PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637018
(AUTONOMOUS)
REGULATIONS 2019
CHOICE BASED CREDIT SYSTEM
B.E. – ELECTRICAL AND ELECTRONICS ENGINEERING

CURRICULUM

(Applicable to the candidates admitted during the academic year 2020-2021 onwards)

SEMESTER V

S. No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	EE20501	Design of Electrical Apparatus	3	0	0	3
2	PC	EE20502	Power Electronics	3	0	0	3
3	PC	EE20503	Control Systems	3	1	0	4
4	PC	EE20504	Electric Vehicle Technology	3	0	0	3
5	PC	EE20505	Power System Analysis	3	0	0	3
6	PE	EE2015*	Professional Elective I	3	0	0	3
Practical							
7	PC	EE20506	Power Electronics Laboratory	0	0	2	1
8	PC	EE20507	Control and Instrumentation Laboratory	0	0	2	1
9	EE	EN20501	Career Development Laboratory I	0	0	2	1
			Total	**18**	**1**	**6**	**22**

SEMESTER VI

S. No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	EE20601	Protection and Switchgear	3	0	0	3
2	PC	EE20602	Solid State Drives	3	0	0	3
3	PC	EE20603	Microprocessors and Microcontrollers	3	0	0	3
4	PC	EE20604	Wind and Solar Energy Systems	3	0	0	3
5	PE	EE2025*	Professional Elective II	3	0	0	3
6	OE	EE2090*	Open Elective I	3	0	0	3
Practical							
7	PC	EE20605	Electrical Drives Laboratory	0	0	2	1
8	PC	EE20606	Microprocessors and Microcontrollers Laboratory	0	0	2	1
9	EE	EN20601	Career Development Laboratory II	0	0	2	1
			Total	**18**	**0**	**6**	**21**

PROFESSIONAL ELECTIVE I

S. No	Category	Course Code	Course Title	L	T	P	C
1	PE	EE20151	Bio Medical Engineering	3	0	0	3
2	PE	EE20152	Nano Science	3	0	0	3
3	PE	EE20153	VLSI Design and Circuits	3	0	0	3
4	PE	EE20154	Communication Engineering	3	0	0	3

PROFESSIONAL ELECTIVE II

S. No	Category	Course Code	Course Title	L	T	P	C
1	PE	EE20251	Restructured Power Systems	3	0	0	3
2	PE	EE20252	Power System Dynamics	3	0	0	3
3	PE	EE20253	Flexible AC Transmission System	3	0	0	3
4	PE	EE20254	Programmable Logic Controllers	3	0	0	3

OPEN ELECTIVE I

S. No	Category	Course Code	Course Title	L	T	P	C
1	OE	EE20901	Basics of Power Electronics	3	0	0	3
2	OE	EE20902	Basics of Power Systems Engineering	3	0	0	3

SEMESTER V

EE20501 DESIGN OF ELECTRICAL APPARATUS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- study about magnetomotive force (MMF) calculation and thermal rating of various types of electrical machines.
- know the design procedure of the armature field commutator, brushes for D.C. machines.
- understand about the core, yoke, windings, and cooling systems of transformers.
- acquire knowledge on dimensions of induction machine.
- gain knowledge on dimensions of synchronous machines.

UNIT I MAGNETIC CIRCUITS AND COOLING OF ELECTRICAL MACHINES 9

Concept of magnetic circuit - MMF calculation for various types of electrical machines, real and apparent flux density of rotating machines; Leakage reactance calculation - Transformers, induction and synchronous machine; Thermal rating - Continuous, short time and intermittent short time rating of electrical machines; Introduction to computer aided design.

UNIT II D.C. MACHINES 9

Constructional details - output equation, main dimensions, choice of specific loadings, choice of number of poles, armature design, design of commutator and brushes, losses and efficiency calculations; Flowchart for computer aided design of D.C. machines.

UNIT III TRANSFORMERS 9

Introduction - output rating of single phase and three phase transformers, optimum design of transformers; Design of core, yoke and windings for core and shell type transformers; Equivalent circuit parameter from designed data; Losses and efficiency calculations; Design of tank and cooling tubes of transformers; Flowchart for computer aided design of transformer.

UNIT IV THREE PHASE INDUCTION MOTORS 9

Introduction - output equation, main dimensions, choice of specific loadings; Design of stator, design of squirrel cage and slip ring rotor, equivalent circuit parameters from designed data, losses and efficiency calculations; Flowchart for computer aided design of three phase induction motors.

UNIT V SYNCHRONOUS MACHINES 9

Introduction - output equation, choice of specific loadings, main dimensions, short circuit ratio; Design of stator and rotor of cylindrical pole and salient pole machines; Design of field coil, performance calculation from designed data; Flowchart for computer aided design of synchronous machines.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of this course, students will be able to

- determine the MMF and thermal rating of electrical machines.
- analyze the dimension to design of D.C Machines.
- estimate the requirements and design the cooling system of transformer.
- examine the design parameters of induction machines.
- analyze the performance of synchronous machine using calculated data.

TEXT BOOKS

1. A.K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, New Delhi,2018.
2. S.K. Sen, "Principles of Electrical Machine Design with Computer Programmes", Oxford and IBH Publishing Co.Pvt Ltd., New Delhi, 2017.

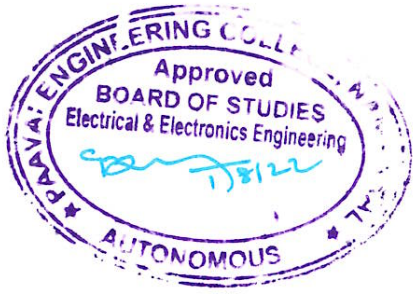
REFERENCES

1. R.K. Agarwal, "Principles of Electrical Machine Design", S.K.Kataria and Sons, Delhi, 2014.
2. V.N. Mittle and A. Mittle, "Design of Electrical Machines", Standard Publications and Distributors, Delhi, 2018.
3. A.ShanmugaSundaram, G.Gangadharan, R.Palani "Electrical Machine Design Data Book", New Age International Pvt. Ltd., Reprint, 2017.
4. M.V.Deshpande —"Design and Testing of Electrical Machine Design" Wheeler Publications, 2018.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2	3	2	1	2	-	1	-	1	2	3	3	3
CO2	3	2	3	2	1	2	-	1	-	1	2	3	3	3
CO3	3	2	3	2	1	2	-	1	-	1	2	3	3	3
CO4	3	2	3	2	1	2	-	1	-	1	2	3	3	3
CO5	3	2	3	2	1	2	-	1	-	1	2	3	3	3



EE20502 **POWER ELECTRONICS** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- impart knowledge on different types of power semi-conductor devices and their switching characteristics.
- know the controlling techniques of switching devices and protection of power semiconductor devices.
- understand the operation of Phase controlled converter and various chopper conversion techniques.
- study the mode of inverters and different modulation techniques.
- learn the types of AC voltage controllers and basics of matrix converters.

UNIT I POWER SEMICONDUCTOR DEVICES **9**

Study of switching devices and its static characteristics - Power diode, SCR, GTO, RCT, LASCR, TRIAC, BJT, power MOSFET, IGBT.

UNIT II GATE DRIVE AND PROTECTION CIRCUITS **9**

Gate triggering circuits - Firing circuit for the SCR, R, RC, UJT; Drive circuits for BJT, gate drive circuits for MOSFET and IGBT; Isolation of gate and base drives - Pulse transformer, optocouplers; Protection circuits - Snubber circuits, di/dt protection with the help of inductor, over current protection; Cooling of semiconductor devices, types of cooling.

UNIT III THYRISTOR RECTIFIERS AND CHOPPER **9**

Phase controlled converter - 2-pulse, 3-pulse and 6-pulse converters; Effect of source inductance; Chopper - Step-down and step-up chopper, switched mode regulators, buck, boost, buck-boost converter; Introduction to resonant converters.

UNIT IV INVERTERS **9**

Single phase and three phase voltage source inverters (both 120^0 mode and 180^0 mode); PWM techniques - Sinusoidal PWM, modified sinusoidal PWM, multi PWM; Introduction to space vector modulation; Current source inverter; Multilevel inverter - Cascaded multilevel inverter, diode clamped multilevel inverter.

UNIT V AC TO AC CONVERTERS **9**

Single phase AC regulator - Sequence control of AC regulators, two stage sequence control, multistage sequence control; Three phase AC regulator; Single phase cycloconverters - Mid-point configuration, bridge configuration; Three phase cycloconverters; Matrix converters.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of this course, students will be able to

- identify and select the switching devices for different power converter applications.
- apply the different controlling techniques and protection schemes based on the load.
- design a suitable DC power supply for given load specification from AC and DC supply.
- describe and analyze the single and three phase inverters.
- explain an AC voltage controller electromagnetic compatibility of power converters.

TEXT BOOKS

1. M.H.Rashid, "Power Electronics: Circuits, Devices Applications", Pearson, 2016.
2. M.D. Singh and Khanchandani K.B., "Power Electronics", Tata Mc.Graw Hill., 2016

REFERENCES

1. L.Umanand, "Power Electronics Essentials and Applications", Wiley India Pvt. Ltd., Reprint, 2015.
2. G.K. Dubey, S.R. Doradla, A. Joshi and R.M.K. Sinha, "Thyristorised Power Controllers", New Age,International Publishers, 2017.
3. Ned Mohan,Tore M. Undeland and William P.Robins, "Power Electronics – Converters, Applications and Design", Third Edition, John Wiley and Sons, 2018.
4. R.S. Ananda Murthy and V. Nattarasu, "Power Electronics: A Simplified Approach", Pearson/Sanguine Technical Publishers,2017 .

