INSTITUTE OF SCIENCE, TECHNOLOGY & ADVANCED STUDIES (VISTAS)
(Deemed to be University Estd. u/s 3 of the UGC Act, 1956)
PALLAVARAM - CHENNAI
ACCREDITED BY NAAC WITH 'A' GRADE
INSTITUTION WITH UGC 12B STATUS
Marching Beyond 30 Years Successfully

B.Tech
Electrical and Electronics Engineering
(Working Professionals)

Curriculum and Syllabus
Regulation 2024

Based on Choice Based Credit System (CBCS)
and
Outcome Based Education (OBE)

Effective from the Academic year
2024-2025

Department of Electrical and Electronics Engineering
School of Engineering

SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION

To impart quality higher education in the field of Electrical and Electronics Engineering and to create globally competent engineers with aptitude for research, innovation and entrepreneurship and prepare them to serve the industrial and societal needs.

MISSION

Mission No.	Mission Statements
M1	To fortify the students with sound technical competency by providing state of the art teaching and learning.
M2	To impart industry oriented training to enable students to meet day-to-day changes of the field.
M3	To increase the employability and entrepreneurship skills of students through personality development programmes and soft-skills training.
M4	To provide good research atmosphere that would enable students and faculties with opportunities to do research, consultancy and constructive contribution and to be of ethical value to the society.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

After few years of completion of B.E Electrical and Electronics Engineering Programme, the graduates will

PEO No.	Program Educational Objective Statements
PEO 1	Demonstrate their knowledge in Analysis, Design and Configuring of Electrical, Electronics and other allied systems.
PEO 2	Keep up with technological developments, acquire software and hardware proficiency in the field of Electrical and Electronics Engineering to provide scientific solution to future challenges.
PEO 3	Upgrade the potential to pursue higher education and research in his/her professional career.
PEO 4	Possess befitting technical skills to contribute to nurturing society in the ethical, economical and environmental contexts.

PROGRAMME OUTCOMES (POs):

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.

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 assess 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.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO No.	Program Specific Outcome Statements
PSO 1	Learners can apply the knowledge acquired in the field of Electrical and Electronics Engineering to Analyze, Design, and solve problems in various systems.
PSO 2	Graduates can develop sustainable solutions for societal requirements by choosing future ready methods.

COMPETENICES AND PERFORMANCE INDICATORS			
PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.			
1.1	Demonstrate competence in mathematical modelling	1.1.1	Apply mathematical techniques such as Calculus, Linear Algebra, Probability theory and Random process, Fourier series, Fourier Transform, Laplace Transform, and Z-Transform to solve problems.
		1.1.2	Apply advanced mathematical techniques to model and solve Electrical and Electronics engineering problems.
1.2	Demonstrate competence in basic sciences	1.2.1	Apply laws of natural science to an engineering problem.
1.3	Demonstrate competence in engineering fundamentals	1.3.1	Apply fundamental engineering concepts to solve engineering problems
1.4	Demonstrate competence in specialized engineering knowledge to the program	1.4.1	Apply Electrical and Electronics engineering concepts to solve engineering problems.
PO 2: Problem analysis: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.			
2.1	Demonstrate an ability to identify and formulate complex engineering problem	2.1.1	2.1.1 Articulate problem statements and identify objectives
		2.1.2	2.1.2 Identify engineering systems, variables, and parameters to solve the problems
		2.1.3	2.1.3 Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
2.2	Demonstrate an ability to formulate a solution plan and methodology for an engineering problem	2.2.1	Reframe complex problems into interconnected sub-problems
		2.2.2	Identify, assemble and evaluate information and resources.
		2.2.3	Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions

		2.2.4	Compare and contrast alternative solution processes to select the best process.
2.3	Demonstrate an ability to formulate and interpret a model	2.3.1	Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate interms of applicability and required accuracy.
		2.3.2	Identify assumptions (mathematical and physical) necessary to allow modeling of a system at the level of accuracy required.
2.4	Demonstrate an ability to execute a solution process and analyze results	2.4.1	Apply engineering mathematics and computations to solve mathematical models
		2.4.2	Produce and validate results through skillful use of contemporary engineering tools and models
		2.4.3	Identify sources of error in the solution process, and limitations of the solution.
		2.4.4	Extract desired understanding and conclusions consistent with objectives and limitations of the analysis
PO 3: Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.			
3.1	Demonstrate an ability to define a complex/ open- ended problem in engineering terms	3.1.1	Recognize that need analysis is key to good problem definition
		3.1.2	Elicit and document, engineering requirements from stakeholders
		3.1.3	Synthesize engineering requirements from a review of the state-of-the-art
		3.1.4	Extract engineering requirements from relevant engineering Codes and Standards such as IEEE, JEET-Springer,Elsevier etc.
		3.1.5	Explore and synthesize engineering requirements considering health, safety risks, environmental, cultural and societal issues

		3.1.6	Determine design objectives, functional requirements and arrive at specifications
3.2	Demonstrate an ability to generate a diverse set of alternative design solutions	3.2.1	Apply formal idea generation tools to develop multiple engineering design solutions
		3.2.2	Build models/prototypes to develop a diverse set of design solutions
		3.2.3	Identify suitable criteria for the evaluation of alternate design solutions
3.3	Demonstrate an ability to select an optimal design scheme for further development	3.3.1	Apply formal decision-making tools to select optimal engineering design solutions for further development
		3.3.2	Consult with domain experts and stakeholders to select candidate engineering design solution for further development
3.4	Demonstrate an ability to advance an engineering design to defined end state	3.4.1	Refine a conceptual design into a detailed design within the existing constraints (of the resources)
		3.4.2	Generate information through appropriate tests to improve or revise the design
PO 4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.			
4.1	Demonstrate an ability to conduct investigations of technical issues consistent with their level of knowledge and understanding	4.1.1	Define a problem, its scope and importance for purposes of investigation
		4.1.2	Examine the relevant methods, tools and techniques of experiment design, system calibration, data acquisition, analysis and presentation
		4.1.3	Apply appropriate instrumentation and/or software tools to make measurements of physical quantities
		4.1.4	Establish a relationship between measured data and underlying physical principles.
4.2	Demonstrate an ability to design experiments to solve open-ended problems	4.2.1	Design and develop an experimental approach, specify appropriate equipment and procedures
		4.2.2	Understand the importance of the statistical design of experiments and choose an appropriate experimental design plan based on the study objectives

4.3	Demonstrate an ability to analyze data and reach a valid conclusion	4.3.1	Use appropriate procedures, tools and techniques to conduct experiments and collect data
		4.3.2	Analyze data for trends and correlations, stating possible errors and limitations
		4.3.3	Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions
		4.3.4	Synthesize information and knowledge about the problem from the raw data to reach appropriate conclusions
PO 5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.			
5.1	Demonstrate an ability to identify/ create modern engineering tools, techniques and resources	5.1.1	Identify modern engineering tools and techniques and resources for engineering activities.
		5.1.2	Create/adapt/modify/extend tools and techniques to solve engineering problems
5.2	Demonstrate an ability to select and apply discipline- specific tools, techniques and resources	5.2.1	Identify the strengths and limitations of tools for (i) acquiring information, (ii) modeling and simulating, (iii) monitoring system performance, and (iv) creating engineering designs.
		5.2.2	Demonstrate proficiency in using discipline-specific tools
5.3	Demonstrate an ability to evaluate the suitability and limitations of tools used to solve an engineering problem	5.31	Discuss limitations and validate tools, techniques and resources
		5.3.2	Verify the credibility of results from tool use with reference to the accuracy and limitations, and the assumptions inherent in their use.
PO 6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.			

