CO3	3	2	1	-	-	-	1	-	-	-	-	1	-	3
CO4	3	2	1	-	-	-	1	-	-	-	-	1	-	3
CO5	3	2	1	-	-	-	1	-	-	-	-	1	-	3
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I INTRODUCTION **9**

Biomass: Current scenario – Types and Characteristics– Conversion mechanisms – Carbon neutrality - Fuel assessment studies

UNIT II BIO METHANATION **9**

Microbial systems – Biogas production – Impact of gas production– Effect of additives on biogas yield – Feedstocks - Biogas plants: Types, construction, operation – Biogas appliances: Burner, illumination and power generation – Kinetics and mechanism – Digesters treatment.

UNIT III COMBUSTION **9**

Perfect, complete, incomplete – equivalence ratio – fixed Bed, fluid Bed – fuel and ash handling – Briquetting: types of Briquetting – feed requirements and preprocessing

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UNIT IV GASIFICATION 9

Types – comparison – application – performance evaluation – economics – dual fuel engines – Gas Engines – engine characteristics on gas mode – gas cooling and cleaning train.

UNIT V PYROLYSIS AND CARBONIZATION 9

Pyrolysis –Types – process governing parameters – differential thermal analysis – differential scanning calorimetry – Typical yield rates. Effect of carbonization temperature on yield and composition of charcoal- Industrial safety in carbonization

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXTBOOKS:

1. Mahendra S. Sevada, Pradip D. Narale and Suhir N. Kharpude, "Bioenergy Engineering", 1st edition, CRC Press, 2021
2. Madhumi Mitra and Abhijit Nagchaudhuri, "Practices and Perspectives in Sustainable Bioenergy", 1st edition, Springer, 2020

REFERENCES:

1. Augustine O. Ayeni, Samuel Eshorame Sanni and Solomon U. Oranusi, "Bioenergy and Biochemical Processing Technologies", 1st edition, Springer, 2022
2. Emmanuel D. Rogdakis, Irene P. Koronaki, "Renewable Energy Engineering: Solar, Wind, Biomass, Hydrogen and Geothermal Energy systems", 1st edition, Bentham Books, 2018

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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		Category: PEC				
U21EEP45	WIND ENERGY TECHNOLOGY	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

Nil

COURSE OBJECTIVES:

- To acquire the knowledge in of wind resource.
- To understand the blade design for modern wind Turbines concepts
- To understand the concept of monitoring and control in wind turbine

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Comprehend the fundamentals of wind energy and its conversion system. (Understand)

CO2: Disseminate with the wind measurement techniques. (Understand)

CO3: Summarize the concepts of aerodynamics, wind farms and cycles. (Understand)

CO4: Analyze the economics of wind energy systems. (Understand)

CO5: Summarize the operation and maintenance cost of wind system (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	2	-	-	-	-	-	3	1	-	3
CO2	3	2	1	-	2	-	-	-	-	-	3	1	-	3
CO3	3	2	1	-	2	-	-	-	-	-	3	1	-	3
CO4	3	2	1	-	2	-	-	-	-	-	3	1	-	3
CO5	3	2	1	-	2	-	-	-	-	-	3	1	-	3
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)			

SYLLABUS:

UNIT I WIND CHARACTERISTICS AND RESOURCES **9**

Characteristics of the Wind Resource – Characteristics of the Atmospheric Boundary Layer – Wind Data Analysis and Resource Estimation – Regional Wind Resource Assessment

UNIT II AERODYNAMICS OF WIND TURBINE **9**

Wind Measurement - One-dimensional Momentum Theory and the Betz Limit – Ideal Horizontal Axis Wind Turbine with Wake Rotation – Air foils - Performance - Horizontal and Vertical Axis Wind Turbines

UNIT III MODERN WIND TURBINE CONTROL AND MONITORING SYSTEM **9**

Pitch and Yaw Systems – Protections and Safety Consideration in Wind Turbines – Wind Turbine Monitoring – SCADA - Operation & Maintenance for Product Life Cycle

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UNIT IV WIND FARMS 9

Wind Farms – Site selection – Installation and Operation Issues – Wind farms in electrical grids-environmental concerns - Radio waves interference

UNIT V ECONOMICS ANALYSIS 9

Economic Assessment of Wind Energy Systems – Capital Costs - Operation and Maintenance Costs – Value of Wind Energy – Economic Analysis Methods

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXTBOOKS:

1. T Burton, et.al, "Wind Energy Handbook", 3rd Edition, John Wiley and Sons, 2021
2. J.F. Manwell, et.al, "Wind Energy Explained", 3rd Edition, John Wiley and Sons, 2019