CO-PO MAPPING

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's

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CO's	Programme Outcomes PO's												PSO's	
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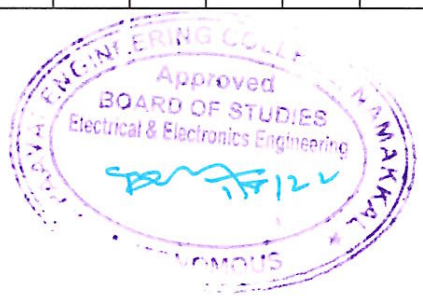
CO1	3	2	3	2	1	2	-	1	-	1	1	3	3	3
CO2	3	2	3	2	1	2	-	1	-	1	1	3	3	3
CO3	3	2	3	2	2	2	-	1	-	1	1	3	3	3
CO4	3	2	3	2	2	2	-	1	-	1	1	3	3	3
CO5	3	2	3	2	2	2	-	1	-	1	1	3	3	3



EE20503 **CONTROL SYSTEMS** **3 1 0 4**

COURSE OBJECTIVES

To enable the students to

- understand the methods of representation of systems and to obtain system transfer function models.
- provide knowledge on time response of systems and steady state error analysis.
- acquaint basic knowledge in obtaining the open loop and closed–loop frequency responses of systems.
- impart the concept of stability of control system and methods of stability analysis, design of compensators for a control system.
- study the concept of state variables, controllability, and observability.

UNIT I SYSTEMS AND THEIR REPRESENTATION 12

Basic elements in control systems - Open and closed loop systems, electrical analogy of mechanical and thermal systems; Transfer function; Synchros; AC and DC servomotors; Block diagram reduction techniques; Signal flow graphs.

UNIT II TIME RESPONSE 12

Time response - Time domain specifications, types of test input, I and II order system response; Error coefficients - Generalized error series, steady state error, P, PI, PID models of feedback control.

UNIT III FREQUENCY RESPONSE 12

Frequency response - Bode plot, Polar plot, Nichol's chart; Determination of closed loop response from open loop response; Correlation between frequency domain and time domain specifications.

UNIT IV STABILITY AND COMPENSATOR DESIGN 12

Characteristics equation - Routh Hurwitz criterion, Nyquist stability criterion, performance criteria; Effect of lag, lead and lag-lead compensation on frequency response; Design of lag, lead and lag - lead compensator using bode plots.

UNIT V STATE VARIABLE ANALYSIS 12

Concept of state variables; State models for linear and time invariant systems; Solution of state and output equation in controllable canonical form; Concepts of controllability and observability.

TOTAL PERIODS: 60

COURSE OUTCOMES

At the end of this course, students will be able to

- model a control system using differential equations and transfer functions.
- analyze the transient response of control systems in using time domain.
- evaluate and analyze control systems using frequency domain methods.
- check the stability of systems and the effect of pole zero addition and design compensators for control systems
- formulate state models for linear and time invariant systems.

TEXT BOOKS

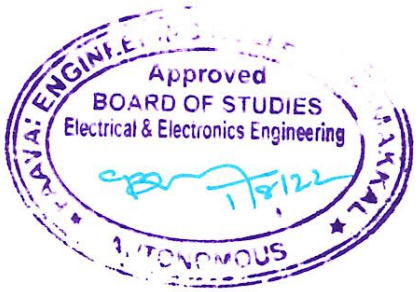
1. I.J. Nagrath& M. Gopal, "Control Systems Engineering", New Age International Publishers, 2017.
2. S.Palani, "Control Systems Engineering", Vijay Nicole Imprints, Third Edition, 2016.

REFERENCES

1. B.C. Kuo, "Automatic Control Systems", Prentice Hall of India Ltd., 2017.
2. M. Gopal, "Control Systems, Principles & Design", Tata McGraw Hill, 2017.
3. K. Ogata, "Modern Control Engineering", Pearson Education, 2015.
4. S.K.Bhattacharya, "Control System Engineering", Pearson, 2018.

CO-PO MAPPING

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
CO's	**Programme Outcomes PO's**												**PSO's**	
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	3	3	3	3	2	1	-	1	1	-	1	1	3	3
CO2	3	2	-	2	3	1	1	-	-	-	1	1	3	3
CO3	3	2	-	2	1	1	-	-	-	1	1	1	3	3
CO4	3	2	3	-	2	1	-	-	1	-	1	1	3	3
CO5	3	2	-	2	1	1	-	-	-	-	1	1	3	3



EE20504 **ELECTRIC VEHICLE TECHNOLOGY** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- learn the architecture, layout of hybrid electric vehicle system.
- acquire knowledge on hybrid electric drive.
- understand the concept of electric motor drive and power converter.
- identify the different types of energy storage systems.
- impart knowledge on electric vehicle charging system.

UNIT I HYBRID ELECTRIC VEHICLES **9**

Classification of hybrid electric vehicles - General architectures of hybrid electric vehicles, typical layouts of the parallel hybrid electric propulsion system; Hybrid electric vehicle system components - Hybrid electric vehicle system analysis, controls of hybrid electric vehicles.

UNIT II HYBRID ELECTRIC DRIVE **9**

Configurations of electric vehicles - Performance of electric vehicles, tractive effort in normal driving; Concept of hybrid electric drive trains; Architectures of hybrid electric drive trains - Series hybrid electric drive trains, parallel hybrid electric drive trains (mechanical coupling).

UNIT III ELECTRIC PROPULSION SYSTEMS **9**

DC motor drives - Principle of operation and performance, combined armature voltage and field control; Induction motor drives - Basic operation principles of induction motors, steady state performance, constant volt/hertz control, power electronic control; Permanent magnetic BLDC (brushless DC) motor drives - Basic principles of BLDC motor drives, BLDC machine construction and classification, control of BLDC motor drives; SRM (Switched Reluctance Motor) drives - basic magnetic structure, torque production., SRM drive converter.

UNIT IV ENERGY STORAGE SYSTEMS **9**

Electrochemical batteries - Ultracapacitors, ultra high speed flywheels; Hybridization of energy storages; Fundamentals of regenerative braking - Braking energy consumed in urban driving, braking energy versus vehicle speed, braking energy versus braking power, braking energy versus vehicle deceleration rate.

UNIT V ELECTRIC VEHICLE CHARGING **9**

Plug-in hybrid vehicle battery system and charging characteristics; Battery life and safety impacts of plug-in charging current and temperature, plug-in charging control, impacts of plug-in charging on the electricity network.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of this course, students will be able to

- explain the general architecture and layout of electric vehicle system.
- enumerate the configuration of electric vehicles and hybrid electric drive trains.
- deliver the concept of electric motor drive and power converter.
- illustrate about different types of energy storage systems.
- understand the concept of electric vehicle charging system.

TEXT BOOKS

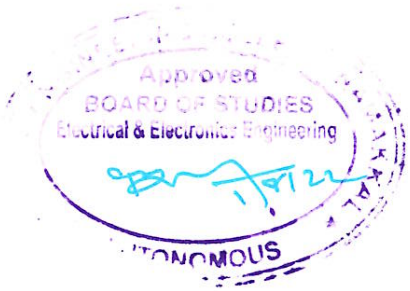
1. Mehrdad Ehsani,Yimin Gao, Stefano Longo, Kambiz M. Ebrahimi, "Modern electric, hybrid Electric, and fuel cell Vehicles" Third Edition, CRC Press, 2018.
2. Wei Liu, "Hybrid Electric Vehicle System Modeling and Control", Second Edition, Wiley, 2017.

REFERENCES

1. James Larminie, John Lowry, "Electric Vehicle Technology Explained", Second Edition, Wiley, 2012.
2. Chris Mi, M. Abul Masrur, David Wenzhong Gao, "Hybrid Electric Vehicles Principles and Applications With Practical Perspectives", Wiley, 2011.
3. Iqbal Husain, "Electric and Hybrid Vehicles Design Fundamentals", Third Edition, CRC Press, 2021.
4. K.T. Chau. "Electric Vehicle Machines and Drives", First Edition, Wiley, 2015.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
	Programme Outcomes PO's												**PSO's**	
CO's	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	3	3	2	3	-	3	-	-	-	3	2	3	3
CO2	3	3	3	2	3	1	3	1	-	-	3	1	3	3
CO3	1	3	3	2	3	-	3	1	-	-	2	2	3	3
CO4	3	3	3	2	3	2	3	-	-	-	3	2	3	3
CO5	1	3	3	2	3	-	3	-	-	-	3	1	3	3



EE20505 **POWER SYSTEM ANALYSIS** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- familiarize the different aspects of modeling of power system components.
- know about the power flow problems using efficient simulation and numerical methods.
- understand the concept of symmetrical faults analysis using algorithms in power system studies.
- study about symmetrical components and unsymmetrical fault analysis.
- know about the power system stability concepts and methods of solving stability problem.

UNIT I THE POWER SYSTEM – AN OVERVIEW AND MODELING **9**

Modern power system; Basic components of a power system; Per phase analysis; Generator model - Transformer model; line model; Per unit system; Change of base.

UNIT II POWER FLOW ANALYSIS **9**

Introduction - Bus admittance matrix, bus classification; Solution of non-linear algebraic equations - Gauss-Seidal method, Newton-Raphson method, fast decoupled method; Flow charts and comparison of the three methods.

UNIT III SYMMETRICAL FAULT ANALYSIS **9**

Assumptions in short circuit analysis - Symmetrical short circuit analysis using Thevenin's theorem; Bus impedance matrix building algorithm (without mutual coupling); Symmetrical fault analysis through bus impedance matrix; Post fault bus voltages, current.

UNIT IV UNSYMMETRICAL FAULT ANALYSIS **9**

Symmetrical components - Sequence impedances, sequence networks; Analysis of unsymmetrical faults at generator terminals - LG, LL and LLG; Unsymmetrical fault occurring at any point in a power system; Computation of post fault currents in symmetrical component and phasor domains.

UNIT V POWER SYSTEM STABILITY ANALYSIS **9**

Importance of stability analysis in power system planning and operation; Classification of power system stability - Angle and voltage stability; Single machine infinite bus (SMIB) system; Development of swing equation - Equal Area criterion, determination of critical clearing angle and time, solution of swing equation by modified Euler method and Runge-Kutta fourth order method.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of this course, students will be able to

- model the analytical concepts of power system components in power systems.
- solve power flow problems by using various methods.
- solve problems on fault analysis under balanced fault conditions in power system.
- compute unsymmetrical faults in power system using bus impedance matrix.
- analyze the stability of power system using modified Euler's method and Runge-Kutta method.