6.1	Demonstrate an ability to describe engineering roles in a broader context, e.g. pertaining to the environment, health, safety, legal and public welfare	6.1.1	Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at the global, regional and local level
6.2	Demonstrate an understanding of professional engineering regulations, legislation and standards	6.2.1	Interpret legislation, regulations, codes, and standards relevant to your discipline and explain its contribution to the protection of the public
PO 7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.			
7.1	Demonstrate an understanding of the impact of engineering and industrial practices on social, environmental and in economic contexts	7.1.1	Identify risks/impacts in the life-cycle of an engineering product or activity
		7.1.2	Understand the relationship between the technical, socio-economic and environmental dimensions of sustainability
7.2	Demonstrate an ability to apply principles of sustainable design and development	7.2.1	Describe management techniques for sustainable development
		7.2.2	Apply principles of preventive engineering and sustainable development to an engineering activity or product relevant to the discipline
PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.			
8.1	Demonstrate an ability to recognize ethical dilemmas	8.1.1	Identify situations of unethical professional conduct and propose ethical alternatives
8.2	Demonstrate an ability to apply the Code of Ethics	8.2.1	Identify tenets of the IEEE professional code of ethics.
		8.2.2	Examine and apply moral & ethical principles to known case studies
PO 9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.			
9.1	Demonstrate an ability to form a team and define a role for each member	9.1.1	Recognize a variety of working and learning preferences; appreciate the value of diversity on a team

		9.1.2	Implement the norms of practice (e.g., rules, roles, charters, agendas, etc.) of effective team work, to accomplish a goal.
9.2	Demonstrate effective individual and team operations--communication, problem-solving, conflict resolution and leadership skills	9.2.1	Demonstrate effective communication, problem-solving, conflict resolution and leadership skills
		9.2.2	Treat other team members respectfully
		9.2.3	Listen to other members
		9.2.4	Maintain composure in difficult situations
9.3	Demonstrate success ina team-based project	9.3.1	Present results as a team, with smooth integration of contributions from all individual efforts
PO 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with the 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			
10.1	Demonstrate an ability to comprehend technical literature and document project work	10.1.1	Read, understand and interpret technical and non-technical information.
		10.1.2	Produce clear, well-constructed, and well-supported written engineering documents.
		10.1.3	Create flow in a document or presentation - a logical progression of ideas so that the main point is clear.
10.2	Demonstrate competence in listening, speaking, and presentation	10.2.1	Listen to and comprehend information, instructions, and viewpoints of others
		10.2.2	Deliver effective oral presentations to technical and non-technical audiences
10.3	Demonstrate the ability to integrate different modes of communication	10.3.1	Create engineering-standard figures, reports and drawings to complement writing and presentations
		10.3.2	Use a variety of media effectively to convey a message in a document or a presentation
PO 11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.			
11.1	Demonstrate an ability to evaluate the economic and financial performance of an engineering activity	11.1.1	Describe various economic and financial costs/benefits of an engineering activity
		11.1.2	Analyze different forms of financial statements to evaluate the financial status of an engineering project

11.2	Demonstrate an ability to compare and contrast the costs/benefits of alternate proposals for an engineering activity	11.2.1	Analyze and select the most appropriate proposal based on economic and financial considerations.
11.3	Demonstrate an ability to plan/manage an engineering activity within time and budget constraints	11.3.1	Identify the tasks required to complete an engineering activity, and the resources required to complete the tasks.
		11.3.2	Use project management tools to schedule an engineering project, so it is completed on time and on budget.
PO 12: Life-long learning: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.			
12.1	Demonstrate an ability to identify gaps in knowledge and a strategy to close these gaps	12.1.1	Describe the rationale for the requirement for continuing professional development
		12.1.2	Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap
12.2	Demonstrate an ability to identify changing trends in engineering knowledge and practice	12.2.1	Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current
		12.2.2	Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field.
12.3	Demonstrate an ability to identify and access sources for new information	12.3.1	Source and comprehend technical literature and other credible sources of information
		12.3.2	Analyze sourced technical and popular information for feasibility, viability, sustainability, etc.
PSO 1:Apply the knowledge acquired in the field of Electrical and Electronics Engineering to Investigate, Analyze, Design and solve problems in various systems			
13.1	Demonstrate an ability to investigate the problems in the field of electrical and electronics engineering	13.1.1	Apply fundamentals of electrical concepts to solve electrical and electronics engineering problems
		13.1.2	Able to find solutions for proper functioning of circuits, systems and products.