REFERENCES:

1. D. A. Spera, "Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering", 2nd Edition, ASME Press, 2016
2. William W. Peng, "Fundamentals of turbo machinery", John Wiley and Sons, 2016
3. Mukund. R. Patel, "Wind and solar power systems" 2nd Edition, Taylor & Francis, 2006

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP46	ENERGY EFFICIENT BUILDINGS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

Nil

COURSE OBJECTIVES:

- To acquire the knowledge of general aspect green building.
- To understand the energy conscious concepts
- To understand the concept of capital cost of Energy management system

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Describe the basic concepts of building and its environment. (Understand)

CO2: Discuss the principle of energy conscious in buildings. (Understand)

CO3: Explain the level of human comfort in Green buildings. (Understand)

CO4: Acquire knowledge about the different climatic zones (Understand)

CO5: Summarize the concept of Energy management in building zones (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	2	-	-	-	-	-	3	1	-	3
CO2	3	2	1	-	2	-	-	-	-	-	3	1	-	3
CO3	3	2	1	-	2	1	-	-	-	-	3	1	-	3
CO4	3	2	1	-	2	1	-	-	-	-	3	1	-	3
CO5	3	2	1	-	2	-	-	-	-	-	3	1	-	3
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I GENERAL ASPECTS 9

Building Envelope – Building Materials – Green building standards - Indoor Environment - Components of Indoor Environment. Quality of Indoor Environment.

UNIT II ENERGY CONSCIOUS IN BUILDINGS 9

Heating – Passive Heating – Direct Gain – Indirect Gain – Isolated Gain-Solarium – Cooling: Passive Cooling –Ventilation Cooling – Evaporative Cooling – Nocturnal Radiation Cooling Desiccant Cooling – Earth Coupling - Principles of Daylighting systems.

UNIT III HUMAN COMFORT 9

Human Comfort –Thermal, Visual, Acoustical and Olfactory comfort - Sol-air temperature and its significance – Ventilation calculation and significance

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UNIT IV CLIMATE ZONES 9

Climatic zones and their characteristics – Factors affecting climate – Implications of climate on building design – Urban climate – Microclimate

UNIT V ENERGY MANAGEMENT SYSTEM 9

Energy Management of Buildings – Energy Audit of Buildings. – Energy management matrix - Tools - Monitoring and targeting.

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXTBOOKS:

1. Handbook on Green Practices published by Indian Society of Heating Refrigerating and Air conditioning Engineers, 2009.
2. Green Building Hand Book by Tom Woolley and Samkimings, 2009.

REFERENCES:

1. Hand book on Energy Conscious Buildings (http://mnre.gov.in/centers/about-sec-2/handbook-on-energy-conscious-buildings/)
2. J.K. Nayak and J.A. Prajapati, "Handbook on Energy Conscious Buildings, Solar Energy Control", MNES, 2017
3. Energy Conservation Building Codes 2017; Bureau of Energy Efficiency.

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Roll Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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		Category: PE				
U21EEP47	ELECTRICAL ENERGY UTILIZATION AND COST ESTIMATION	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

Nil

COURSE OBJECTIVES:

- To acquire the knowledge on working principle and characteristics of traction motors
- To understand the importance of tariff and energy conservation
- To design illumination systems and estimate cost various lighting schemes

COURSE OUTCOMES

Upon completion of the course, the student will be able to

CO1: Explain the electrical traction system. (Understand)

CO2: Describe the economic aspects in tariff and energy auditing. (Understand)

CO3: Design the illumination systems for various types of lighting schemes. (Understand)

CO4: Develop bill of material and selection of appropriate purchase mode. (Apply)

CO5: Identify the wiring design and selection of cable for electrical installations. (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	1	-	-	-	1	2	-
CO2	3	2	1	-	-	-	-	1	-	-	1	1	2	-
CO3	3	3	2	-	-	-	-	1	-	-	-	1	2	-
CO4	3	2	1	-	-	-	-	1	-	-	1	1	2	-
CO5	3	3	2	-	-	-	-	1	-	-	1	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I ELECTRIC TRACTION SYSTEM **9**

Traction motor characteristics – Starting and speed control – Electric braking – Energy recovered using regenerative braking – Power of electric traction – Use of electronic control of traction motor – Track equipment and collection gear – Block diagram of a modern locomotive – Metro-rail system.