TEXT BOOKS

1. I.J.Nagrath and D.P.Kothari, "Modern Power System Analysis", Tata McGraw-Hill publishing company, New Delhi, 2019.
2. P.Kundur, "Power System Stability and Control", Tata McGraw Hill Publishing Company,New Delhi, 2018.

REFERENCES

1. Olle. I. Elgerd, "Electric Energy Systems Theory – An Introduction", Tata McGraw Hill Publishing Company Limited, New Delhi, Second Edition, 2017.
2. Pai M A, "Computer Techniques in Power System Analysis", Tata McGraw-Hill Publishing Company Ltd., New Delhi, Second Edition, 2018.
3. J. Duncan Glover, Mulukutla S. Sarma, Thomas J. Overbye, "Power System Analysis & Design",CengageLearning, Fifth Edition, 2018.
4. William D Stevenson, "Elements of power system analysis" Fifth Edition Reprint, 2017.

CO-PO MAPPING

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
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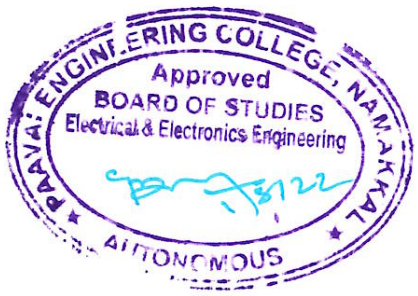
CO1	3	1	1	-	-	1	-	-	2	-	1	2	3	3
CO2	3	3	1	2	-	1	-	-	-	1	1	2	3	3
CO3	3	2	1	2	-	1	-	1	-	2	1	2	3	3
CO4	3	2	1	1	-	1	-	-	-	-	1	2	3	3
CO5	3	3	1	2	-	1	-	-	1	-	1	2	3	3



EE20506 **POWER ELECTRONICS LABORATORY** **0 0 2 1**

COURSE OBJECTIVES

To enable the students to

- study the characteristics of switching devices.
- learn the applications of rectifiers.
- know the performance of inverters and choppers.
- train with the design concepts of AC voltage controllers, and it's controlling techniques.

LIST OF EXPERIMENTS

1. Characteristics of SCR and MOSFET
2. Gate Pulse Generation (Firing angle and PWM Pulse)
3. AC to DC Half and fully controlled converter.
4. Step-down and step-up choppers.
5. IGBT based (1ϕ and 3ϕ) PWM inverter.
6. AC Voltage controller.
7. Simulation of Half and fully controlled converter (1ϕ and 3ϕ)
8. Simulation of 1ϕ and 3ϕ inverter.
9. Simulation of Chopper (Step down, Step up)
10. Simulation of AC Voltage controller (1ϕ and 3ϕ)

TOTAL PERIODS: 30

COURSE OUTCOMES

At the end of this course, students will be able to

- analyze the performance characteristics and applications of various power semi converter devices.
- design the various phase-controlled rectifiers with different loads.
- analyze performance of inverters and choppers using MOSFET, IGBT and PWM inverters.
- evaluate the performance of controlling circuits using AC voltage controllers.

CO-PO MAPPING

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CO1	2	2	1	2	-	1	-	1	-	-	2	2	3	3
CO2	2	2	1	2	-	2	1	-	-	1	2	2	3	3
CO3	2	2	1	2	-	2	-	-	1	-	2	2	3	3
CO4	2	2	1	2	-	1	-	-	1	-	2	2	3	3

EE20507 CONTROL AND INSTRUMENTATION LABORATORY 0 0 2 1

COURSE OBJECTIVES

To enable the students to

- acquire the concept of frequency response of lead/lag compensator and digital control of P,PI,PID.
- gain the knowledge for deriving transfer function and to analyze the stability of systems.
- observe the resistance, inductance and capacitance using bridges.
- learn the performance of instrumentation amplifier, ADC and DAC.

LIST OF EXPERIMENTS

CONTROL SYSTEMS

1. Frequency response of lead/lag compensator.
2. Digital control of P, PI, PID.
3. Study of DC position control system
4. Transfer function of DC motor.
5. Transfer function of DC generator

INSTRUMENTATION

1. AC and DC bridges
2. Temperature and strain measurement.
3. Flow measurement.
4. Instrumentation Amplifier
5. Analog to digital and digital to analog converters.

TOTAL PERIODS: 30

COURSE OUTCOMES

At the end of this course, students will be able to

- analyze the stability of linear systems by various plots.
- test the performance of transfer functions.
- measure the different values of resistance, inductance and capacitance using bridges.
- understand the concept of instrumentation amplifier, ADC and DAC.

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CO1	2	2	1	2	-	1	-	-	-	1	2	2	3	3
CO2	2	2	1	2	-	2	-	1	-	-	2	2	3	3
CO3	2	2	1	2	1	2	-	-	-	-	2	2	3	3
CO4	2	2	1	2	-	1	-	-	-	-	2	2	3	3

EN20501 CAREER DEVELOPMENT LABORATORY I 0 0 2 1

COURSE OBJECTIVES

To enable students to

- enhance their writing skills.
- evaluate their presentation skill to face the corporate world.
- solve the quantitative aptitude problems and improve their mental ability.
- improve the critical thinking and reasoning skills.

UNIT I WRITING SKILLS 6

Writing Skills: The Essentials of Writing – The Importance of Structure – Types of Writing – Common Mistakes in Writing.

Activities: Email Writing - Paragraph writing – Report Writing – Story Writing - Story Telling Session: 2 – JAM Session 1.

UNIT II PRESENTATION SKILLS AND GROUP DISCUSSION 6

Presentation Skills: Types of Presentation– Methods of Delivering Presentation –Ways to improve the Presentation – Presentation Aids: Group Discussion: Introduction –Types and Importance – Why GD – Types of GD- Evaluation Criteria – Do's and Don'ts of GD.

Activities: Presentation Session I, Group Discussion Session I, Role Play Session (Team): Level II – Personality Profile Session II – Company Profile Analysis Session II

UNIT III QUANTITATIVE APTITUDE 6

Simplification – Cubes and Cube Roots – Squares and Square Roots – Boats and Streams – Trains – Profit and Loss – Pipes and Cisterns.

UNIT IV LOGICAL REASONING - I 6

Series Completion – Letter Series – Symbol Series – Number Series – Arithmetic Reasoning.

UNIT V LOGICAL REASONING - II 6

Blood Relations – Seating Arrangement - Character Puzzle.

TOTAL PERIODS: 30

COURSE OUTCOMES

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

- excel in drafting mails and speaking
- demonstrate the participative skills in group discussions.
- solve problems based on quantitative aptitude.
- enhance their logical and verbal reasoning.

TEXTBOOKS

1. Agarwal, R.S." a modern approach to Verbal and Non Verbal Reasoning", S.Chand and Co Ltd, new delhi.2015.

2. Agarwal, R.S. "Objective General English", S.Chand and Co.2016.

REFERENCES

1. Abhijit Guha, "Quantitative Aptitude ", Tata-Mcgraw Hill.2015
2. Word Power Made Easy By Norman Lewis ,Wr.Goyal Publications.2016
3. Johnson, D.W. Reaching out – Interpersonal Effectiveness and self actualization. Boston: Allyn and Bacon.2019
4. Infosys Campus Connect Program – students' guide for soft skills.2015

CO - PO Mapping

Mapping of Course Outcomes with Programme Outcomes: **(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	3	3	1	-	-	-	-	-	-	3	2
CO2	-	2	3	-	2	-	2	-	-	-	-	-	3	2
CO3	3	2	2	-	-	1	-	-	-	-	2	-	2	3
CO4	2	3	3	2	1	3	3	1	-	1	2	-	2	3

SEMESTER VI

EE20601 PROTECTION AND SWITCHGEAR 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- know the characteristics and functions of relays and protection schemes.
- impart knowledge on general protection schemes of the electrical apparatus.
- learn the causes of abnormal operating conditions of the apparatus.
- study the functioning of circuit breakers.
- establish the concept of static and numerical relays.

UNIT I PROTECTIVE RELAYS 9

Principles and need for protective schemes; Methods of neutral grounding - Zones of protection and essential qualities of protection; Construction and characteristics of relays - Over current relays, directional, distance and differential relays, under frequency relays, negative sequence relays.

UNIT II APPARATUS PROTECTION 9

Apparatus protection - Generator and transformer protection, protection of bus bars, transmission lines, CT's, PT's and their application in protective schemes.

UNIT III THEORY OF CIRCUIT INTERRUPTION 9

Physics of arc phenomena and arc interruption - Restriking voltage and recovery voltage, rate of rise of recovery voltage; Current chopping - interruption of capacitive current, resistance switching; DC circuit breaking.

UNIT IV CIRCUIT BREAKERS 9

Types of circuit breakers - Air blast, oil, SF6 and vacuum circuit breakers; Comparative merits of different circuit breakers; Testing of circuit breakers; Circuit breaker ratings.

UNIT V STATIC RELAYS AND NUMERICAL PROTECTION 9

Static relays - phase, amplitude comparators; Synthesis of various relays using static comparators; Block diagram of numerical relays - Over current protection, transformer differential protection and distant protection of transmission lines.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of this course, students will be able to

- recapitulate the construction and operation of protective relays.
- describe the general protection schemes of the electrical apparatus.
- evaluate the theory of circuit interruption.
- identify the circuit breakers based on the operation and characteristics.
- perform synthesis of numerical protection of transmission line using static comparator.

TEXT BOOKS

1. V.K.Mehta, Rohit Mehta "Principles of Power systems" S.Chand Publications, 2017.
2. Y.G.Paithankar and S.R.Bhide, "Fundamentals of Power System Protection", Second Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2016.

REFERENCES

1. Badri Ram ,B.H. Vishwakarma, "Power System Protection and Switchgear", New Age International Pvt. Ltd. Publishers, Second Edition, 2016.
2. C.L. Wadhwa, "Electrical Power Systems", New Age International (P) Ltd., 2014.
3. RavindraP.Singh, "Switchgear and Power System Protection", PHI Learning Private Ltd., NewDelhi, 2015
4. M.L.Soni, P.V.Gupta, U.S.Bhatnagar, A.Chakrabarti, "A Text Book on Power System Engineering", Dhanpat Raiand Co., 2014.