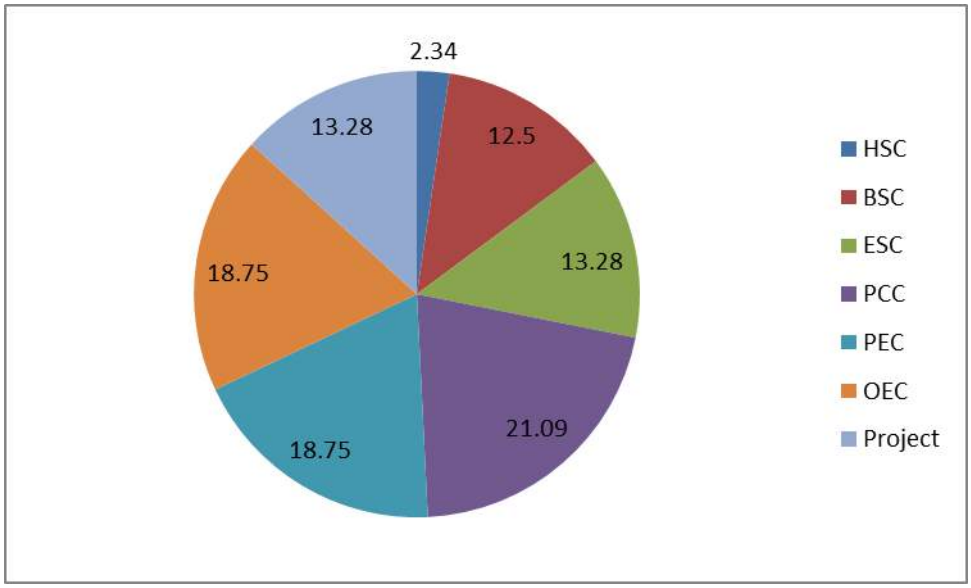
13.2	Demonstrate an ability to analyze, design and evaluate problems in various systems	13.2.1	Able to locate and investigate the problem
		13.2.2	Select and use the suitable tools and methodology for identification of the problem
		13.2.3	Able to eliminate the problem with optimum efforts for proper functioning of circuits, systems and products
PSO 2: Ability to develop sustainable solutions to complex problems in industry and society			
14.1	Demonstrate an ability to develop solutions for electrical and electronics engineering problems in industrial practices	14.1.1	Describe the reason for choosing solutions based on engineering principles
14.2	Demonstrate an understanding of the impact of electrical and electronics engineering on social, environmental and in economic contexts	14.2.1	Design solutions for engineering problems by considering it's effect and society and environment
		14.2.2	Recognize the economic impact of the various process and methods in designing solutions

BOARD OF STUDIES

EXTERNAL MEMBERS		
SL.NO.	**Name & Designation**	**Name of the Institute & Address**
1	**Dr.C.Sharmeela** **Professor/EEE**	Professor/ Electrical and Electronics Engineering, Guindy Campus, Anna University
2	**Dr G Balamurali,** **Executive Engineer /ATC**	Executive Engineer/ATC Office of SE/ Load Despatch and Grid Operation, TANTRANSCO (Tamil Nadu Transmission Corporation Limited), New Building, Third Floor,144, Anna Salai, Chennai 02
3.	**B. Vasanth Kumar** **(Alumnus 2014-2018)**	L-4 Sep automation specialist, Amazon, Bangalore
INTERNAL MEMBERS		
1	**Dr. K. Sasikala,** Associate Professor & Head(i/c)	Department of EEE, Vels Institute of Science, Technology and Advanced Studies
2	**Dr. N. Shanmuga Sundaram,** Associate Professor	Department of EEE, Vels Institute of Science, Technology and Advanced Studies.
3	**Dr.T.R.Premila,** Associate Professor	Department of EEE, Vels Institute of Science, Technology and Advanced Studies.
4.	**Dr. A. Wisemin Lins,** Assistant Professor	Department of EEE, Vels Institute of Science, Technology and Advanced Studies.
5.	**Dr.S.Pradeep Kumar,** Assistant Professor	Department of EEE, Vels Institute of Science, Technology and Advanced Studies.