UNIT II ECONOMIC ASPECTS OF UTILIZATION **9**

Load curves – Load factors and its improvement – Availability based tariff – Demand side management – Peak clipping – Peak shifting – Valley filling – Use of off-peak energy – Case studies on energy efficiency in thermal and electrical utilities (Quantitative analysis only)

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UNIT III DESIGN OF ILLUMINATION SCHEMES 9

Illumination engineering – Lamp types – Incandescent lamp, fluorescent lamp – Design of illumination systems – Different lighting scheme & their design methods – Flood and street lighting – CFL, OCFL, and LED lighting system

UNIT IV ESTIMATION AND COSTING 9

Estimation and costing – Electrical schedule, catalogues, market survey and source selection, bill of materials – Purchase system – Estimation and costing: electrical installation for residential buildings, commercial buildings and small industries

UNIT V ELECTRICAL INSTALLATION 9

Guidelines for wiring of residential installation and positioning of equipment – Circuit design in light and power circuits – Selection of wires and cables – Load calculations and selection of conductor– Selection of switch rating, protective switchgear ELCB, MCB and wiring accessories – Case studies- House wiring

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Openshaw Taylor E., "Utilization of Electric Energy in SI Units", reprint, Universities Press, Hyderabad, 2011
2. Wayne J. Del Pico, "Electrical Estimating Methods", 4th edition, John Wiley & Sons, 2015

REFERENCES:

1. Wadhwa C.L., "Generation, Distribution and Utilization of Electrical Energy", 3rd edition, New Academic Science, 2011
2. Rajput R.K., "Utilization of Electrical Power", 2nd edition,Laxmi Publication Pvt. Ltd, 2013
3. Rajiv Shankar, "Energy Auditing in Electrical Utilities", Viva Books, 2014

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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U21EEP48	ENERGY MANAGEMENT AND AUDITING	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge on energy scenario and its policies
- To understand the concepts of energy conservation, energy management and audit procedures
- To apply the financial and project planning techniques for real time applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the energy scenario and needs in India (understand)

CO2: Infer the energy conservation act and its policies (understand)

CO3: Summarize the types of energy audit process (understand)

CO4: Apply the financial analysis and project planning techniques for energy Management (understand)

CO5: Explain the concept of energy efficiency and climate change (understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	-	1	-	-	-	-	-	1	-	3
CO2	3	2	2	1	-	1	-	1	-	-	-	1	-	3
CO3	3	2	2	1	-	1	-	1	-	-	-	1	-	3
CO4	3	2	2	1	-	1	-	1	-	-	-	1	-	3
CO5	3	2	2	1	-	1	-	1	-	-	-	1	-	3
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I ENERGY SCENARIO 9

Primary and secondary energy – Commercial and non-commercial energy – Global primary energy reserves – Energy consumption – Indian energy scenario – Sector wise energy consumption in India – Energy needs of growing economy – Integrated energy policy – Purchasing power parity

UNIT II ENERGY CONSERVATION ACTS AND POLICIES 9

Energy conservation – Importance – Features of energy conservation act – Schemes of BEE – Electricity acts – Integrated energy policy – National action plan on climate change.

UNIT III ENERGY MANAGEMENT AND ENERGY AUDIT 9

Energy Management – Need for energy audit – Types – Costs – Benchmarking – Energy performance – Instruments and metering for audit – Audit procedures and time intervals – Case study

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UNIT IV FINANCIAL AND PROJECT MANAGEMENT 9

Financial analysis techniques – Cash flow – Sensitivity and risk analysis – Financing options – ESCOs – Project development cycle – Project planning techniques

UNIT V ENERGY EFFICIENCY AND CLIMATE CHANGE 9

Energy and environment – Global environmental issues – Ozone layer depletion – Global warming and climate change – UNFCCC – IPCC – COP – Kyoto Protocol – Sustainable development

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. "General Aspects of Energy Management and Energy Audit", 4th edition, Bureau of Energy Efficiency, New Delhi, India, 2015
2. Wayne C. Turner, Steve Doty, "Energy Management Handbook", 6th edition, CRC Press, 2006
3. K V Sharma and P Venkataseshaiah, "Energy Management and Conservation", 1st edition, International Publishing House pvt.ltd,2011.

REFERENCES:

1. Albert Thumann, William J. Younger, "Handbook of Energy Audits", 9th Edition, Taylor & Francis Group, 2013
2. Rajiv Shankar, "Energy Auditing in Electrical Utilities", Viva Books, 2014
3. Rajan, G.G., "Optimizing Energy Efficiencies in Industry", Tata McGraw Hill Publication Company, 2001

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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