CO-PO MAPPING

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
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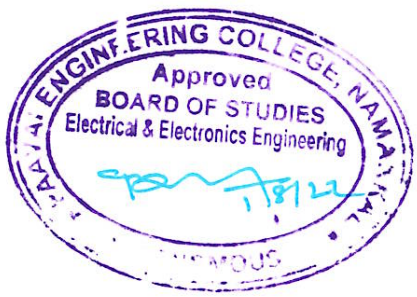
CO5	3	3	1	2	-	1	-	1	-	-	1	2	3	3



EE20602 **SOLID STATE DRIVES** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- understand the stable steady-state operation and transient dynamics of a motor-load system.
- study the operation of the converter/chopper fed dc drive and to solve simple problems.
- learn the operation of both classical and modern induction motor drives.
- comprehend the differences between synchronous motor drive and induction motor drive and to learn the basics of permanent magnet synchronous motor drives.
- know about current and speed controllers for a closed loop solid-state DC motor drive.

UNIT I CHARACTERISTICSOF ELECTRIC DRIVES **9**

Electric Drives - Equations governing motor load dynamics, dynamics of electrical drives, multi quadrant dynamics in the speed torque plane; Regenerative braking - Electrical drives modes of acceleration; Rating of motors and heating cooling of drives; Selection of drives - classes of duty and selection of motor.

UNIT II SOLID STATE CONTROL OF DC DRIVES **9**

Converter fed DC drives; Steady state analysis of single phase and three phase DC drives; Chopper fed DC drive - Four quadrant chopper; Closed loop drive system - Closed loop current limit control scheme, closed loop torque control, closed loop speed control.

UNIT III SOLID STATE CONTROL OF INDUCTION MOTOR DRIVES **9**

Speed control of induction motor drives - Stator voltage control; Adjustable frequency induction motor drives - Voltage / frequency control, closed loop induction motor drive with constant volts/Hz control strategy, rotor controlled induction motor drives, closed loop control of static rotor resistance control; Slip power recovery system; Static Kramer system; Current source inverter fed induction motor drives.

UNIT IV SOLID STATE CONTROL OF SYNCHRONOUS MOTOR DRIVES **9**

Types of synchronous motors - Self-controlled synchronous motor drives; Voltage source inverter fed synchronous motor; Current source inverter fed Synchronous motor; Synchronous motor fed cycloconverter; Brushless DC motor drives; Brushless excitation wound field synchronous motor drives; Synchronous motor power factor control; Closed loop control of synchronous motor drives.

UNIT V DESIGN OF CONTROLLERS FOR SOLID STATE DRIVES **9**

Transfer functions of the DC drive subsystems; DC motor and load, converter, current and speed controllers, Feedback - Current, speed, closed loop control with current and speed feedback; Design of controllers - Current controller and speed controller; Converter selection and characteristics.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of this course, students will be able to

- obtain the stable steady-state and transient dynamics of a motor-load system.
- analyze the operation of the converter / chopper fed dc drive.
- perform analysis of classical and modern induction motor drives.
- differentiate between synchronous motor drive and induction motor drive.
- analyze and design the current, speed controllers for a closed loop solid-state DC motor drive.

TEXT BOOKS

1. Dubey.G.K., "Fundamental of Electrical Drives", Narosa Publishing House, New Delhi, 2018.
2. R.Krishnan, "Electric Motor & Drives: Modeling, Analysis and Control", Prentice Hall of India, 2019.

REFERENCES

1. Murphy, J.M.D and Turnbull.F.G., "Thyristor control of AC Motors", Pergamon Press, New Delhi, 2018
2. Vedam Subramanyan, "Thyristor Control of Electrical Drives", Tata McGraw Hill Publishing Company, New Delhi 2017.
3. Shaahin Felizadeh, "Electric Machines and Drives", CRC Press (Taylor and Francis Group), 2018.
4. Bimal K. Bose. "Modern Power Electronics and AC Drives", Pearson Education, 2016.

CO-PO MAPPING

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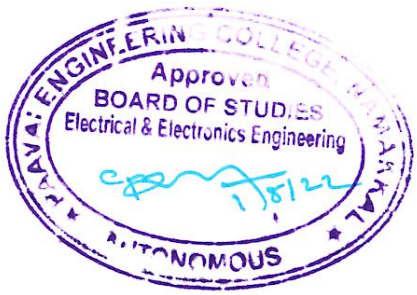
CO4	3	1	2	-	2	1	-	2	-	1	-	1	3	3
CO5	3	1	3	-	3	1	-	-	-	-	1	1	3	3



EE20603 MICROPROCESSORS AND MICROCONTROLLERS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- acquire knowledge on the architecture of 8085 microprocessor.
- familiarize the instructions for 8085 programming.
- gain information about the architecture of 8051 microcontrollers.
- understand the importance of peripheral interfacing.
- know about the programming of microcontroller for application.

UNIT I 8085 PROCESSOR 9

Hardware architecture - Pinouts, functional building blocks of processor; Memory organization - I/O ports and data transfer concept; Timing diagram; Interrupts.

UNIT II PROGRAMMING OF 8085 PROCESSOR 9

Instruction format and addressing modes; Assembly language format - Data transfer, data manipulation and control instructions; Programming - Loop structure with counting and indexing; Look up table - Subroutine instructions - stack.

UNIT III 8051 MICRO CONTROLLER 9

Hardware architecture - Pinouts, functional building blocks of processor; memory organization - I/O ports and data transfer concepts - Data transfer, manipulation, control algorithms and I/O instructions; Timing diagram; Interrupts;.

UNIT IV PERIPHERAL INTERFACING 9

Study on architecture - configuration; Interfacing with ICs - 8255, 8259, 8254, 8279; A/D and D/A converters and interfacing with 8085.

UNIT V MICRO CONTROLLER PROGRAMMING AND APPLICATIONS 9

Simple programming exercises - Keyboard and display interface; Control of servo motor; Stepper motor control; Washing machine control; Application to automation systems.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of this course, students will be able to

- explain the architecture of 8085 microprocessor
- write program using 8085 assembly language.
- describe the architecture of 8051 microcontrollers.
- interface various ICs with 8085.
- develop the microprocessor and microcontroller-based applications

TEXT BOOKS

1. R.S. Gaonkar, "Microprocessor Architecture Programming and Application with 8085", Wiley Eastern Ltd., New Delhi, 2013.
2. Sunil Mathur, Jeebananda Panda, "Microprocessor and Microcontrollers", PHI Learning Pvt. Ltd., 2016.

REFERENCES

1. Muhammad Ali Mazidi, Janice Gilli Mazidi, R.D.Kinely "The 8051 Micro Controller and Embedded Systems", PHI Pearson Education, Fifth Indian Reprint, 2018.
2. Krishna Kant, "Microprocessor and Microcontrollers", Eastern Company Edition, Prentice Hall of India, New Delhi, Reprint 2017.
3. Soumitra Kumar Mandal, "Microprocessor & Microcontroller Architecture, Programming and Interfacing using 8085,8086,8051", McGraw Hill Education, 2013.
4. Ajay V.Deshmukh, "Microcontroller Theory and Applications", McGraw Hill Education, 2016

CO-PO MAPPING

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
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CO2	3	-	1	1	3	1	-	-	-	1	1	1	3	3
CO3	3	-	1	2	3	1	-	-	1	-	2	1	3	3
CO4	3	-	2	1	3	1	-	-	-	1	2	1	3	3
CO5	3	-	2	2	3	1	-	-	1	-	2	1	3	3

EE20604 **WIND AND SOLAR ENERGY SYSTEMS** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- impart knowledge on wind energy conversion(WEC).
- gain idea on performance of wind power generators and control strategies of wind energy conversion systems(WECS).
- understand the process of solar energy conversion using photovoltaic (PV) system.
- impart detailed knowledge of grid connected PV system and MPPT algorithms.
- get basic information of hybrid wind-PV and energy storage.

UNIT I WIND ENERGY CONVERSION SYSTEMS **9**

Basic principle of wind energy conversion - Wind data and energy estimation - Site selection considerations - Basic components of WECS - Classification of WEC systems - Types of wind machines - Horizontal axis machines, vertical axis machine; Wind survey in India.

UNIT II WIND GENERATOR TOPOLOGIES **9**

Induction generators - Doubly-fed induction generators and their characteristics; Permanent-magnet synchronous generators; Power electronics converters; Generator-converter configurations; Converter control; Grid connected WECS.

UNIT III SOLAR PHOTOVOLTAIC SYSTEMS **9**

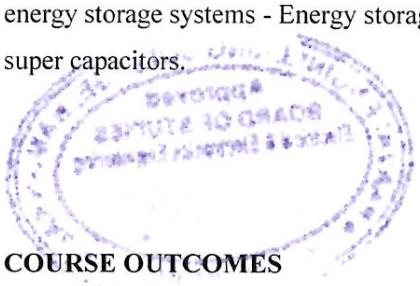
Introduction to PV cell technologies; PV cell - Module and array, equivalent electrical circuit, open circuit voltage and short circuit current, I-V and P-V curves, array design, peak power operation, system components.

UNIT IV PHOTOVOLTAIC ENERGY CONVERSION SYSTEMS **9**

Stand-alone PV systems – Applications; Grid-Connected PV Systems; Grid connection issues; Maximum power point tracking (MPPT) algorithms; Factors affecting PV output; Selection of inverter; Battery sizing; Array sizing; Charge controllers.

UNIT V HYBRID SYSTEM **9**

Need for hybrid systems - Range and types of hybrid systems, layout of wind-PV hybrid system; Role of energy storage systems - Energy storage, construction and working of lithium-ion battery, fuel cells and super capacitors.



TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of this course, students will be able to

- describe about basis of wind power conversion and types of wind machines used.
- analyse the performance of power generators in wind energy conversion.
- explain the process of solar energy conversion using photovoltaic system and applications.

- enumerate the performance of grid connected operation of solar system, selection of inverter, battery and array sizing.
- analyse the layout of hybrid wind-PV system and importance of energy storage.