CREDIT DISTRIBUTION

S. No	Course Category	1	2	3	4	5	6	7	Total Credits
1	HSC	-	3	-	-	-	-		3
2	BSC	8	8	-	-	-	-		16
3	ESC	10	7	-	-	-	-		17
4	PCC	-	-	12	9	6	-		27
5	PEC	-	-	3	6	6	6	3	24
6	OEC	-	-	3	3	6	9	3	24
7	Project	-	-	-	-	-	5	12	17
	TOTAL	18	18	18	18	18	20	18	128



LIST OF ABBREVIATIONS

Course code	Definitions
L	Lecture
T	Tutorial
P	Practical
C	Credits
BSC	Basic Science Courses
ESC	Engineering Science Courses
PCC	Professional core courses
PEC	Professional Elective courses
OEC	Open Elective courses
PROJ	Project

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

CURRICULUM 2024– 2025 (REGULATION – 2024)

Category	Course Title	Hours/Week				Maximum Marks		
		Lecture	Tutorial	Practical	Credits	CA	SEE	Total
SEMESTER I								
BSC	Mathematics (Numerical Methods)	3	1	-	4	40	60	100
ESC	Basic Civil and Mechanical Engineering	3	-	-	3	40	60	100
PCC	Electric Circuit Analysis	3	-	-	3	40	60	100
PCC	Analog Electronics	3	-	-	3	40	60	100
PCC	Electrical Machines - I	3	-	-	3	40	60	100
PCC	Electric Circuits Laboratory	-	-	2	1	40	60	100
PCC	Electrical Machines - I Laboratory	-	-	2	1	40	60	100
Total		**15**	**1**	**4**	**18**			

Category	Course Title	Hours/Week				Maximum Marks		
		Lecture	Tutorial	Practical	Credits	CA	SEE	Total
SEMESTER II								
BSC	Environmental Science and Engineering	3	-	-	3	40	60	100
ESC	Engineering Mechanics	3	-	-	3	40	60	100
PCC	Measurements and Instrumentation	3	-	-	3	40	60	100
PCC	Control Systems	3	1	-	4	40	60	100
PCC	Electrical Machines - II	3	-	-	3	40	60	100
PCC	Measurements and Control System Laboratory	-	-	2	1	40	60	100
PCC	Electrical Machines - II Laboratory	-	-	2	1	40	60	100
Total		**15**	**1**	**4**	**18**			

Category	Course Title	Hours/Week				Maximum Marks		
		Lecture	Tutorial	Practical	Credits	CA	SEE	Total
SEMESTER III								
PCC	Power Electronics	3	1	-	4	40	60	100
PCC	Linear Integrated Circuits	3	-	-	3	40	60	100
PCC	Electrical Machine Design	3	-	-	3	40	60	100
PEC	Professional Elective courses – I	3	-	-	3	40	60	100
OEC	Open Elective Course Technical – I	3	-	-	3	40	60	100
PCC	Analog and Digital Electronics Laboratory	-	-	2	1	40	60	100
PCC	Power Electronics Laboratory	-	-	2	1	40	60	100
Total		**15**	**1**	**4**	**18**			

Category	Course Title	Hours/Week				Maximum Marks		
		Lecture	Tutorial	Practical	Credits	CA	SEE	Total
SEMESTER IV								
PCC	Power System Analysis	3	1	-	4	40	60	100
PCC	Transmission and Distribution	3	-	-	3	40	60	100
PEC	Professional Elective courses– II	3	-	-	3	40	60	100
PEC	Professional Elective courses – III	3	-	-	3	40	60	100
OEC	Open Elective Course Technical – II	3	-	-	3	40	60	100
PCC	Microprocessors and Micro Controllers Laboratory	-	-	2	1	40	60	100
PCC	Power Systems Laboratory	-	-	2	1	40	60	100
Total		**15**	**1**	**4**	**18**			

Category	Course Title	Hours/Week				Maximum Marks		
		Lecture	Tutorial	Practical	Credits	CA	SEE	Total
SEMESTER V								
PCC	Solid State Drives	3	1	-	4	40	60	100
PEC	Professional Elective courses – IV	3	-	-	3	40	60	100
PEC	Professional Elective courses – V	3	-	-	3	40	60	100
OEC	Open Elective Course Technical –III	3	-	-	3	40	60	100
OEC	Open Elective Course Management – I	3	-	-	3	40	60	100
PCC	Electrical Drives Laboratory	-	-	2	1	40	60	100
PCC	Power System Protection Laboratory	-	-	2	1	40	60	100
Total		**15**	**1**	**4**	**18**			