TEXT BOOKS

1. Mukund R.Patel, "Wind and Solar Power Systems Design, Analysis and Operation", CRC Press, Third Edition, 2021.
2. Muhammad H.Rashid, "Power Electronics Handbook", Butterworth-Heinemann, Fourth Edition, 2017.

REFERENCES

1. G.D.Rai, "Non- conventional resources of energy", Khanna Publishers, Fourth Edition, 2018.
2. Thomas Ackermann, "Wind Power in Power Systems", John Wiley & Sons, Ltd, Second Edition, 2012.
3. S.Sumathi, L.Ashok Kumar, P.Sureka, "Solar PV and Wind Energy Conversion Systems", Springer International Publishing, 2016.
4. Solanki C. S. "Solar Photovoltaics: Fundamentals, Technologies and Applications", Prentice Hall India 2017.

CO-PO MAPPING

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CO4	3	2	2	3	2	1	-	1	-	2	2	3	3	3
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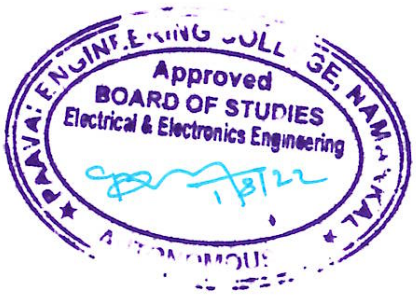

EE20605 **ELECTRICAL DRIVES LABORATORY** **0 0 2 1**

COURSE OBJECTIVES

To enable the students to

- familiar with the speed control concepts of motor drives.
- gain knowledge on DSP induction motor drive.
- acquire knowledge on FPGA for induction motor speed control.
- enhance concepts using chopper fed motor drives.

LIST OF EXPERIMENTS

1. Speed control of DC motor using three phase rectifiers.
2. Speed control of three phase induction motor using PWM inverter.
3. DSP based induction motor drive.
4. Induction motor speed control using FPGA.
5. Speed control of brushless DC motor.
6. DSP based chopper fed DC motor drive.
7. Speed control of DC motor using dual converter.

TOTAL PERIODS: 30

COURSE OUTCOMES

At the end of this course, students will be able to

- apply the speed control concepts of motor drives.
- implement concepts of DSP based electrical drives.
- work with FPGA for induction motor speed control.
- implement chopper fed motor drives.

CO-PO MAPPING

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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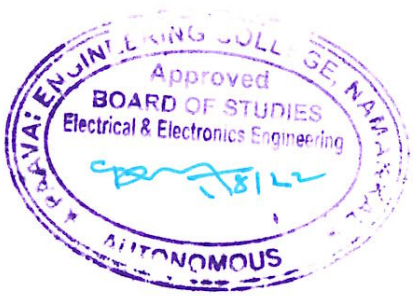

EE20606 **MICROPROCESSORS AND MICROCONTROLLERS LABORATORY** **0 0 2 1**

COURSE OBJECTIVES

To enable the students to

- understand 8085, 8051 programming and instruction sets.
- acquire knowledge on programming concepts.
- know the ideas for code conversion programming.
- Understand 8085 I/O interfacing with peripheral devices such as ADC, DAC, and stepper motor.

LIST OF EXPERIMENTS

I. PROGRAMS USING 8085

1. 8 bit addition and subtraction.
2. 8 bit multiplication and division.
3. Sorting the given set of numbers in ascending and descending order.
4. Code conversion.
5. Interfacing with ADC and DAC.

6 Interfacing with stepper motor.

III.PROGRAMS USING 8051

1. 16 bit addition and subtraction.
2. 16 bit multiplication and division.

TOTAL PERIODS: 30

COURSE OUTCOMES

At the end of this course, students will be able to

- develop programming skills in 8085 microprocessors and 8051 microcontrollers based on its instruction sets.
- write basic programming using 8085 and 8051.
- apply programming concept for code conversion process.
- interface the peripheral devices with 8085.

CO-PO MAPPING

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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EN20601 CAREER DEVELOPMENT LABORATORY II 0 0 2 1

COURSE OBJECTIVES

To enable students to

- draft resume and enhance their skills to manage stress to survive in corporate world.
- excel in interview skills.
- solve the quantitative aptitude problems and improve their problem-solving skills.
- improve their reasoning skills to get placed in reputed companies.

UNIT I RESUME WRITINGS **6**

Resume Writing Skills: Curriculum Vitae and Resume – Things to do while writing a Resume – Mistakes and Pitfalls to Avoid- Cover Letter: General Guidelines – The Content - Stress Management – Dressing Etiquette

Activities: Corporate Resume Building Session I – JAM Session: Level III – Role Play Session (Individual): Level III - Company Profile Analysis Session III – Personality Profile Analysis Session III

UNIT II INTERVIEW SKILLS **6**

Interview Skills: Introduction – Before the Interview – During the Interview – After the Interview – Types of Interview.

Activities: Presentation Session: Level II- Group Discussion Session: Level III ,Mock Interview Practice Session, Corporate Resume Building Session II

UNIT III QUANTITATIVE APTITUDE **6**

Permutation and Combination – Probability: Dice, Colours, Coin, Cards ; Partnership – Ages – Calendars

UNIT IV LOGICAL REASONING -I **6**

Making Judgements – Matching Definitions – Cause and Effect

UNIT V LOGICAL REASONING II **6**

Directions – Syllogism – Analogy – Statements and Arguments

TOTAL PERIODS: 30

COURSE OUTCOMES

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

- write resume and enhance their etiquettes.
- demonstrate the interpersonal skills in group discussions.
- compute problems based on quantitative aptitude.
- reveal their logical and verbal reasoning by scoring the expected percentage to get placed in reputed companies.

TEXTBOOKS

1. Agarwal, R.S." a modern approach to Verbal and Non Verbal Reasoning", S.Chand and Co Ltd, new delhi.2015.
2. Agarwal, R.S. "Objective General English",S.Chand and Co.2016.

REFERENCES

1. Abhijit Guha, "Quantitative Aptitude ", Tata-Mcgraw Hill.2015.
2. Word Power Made Easy By Norman Lewis, Wr.Goyal Publications.2016.
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CO4	2	3	3	2	1	3	3	1	-	1	2	-	2	3

PROFESSIONAL ELECTIVE I

EE20151 BIO MEDICAL ENGINEERING 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the knowledge about the organs of human body and medical instrumentation
- learn the bioelectric signals and electrodes types and various oximeters.
- gain the knowledge about the various measurements of biomedical recorders and types of patient monitoring systems.
- study about the modern imaging systems.
- know the latest technologies in biomedical engineering.

UNIT I FUNDAMENTAL OF MEDICAL INSTRUMENTATION 9

Anatomy and physiology - Physiological systems of the body, heart, lung, kidney; Sources of biomedical signals; Basic medical instrumentation system; Performance requirements of medical instrumentation systems; Intelligent medical instrumentation systems; General constraints in design of medical instrumentation systems; Regulation of medical devices.

UNIT II BIOELECTRIC SIGNALS, ELECTRODES AND OXIMETERS 9

Bioelectric signals and electrodes - Origin of bioelectric signals recording electrodes; Silver-silver chloride electrodes; Electrical conductivity of electrode jellies and creams; Microelectrodes oximeter - Oximetry, ear oximeter, pulse oximeter, skin reflectance oximeter, intravascular oximeter

UNIT III BIOMEDICAL RECORDERS AND PATIENT MONITORING SYSTEMS 9

Biomedical recorders - Electrocardiograph; Vector cardiograph (VCG); Electroencephalograph (EEG); Electromyography (EMG); Patient monitoring systems concepts - Cardiac monitor, Bedside patient monitoring systems, central monitors, measurement of heart rate, measurement of pulse rate.

UNIT IV MODERN IMAGING SYSTEM 9

Ultrasonic diagnosis - Ultrasonic scanning, isotopes in medical diagnosis; Pace makers; Defibrillators; Doppler Monitor (colour); Medical imaging - X-ray generation; Radiographic and fluoroscopic techniques; Image intensifiers; Computer aided tomography; PET; Laser applications; MRI/NMR; Endoscopy.

UNIT V RECENT TRENDS AND INSTRUMENTS FOR THERAPY 9

Dialysers; Surgical diathermy; Electro anaesthetic and surgical techniques; Sources of electric hazards and safety techniques; Telemetry - Single channel, multi-channel, implantable, wireless; Telemedicine - Telemedicine applications; Robotic surgery.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of this course, students will be able to

- acquaint the physiology of the heart, lung, blood circulations, respirations and Medical instrumentation.
- apply the proper bioelectric signals and electrodes types and various oximeters based on the application.
- obtain the knowledge in various biomedical recorders and using of patient monitoring systems.
- know how to use the latest medical equipment's available for measurement of non-electrical parameters in the physiological systems of the human body and the modern methods of imaging techniques used for diagnostic purpose in the health care centre.
- identify the latest procedure adopted for providing medical assistance through telemedicine and the therapeutic equipments used for diagnostic and surgery purposes.

TEXT BOOKS

1. Khandpur, "Handbook of Biomedical Instrumentation" Second Edition, Reprint, Tata McGraw Hill, 2018.
2. M.Arumugam, "Biomedical Instrumentation", Anuradha Publications, Reprint 2017.

REFERENCES

1. Leslie Cromwell, Fred J. Werbell and Eruch A. Pfeigger, "Biomedical Instrumentation and Measurements",Second Edition, Reprint 2017.
2. WQ. J.Tompskins and J.G. Webster, "Design of Microcomputer Based Medical Instrumentation", Prentice-Hall, 2016.
3. Geddes and Baker, "Principle of Applied Biomedical Instrumentation", John Wiley and Sons, New York, 2016.
4. B.M.Weedy and B.J. Cory, "Electric Power Systems", Wiley Fifth Edition, Reprint 2018.

CO-PO MAPPING

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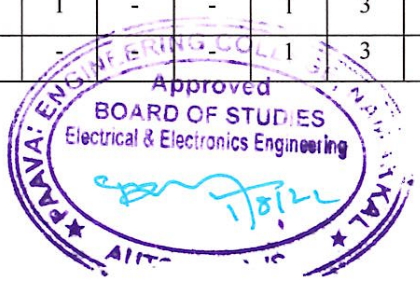
CO5	3	2	-	-	3	2	-	2	-	-	-	1	3	3



EE20152 **NANO SCIENCE** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- impart knowledge on the basics about the semiconductor and optoelectronic materials.
- know about the nano structure properties.
- understand the analysis of quantum techniques.
- know about the different techniques in characterization.
- understand the application of nano science.

UNIT I BASICS OF NANOSCIENCE **9**

Basic properties of conductors, Insulators and semiconductors; Band diagram concept of typical semiconductors; Basic chemistry concepts; Physical aspects, bonding, wave-particle duality, Heisenberg uncertainty principle, Schrodinger wave equation, quantum confinement in 1-D, 2-D and 3-D; Effects of the nanometer length scale - Change in properties.

UNIT II PROPERTIES AND ANALYSIS OF NANOSTRUCTURES **9**

Basic types of nanostructures - Quantum wells, quantum wires, carbon nanotubes, nanowires; Quantum dots, nanoclusters; Nanoparticles - Colloidal nanoparticle crystals, functionalized nanoparticles; Fabrication methods - Top-down processes, bottom-up processes, nanolithography techniques, arc discharge method, laser ablaton method, ion implantation, chemical vapour deposition.

UNIT III ANALYSIS OF QUANTUM TECHNIQUES **9**

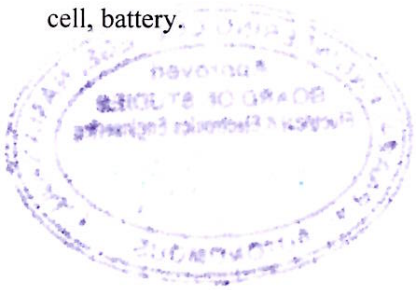
Charging of quantum dots, coulomb blockade, quantum mechanical treatment of quantum wells, wires and dots, widening of band gap in quantum dots, strong and weak confinement; properties of coupled quantum dots; Optical scattering from nan defects.

UNIT IV CHARACTERIZATION TECHNIQUES **9**

Classification of characterization methods; Different microscopy techniques - Light microscopy - Principle, resolution, electron microscopy; Scanning electron microscopy (SEM) - Principle, resolution; Scanning probe microscopy; Scanning tunneling microscopy (STM); Atomic force microscopy (AFM) - Principle, resolution.

UNIT V APPLICATIONS **9**

Information storage - Nano electronics, molecular switch, super chip, nano crystal; Nano biotechlogy - Nano probes in medical diagnostics and biotechnology, nano medicines, targetted drug delivery; Bio imaging - Micro electro mechanical systems (MEMS), nano electro mechanical systems (NEMS); Solar cell, battery.



TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of this course, students will be able to

- explain the concept of nano physics and quantum dots.
- determine the behavior of materials in nano scale.
- examine the energy level of different materials.
- analyze different techniques used in characterization.
- Implement nano science technology in various applications.

TEXT BOOKS

1. K.Bamam and D.Vvedensky, "Low Dimensional Semiconductor Structures", Cambridge University Press, 2017.
2. B. H. Bransden, Charles Jean Joachain "Quantum Mechanics" Prentice Hall, 2017.

REFERENCES

1. A.S. Edelstein and R.C. Cammearata, eds., "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Publishing, Bristol and Philadelphia, 2017.
2. N John Dinardo, "Nanoscale Charecterisation of surfaces & Interfaces", Second Edition, Weinheim Cambridge, Wiley-VCH, 2016.
3. Akhlesh Lakhtakia, "The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations", Prentice-Hall of India (P) Ltd, New Delhi, 2017.
4. Krause P.C. and Wasynczuk O., "Electromechanical Motion Devices", McGraw-Hill, New York, 2017.

CO-PO MAPPING

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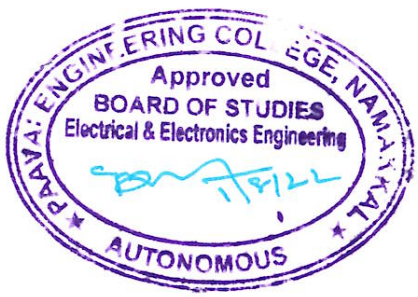

EE20153 **VLSI DESIGN AND CIRCUITS** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- understand the concept of MOS transistors operations and their characteristics.
- analyze about the fabrication process of CMOS technology and its layout design rules.
- devise the process of CMOS and their circuit families.
- know about sheet resistance, area capacitance of layers gate logic, some clocked sequential circuits.
- identify the concepts of algorithmic design flow and programmable logic devices.

UNIT I MOS TECHNOLOGY AND CIRCUITS **9**

Introduction to integrated circuit technology - Basic MOS transistor, depletion mode, enhancement mode; NMOS fabrication; CMOS fabrication - n well, p well, twin tub, SOI, basic electrical properties of MOS device, threshold voltage, body effect, comparison of CMOS and bipolar .

UNIT II MOS CIRCUIT DESIGN PROCESS **9**

MOS layers, stick diagrams, NMOS design style, CMOS design style, design rules and layout, lambda based design rules, contact cut, propagation delays, combinational logic, pass transistor and trans conductance.

UNIT III COMBINATIONAL LOGIC CIRCUITS **9**

Design - Half adder, full adder, multiplexer, demultiplexer, transmission gates; Elmore's delay model - static CMOS design; Power dissipation; Low power design principles; Comparison of circuit families.

UNIT IV DESIGN OF ARITHMETIC BUILDING BLOCKS AND SUBSYSTEM **9**

Arithmetic building blocks - Data paths, adders, multipliers, shifters, ALUs, power and speed tradeoffs; Designing memory and array structures - Memory architectures and building blocks, memory core, memory peripheral circuitry.

UNIT V IMPLEMENTATION STRATEGIES **9**

Full custom and semi-custom ASIC design; Classification of gate arrays; Programmable logic devices PLD; Programming of PAL; FPGA building block architectures; ASIC design flow.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of this course, students will be able to

- design the CMOS circuits, including logic components.
- apply CMOS technology-specific layout rules in the placement and routing of transistors and interconnect.
- verify the functionality, timing, power, and operations of different logic circuits.
- design the logic gates with its characteristics.
- identify to analyze circuits using programmable logic device and design flow.

TEXT BOOKS

1. Neil H.E. Waste and Kamran Eshraghian, "Principles of CMOS VLSI Design", Pearson Education ASIA, Second Edition, 2017.
2. D.A.Pucknell, K.Eshraghian, "Basic VLSI Design", 3rd Edition, Prentice Hall of India, New Delhi, 2016.

REFERENCES

1. Kaushik Roy, Sharat Prasad, "Low Power CMOS VLSI Circuit Design ", Wiley, 2016.
2. N.H.Weste, "Principles of CMOS VLSI Design", Pearson Education, India, 2015.
3. Wayne Wolf, "Modern VLSI Design", Second Edition, Prentice Hall, 2016.
4. S.H.Gerez, "Algorithms for VLSI Design Automation", Wiley, 2015.

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CO5	3	-	2	-	2	-	1	-	-	-	-	2	3	3

EE20154 **COMMUNICATION ENGINEERING** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- understand the fundamentals of analog communication and different type of modulation.
- know about the pulse modulation and on off keying (OOK) Systems.
- gain knowledge on the different coding techniques.
- familiar with the spread spectrum and multiple access techniques in communication systems.
- basics of telecommunication, satellite and optical communication services.

UNIT I ANALOG COMMUNICATION **9**

Amplitude modulation - AM, DSBSC, SSBSC, VSB, PSD modulators and demodulators; Angle modulation; PM and FM ; PSD; Modulators and demodulators; Super heterodyne receivers.

UNIT II DIGITAL COMMUNICATION **9**

Pulse Modulations - Concepts of sampling and sampling theorems; PAM, PWM, PPM, PTM; Quantization technique - Delta modulation, slope overload error; ADM; Pulse code modulation, DPCM; OOK systems - ASK, FSK, PSK, applications of data communication; Time division multiplexing; Frequency division multiplexing.

UNIT III CODING TECHNIQUES **9**

Primary communication - Entropy, properties, BSC, BEC; Source coding - Shannon fanon and Huffman coding theorem; Efficiency of transmissions; Error control codes and applications - Convolutional and block codes.

UNIT IV SPREAD SPECTRUM AND MA TECHNIQUES **9**

Introduction to SS techniques - Direct sequence spread spectrum (DSSS); Frequency hopping spread spectrum (FHSS); Time hopping spread spectrum (THSS); MA Techniques - FDMA , TDMA, CDMA, SDMA, OFDM.

UNIT V COMMUNICATION SERVICES **9**

Telecommunication - GSM architecture, frequency reuse; GPRS; EDGE; Satellite communication - Read, orbit, satellite altitude, transmission path, satellite system; Fiber optical communication - Need, principles of light transmission, optical fiber communication system, light sources, types and configuration of optical fiber.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of this course, students will be able to

- characterize and determine different methods of analog communication schemes.
- describe the pulse modulation of digital communication techniques.
- characterize the different type of coding techniques.
- analyze different spread spectrum and multiple access techniques.
- describe the operation of telecommunication, satellite and optical communication systems.

TEXT BOOKS

1. Taub & Schiling, "Principles of communication systems", Tata McGraw hill, 2017.
2. J.Das, "Principles of digital communication", New Age International, 2015.

REFERENCES

1. Thedore.S.Rappaport, "Wireless Communication", Pearson Education, 2016.
2. Kennedy, "Electronics of Communication Systems", McGraw Hill, Fifth Reprint 2014.
3. Simon Haykin, "Digital Communications", John Wiley, 2016.
4. Lathi B.P. "Modern Digital and Analog Communication Systems", Oxford University Press, 2016.

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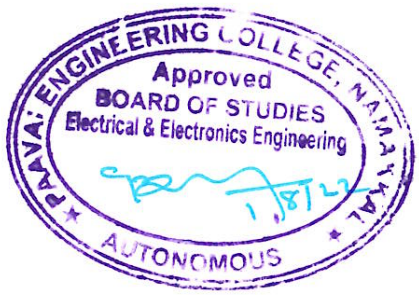

EE20251 **RESTRUCTURED POWER SYSTEMS** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- know the basic restructuring of power industry and market models based on contractual arrangements.
- infer knowledge on fundamental concepts of congestion management.
- gain the concepts of locational marginal pricing and financial transmission rights.
- understand marginal transmission pricing , ancillary services.
- realize the need for tariff, framework of Indian power sector.

UNIT I INTRODUCTION TO RESTRUCTURING OF POWER INDUSTRY **9**

Introduction - Deregulation of power industry, restructuring process, issues involved in deregulation; Deregulation of various power systems; Fundamentals of economics - Consumer behavior, supplier behavior, market equilibrium, short and long run costs, various costs of production; Market models - Market models based on contractual arrangements, comparison of various market models.

UNIT II TRANSMISSION CONGESTION MANAGEMENT **9**

Introduction - Definition of congestion, reasons for transfer capability limitation, importance of congestion management, features of congestion management; Classification of congestion management methods; Calculation of ATC - Non-market methods, market methods, nodal pricing, inter zonal and intra zonal congestion management; Price area congestion management; Capacity alleviation method.

UNIT III LOCATIONAL MARGINAL PRICES AND FINANCIAL TRANSMISSION RIGHTS **9**

Mathematical preliminaries - Locational marginal pricing, lossless DCOPF model for LMP calculation, loss compensated DCOPF model for LMP calculation, ACOPF model for LMP calculation, financial transmission rights; Risk hedging functionality; Simultaneous feasibility test and revenue adequacy; FTR issuance process - FTR auction, FTR allocation; Treatment of revenue shortfall - Secondary trading of FTRs, flow gate rights; FTR and market power, FTR and merchant transmission investment.

UNIT IV ANCILLARY SERVICE MANAGEMENT AND PRICING OF TRANSMISSION NETWORK **9**

Introduction of ancillary services - Types of ancillary services, Classification of ancillary services, load generation balancing related services; Voltage control and reactive power support devices; Black start capability service - ancillary service, co-optimization of energy and reserve services; International comparison; Transmission pricing - Principles, classification, role in transmission pricing methods, marginal transmission pricing paradigm, composite pricing paradigm, merits and demerits of different paradigm.

UNIT V REFORMS IN INDIAN POWER SECTOR **9**

Introduction - Framework of Indian power sector, reform initiatives, availability based tariff; Electricity act 2003, open access issues; Power exchange - Power sector reforms and issues; Case study in India.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of this course, students will be able to

- explain the market models for restructuring of power industry on contractual arrangements.
- implement the concept of congestion management.
- analyze about marginal pricing and financial transmission rights.
- evaluate marginal transmission pricing, ancillary services.
- investigate Indian power sectors reformation through case study.

TEXT BOOKS

1. Mohammad Shahidehpour, Muwaffaq Alomoush, Marcel Dekker, "Restructured Electrical Power Systems: Operation, Trading and Volatility", CRC Press, 2016.
2. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, "Operation of Restructured Power Systems", Kluwer Academic, 2016.

REFERENCES

1. Sally Hunt, "Making Competition Work in Electricity", John Willey and Sons Inc., 2012.
2. Steven Stoft, "Power System Economics: Designing Markets for Electricity", John Wiley and Sons, 2015.
3. S.K Gupta, "Restructuring of Power Systems", I.K. International Publishing House Pvt. Limited, 2018.
4. Ilic, Marija, Galiana, Francisco, Fink, Lester, "Power Systems Restructuring Engineering and Economics", Springer US, 2015.

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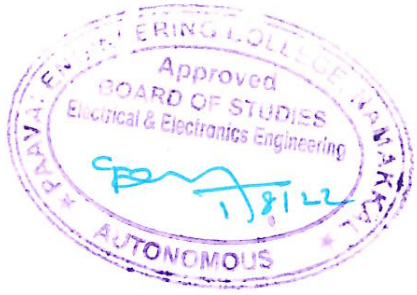

EE20252 **POWER SYSTEM DYNAMICS** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- know the basics of mathematical description of a synchronous machine.
- acquire the knowledge of small signal stability analysis.
- understand the concept of excitation system and its modelling.
- know the stability analysis of various power system networks.
- gain basic concept related to voltage stability in transmission system.

UNIT I SYNCHRONOUS MACHINE MODELING **9**

Synchronous machine - Physical and mathematical description of a synchronous machine; Basic equations of a synchronous machine – dq_0 transformation, per unit representation, equivalent circuits for direct and quadrature axes.

UNIT II SMALL SIGNAL STABILITY ANALYSIS **9**

Classification of stability - Basic concepts and definitions - Rotor angle stability, fundamental concepts of stability of dynamic systems; State-space representation - Stability of dynamic system, linearization, Eigen properties of the state matrix; Single-machine infinite bus (SMIB) configuration - Classical machine model stability analysis with numerical example, small signal stability of multi-machine system.

UNIT III EXCITATION SYSTEMS AND IT'S MODELLING **9**

Excitation system modeling - Excitation system requirements, types of excitation; Dynamic performance measures - Large signal and small signal performance measures, control and protective functions; Modelling of excitation system - Per unit system, modelling of excitation system components, modeling of complete excitation system, field testing for model development and verification.

UNIT IV STABILITY ANALYSIS **9**

Introduction - Factors influencing transient stability, simulation of power system dynamic response; Structure of power system model - Synchronous machine representation, excitation system representation, transmission network and load representation, overall system equations, solution for overall system equation; Analysis of unbalanced faults - Introduction to symmetrical components, sequence impedance of synchronous machine, transmission lines and transformers; Simulation of different types of faults.

UNIT V VOLTAGE STABILITY **9**

Basic concepts related to voltage stability - Transmission system characteristics, generator and load characteristics, characteristics of reactive compensating devices; Voltage collapse - Modelling requirement, dynamic and static analysis, determination of shortest distance to instability; Continuous power flow analysis; Prevention of voltage collapse - System design measures, system operating measures.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of this course, students will be able to

- deliver the basic design consideration of synchronous machine.
- describe the fundamental dynamic behavior of stability analysis in power systems.
- explain excitation system and its modelling.
- interpret analysis of system stability.
- analyze voltage collapse and modelling requirement.

TEXT BOOKS

1. Padiyar K.R., "Power System Dynamics, Stability and Control", Interline Publications, 2017.
2. Prabha, Kundur, "Power System Stability and Control", TMH, Ninth Reprint, 2016.

REFERENCES

1. MarijaIlic; John Zaborszky. "Dynamics and Control of Large Electric Power Systems", IEEE Press and John Wiley and Sons, Inc, 2017.
2. Chakrabarti A, "Power System Dynamics and Simulation", PHI learning private Ltd., 2016.
3. Selected topics from IEEE Transaction and Conference Proceedings.
4. Mircea, Eremia Mohammad Shahidehpour. "Handbook of Electrical Power System Dynamics: Modeling, Stability, and Control", Wiley Publication, 2016.

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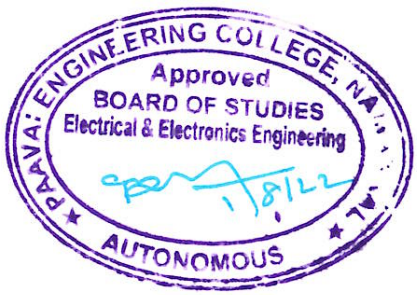

EE20253 **FLEXIBLE AC TRANSMISSION SYSTEM** 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the concepts of FACTS.
- recognize the applications of static VAR compensators in power systems.
- learn about thyristor controlled series capacitor.
- study the operation of static synchronous compensator, static synchronous series compensator.
- understand the working of unified and interline power flow controller.

UNIT I REACTIVE POWER COMPENSATOR 9

FACTS terms and definitions - Reactive power compensation in transmission line, uncompensated transmission line; Principle of reactive power compensation - Passive shunt compensation, passive series compensation, effect on power transfer capacity, series compensation, shunt compensation, compensation devices, passive compensation, active compensation.

UNIT II STATIC VAR COMPENSATOR (SVC) AND APPLICATIONS 9

Static VAR Compensator - FC/TCR type SVC, TCS-TCR type SVC, SVC V-I characteristics; Voltage control by SVC - Advantages of slope in dynamic characteristics, applications; Increases in steady state power transfer capacity, Enhancement of transient stability; Enhancement of power oscillation damping; Prevention of voltage instability.

UNIT III THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC) AND APPLICATIONS 9

Thyristor controlled series capacitor - Operating limits, principle of operation, impedance characteristics, operating modes of TCSC, variable reactance model; Modelling of TCSC - TCSC modeling for steady state and dynamic stability studies, TCSC model for transient and oscillatory stability studies, applications; Improvement of the system stability limit - Enhancement of system damping; Voltage collapse prevention.

UNIT IV STATIC SYNCHRONOUS COMPENSATOR (STATCOM) AND STATIC SYNCHRONOUS SERIES COMPENSATOR (SSSC) 9

Static synchronous compensator - Principle of operation, V-I characteristics, harmonic analysis of VSC/VSI; Multipulse converter configuration; Multilevel configuration; Pulse width modulation, applications; Increases in steady state power transfer capacity; Enhancement of transient stability; Prevention of voltage instability; Static synchronous series compensator (SSSC) - Principle of operation.

UNIT V UNIFIED POWER FLOW CONTROLLER (UPFC) AND INTERLINE POWER FLOW CONTROLLER 9

Unified power flow controller - Principle of operation, modes of operation, UPFC modeling, UPFC load flow model, interfacing the UPFC with the power network, UPFC dynamic model, injection model, applications; Improve damping of power system oscillations - Power system stability enhancement using PSS and UPFC; Interline power flow controller - Principle of operation.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of this course, students will be able to

- analyze the concept of FACTS.
- implement static VAR compensators in power systems.
- apply the thyristor controlled series capacitor concepts in various application.
- describe the static synchronous compensator, static synchronous series compensator.
- explain unified and interline power flow controller.

TEXT BOOKS

1. K.R. Padiyar, "FACTS Controllers for Power Transmission and Distribution" New Age International Publishers, 2016.
2. Narain G. Hingorani, " Understanding FACTS", Wiley, Reprint 2017.

REFERENCES

1. Xiao-Ping Zhang ,"Flexible AC Transmission Systems", Springer, 2016.
2. Narain G.Hingorani, LaszioGyugyi, "Understanding FACTS Concept and Technology", Standard Publisher, Delhi, 2015.
3. A.T.John, "Flexible A.C. Transmission Systems", Institution of Electrical and Electronic Engineers(IEEE), 2016.
4. Vijay K.Sood, "HVDC and FACTS controllers - Applications of Static Converters in Power System", Kluwer Academic Publishers, 2014.

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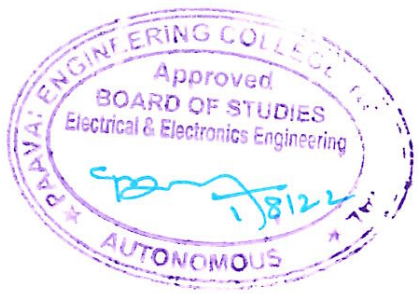
CO2	3	2	2	1	2	-	2	-	-	-	-	1	3	3
CO3	3	2	3	1	2	1	-	1	-	-	-	1	3	3
CO4	3	2	2	2	2	-	-	-	-	1	-	1	3	3
CO5	3	2	2	1	2	-	-	1	-	-	-	1	3	3



EE20254 PROGRAMMABLE LOGIC CONTROLLERS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- develop basic knowledge about PLC architecture.
- study the logical operation of ladder diagram and functional blocks.
- learn implementation of timers, counters and registers in PLC.
- gain knowledge of the data handling and designing systems.
- develop skill in writing simple program in PLC applications.

UNIT I PROGRAMMABLE LOGIC CONTROLLERS 9

Controllers- Hardware, internal architecture; PLC systems - Input/output devices; Number systems - Binary system, octal and hexadecimal, binary arithmetic; PLC data - Input/output units, signal conditioning, remote connections, processing inputs, I/O addresses.

UNIT II LADDER, FUNCTIONAL BLOCK PROGRAMMING AND INTERNAL RELAYS 9

Ladder diagrams - Logic functions, latching, multiple outputs, entering programs; Function blocks - Internal relays, ladder programs; Battery-backed relays - One-shot operation, set and reset, master control relay.

UNIT III TIMERS, COUNTERS AND REGISTERS 9

Types of timers - Programming timers, off-delay timers, pulse timers, forms of counter; Programming - Up and down counting, timers with counters, sequencer, shift registers, ladder programs.

UNIT IV DATA HANDLING AND DESIGNING SYSTEMS 9

Registers and bits - Data handling, arithmetic functions, closed loop control; Program development - Safe systems, commissioning, fault finding, system documentation.

UNIT V PROGRAMMING APPLICATIONS 9

Temperature control; Valve sequencing; Conveyor belt control; Control of a process; Problems.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of this course, students will be able to

- explain the architecture of PLC.
- develop logical operation of ladder diagram in PLC.
- describe implementation of timers, counters and registers in PLC.
- analyze the parameters of data handling and designing systems.
- apply programming for various application in PLC.

TEXT BOOKS

1. W. Bolton, "Programmable Logic Controllers", Elsevier Science, Fourth Edition, Reprint, 2016.
2. Michael P. Lukas, "Distributed Control System", Van Nostrand Reinhold Co.,Canada, 2016.

REFERENCES

1. Hughes, T.A "Programmable Controllers" Fourth Edition, ISA Press, 2015.
2. John W Webb and Ronald A Reis, "Programmable Logic Controllers - Principles and Applications", Prentice Hall Inc., New Jersey, Third Edition, 2013.
3. John R. Hackworth, Frederick D. Hackworth, Jr., "Programmable Logic Controllers – Programming Methods and Applications" Fourth Edition, Pearson Education, 2008.
4. E.A.Parr, "Programmable Controllers an Engineer's Guide", Elsevier Newnes publications 2015.

CO-PO MAPPING

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

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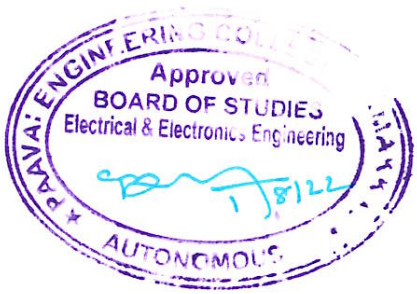

OPEN ELECTIVE I

EE20901 BASICS OF POWER ELECTRONICS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- impart knowledge on different types of power semi-conductor devices and their switching characteristics.
- know the operation of single phase controlled converter with R load.
- understand the various chopper conversion techniques.
- study the mode of inverters and different modulation techniques.
- learn the types of AC voltage controllers and basics of cyclo converters.

UNIT I POWER SEMI-CONDUCTOR DEVICES 9

Study of switching devices - Construction, principle of operation, I-V characteristics of power diode, SCR, TRIAC, GTO, BJT, MOSFET and IGBT.

UNIT II PHASE-CONTROLLED CONVERTERS 9

One pulse converter - Single phase half wave controlled rectifier with R load; Two pulse converter - Single phase half and full wave controlled rectifier with R load, single phase bridge rectifier with R load.

UNIT III DC TO DC CONVERTERS 9

Step-down and step-up chopper - Control strategy; Introduction to types of choppers - Type A, B, C, D and E Chopper; Switched mode regulators - Buck, boost, buck-boost regulator.

UNIT IV INVERTERS 9

Classification of inverter; Single phase half bridge inverter with R load, single phase full bridge inverter with R load; PWM techniques - Multiple PWM, sinusoidal PWM, modified sinusoidal PWM; Current source inverter - Single phase capacitor commutated inverter with R load.

UNIT V AC TO AC CONVERTERS 9

AC voltage controller - Single phase half and full wave AC voltage controllers with R load; Cyclo converter - Step-up cyclo converter, step-down cyclo converter, single phase to single phase cyclo converter, three phase to single phase cyclo converter, three phase to three phase cyclo converter.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of this course, students will be able to

- identify and select the switching devices for different power converter applications.
- apply the different rectification scheme for converting AC into DC voltage.
- design a suitable DC power supply for given load specification from AC and DC supply.
- describe and analyze the single inverters.
- explain an AC voltage controller and cyclo converters.

TEXT BOOKS

1. M.H.Rashid, "Power Electronics: Circuits, Devices Applications", Pearson, 2016.
2. M.D. Singh and Khanchandani K.B., "Power Electronics", Tata Mc.Graw Hill., 2016

REFERENCES

1. L.Umanand, "Power Electronics Essentials and Applications", Wiley India Pvt Ltd, Reprint, 2015.
2. G.K. Dubey, S.R. Doradla, A. Joshi and R.M.K. Sinha, "Thyristorised Power Controllers", New Age, International Publishers, 2017.
3. Ned Mohan,Tore M. Undeland and William P.Robins, "Power Electronics – Converters, Applications and Design", Third Edition, John Wiley and Sons, 2018.
4. R.S. Ananda Murthy and V. Nattarasu, "Power Electronics: A Simplified Approach", Pearson/Sanguine Technical Publishers, 2017 .

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CO5	3	-	1	-	2	1	-	1	-	-	2	1	3	3

EE20902 **BASICS OF POWER SYSTEMS ENGINEERING** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- know the basic components of power systems.
- understand the concept of transmission systems.
- acquire knowledge on distribution systems.
- know about protecting devices in power systems
- impart knowledge on substation and grounding.

UNIT I INTRODUCTION **9**

Structure of electric power system; Variable load on power station; Important terms and factors - Connected load, maximum demand, demand factor, average load, load factor, diversity factor, plant capacity factor, plant use factor; Units generated per annum - Load duration curve.

UNIT II TRANSMISSION SYSTEM **9**

Comparison of D.C. and A.C. transmission; Conductor materials; Line supports; Insulators - Pin type insulator, suspension type insulator, strain insulator; Corona - Definition, factors affecting corona; Underground cables - Basic construction of underground cable.

UNIT III DISTRIBUTION SYSTEMS **9**

Classification of distribution systems; A.C. distribution; D.C. distribution; Overhead versus underground system; Connection schemes of distribution system; Requirements of a distribution system; Design considerations in distribution system.

UNIT IV PROTECTING SYSTEMS **9**

Switchgear - Essential features of switchgear; Switchgear equipment – Switches, fuses, circuit breakers, relays; Faults in power system; Circuit breakers and types - Air blast circuit breakers, SF6 circuit breaker, vacuum circuit breaker.

UNIT V SUBSTATION AND GROUNDING **9**

Classification of substations - Transformer substations, pole mounted substation, underground substation; Grounding - Equipment grounding, system grounding.

TOTAL PERIODS: 45

COURSE OUTCOMES

At the end of this course, students will be able to

- explain about the basic components of power systems.
- describe the concept of transmission systems.
- enumerate knowledge on distribution systems.
- identify protecting devices in power systems
- explain the concept on substation and grounding.

TEXT BOOKS

1. V.K.Mehta, Rohit Mehta "Principles of Power systems" S.Chand Publications, 2017.
2. Y.G.Paithankar and S.R.Bhide, "Fundamentals of power system protection", Second Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2016.

REFERENCES

1. S.N.Singh, "Electric Power Generation, Transmission and Distribution", Prentice Hall of India Pvt.Ltd, New Delhi, 2018.
2. C.L. Wadhwa, "Electrical Power Systems", New Age International (P) Ltd., 2014.
3. Badri Ram, B.H. Vishwakarma, "Power System Protection and Switchgear", New Age International Pvt Ltd Publishers, Second Edition, 2016.
4. M.L.Soni, P.V.Gupta, U.S.Bhatnagar, A.Chakrabarti, "A Text Book on Power System Engineering", Dhanpat Raiand Co.,2014.

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CO5	3	1	1	1	-	1	-	1	1	-	2	1	3	3

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