Category	Course Title	Hours/Week				Maximum Marks		
		Lecture	Tutorial	Practical	Credits	CA	SEE	Total
SEMESTER VI								
PEC	Professional Elective courses – VI-	3	-	-	3	40	60	100
PEC	Professional Elective courses – VII	3	-	-	3	40	60	100
OEC	Open Elective Course Technical -IV	3	-	-	3	40	60	100
OEC	Open Elective Course Technical - V	3	-	-	3	40	60	100
OEC	Open Elective Course Management – II	3	-	-	3	40	60	100
Project	Project Phase - I	-	-	4	5	40	60	100
Total		**15**	**-**	**4**	**20**			

Category	Course Title	Hours/Week				Maximum Marks		
		Lecture	Tutorial	Practical	Credits	CA	SEE	Total
SEMESTER VII								
PEC	Professional Elective courses – VIII	3	-	-	3	40	60	100
OEC	Open Elective Course Technical – VI	3	-	-	3	40	60	100
Project	Project Phase - II	-	-	6	12	40	60	100
Total		**6**	**-**	**6**	**18**			

CA - Continuous Assessment, SEE - Semester End Examination

Total Credits: 128

LIST OF COURSES

Basic Science Courses

Code No	Course	Hours/Week			Credits
		Lecture	Tutorial	Practical	
BSC-01	Mathematics(Numerical Methods)	3	1	-	4
BSC-02	Environmental Science and Engineering	3	-	-	3

Engineering Science Courses

Code No	Course	Hours/Week			Credits
		Lecture	Tutorial	Practical	
ESC-01	Basic Civil and Mechanical Engineering	3	-	-	3
ESC-02	Engineering Mechanics	3	-	-	3

Professional Core Courses

Code No	Course	Hours/Week			Credits
		Lecture	Tutorial	Practical	
PCC-01	Electrical Circuit Analysis	3	-	-	3
PCC-02	Analog Electronics	3	-	-	3
PCC-03	Electrical Machines – I	3	-	-	3
PCC-04	Electric Circuits Laboratory	-	-	2	1
PCC-05	Electrical Machines- I Laboratory	-	-	2	1
PCC-06	Measurements and Instrumentation	3	-	-	3
PCC-07	Control Systems	3	1	-	4
PCC-08	Electrical Machines – II	3	-	-	3
PCC-09	Measurements and Control Systems Laboratory	-	-	2	1

PCC-10	Electrical Machines – II Laboratory	-	-	2	1
PCC-11	Power Electronics	3	1	-	4
PCC-12	Linear Integrated Circuits	3	-	-	3
PCC-13	Electrical Machine Design	3	-	-	3
PCC-14	Analog and Digital Electronics laboratory	-	-	2	1
PCC-15	Power Electronics Laboratory	-	-	2	1
PCC-16	Power System Analysis	3	1	-	4
PCC-17	Transmission and Distribution	3	-	-	3
PCC-18	Microprocessor Microcontroller Laboratory	-	-	2	1
PCC-19	Power Systems Laboratory	-	-	2	1
PCC-20	Solid State Drives	3	-	-	3
PCC-21	Electrical Drives laboratory	-	-	2	1
PCC-22	Power System Protection laboratory	-	-	2	1

Professional Elective courses

COURSE CODE	Course	Lecture	Tutorial	Practical	Credits
PEC-01	Power Plant Engineering	3	-	-	3
PEC-02	High Voltage Engineering	3	-	-	3
PEC-03	Special Electrical Machines	3	-	-	3
PEC-04	Power System Operation and Control	3	-	-	3
PEC-05	Microprocessor and Microcontroller	3	-	-	3
PEC-06	Power System Protection and Switchgear	3	-	-	3
PEC-07	Electrical Energy conservation and Auditing	3	-	-	3
PEC-08	Power Quality And Facts	3	-	-	3

PEC-09	Wind And Solar Energy Systems	3	-	-	3
PEC-10	Power Electronics for Renewable Energy Systems	3	-	-	3
PEC-11	Smart Grid	3	-	-	3
PEC-12	SCADA and DCS	3	-	-	3
PEC-13	Digital Electronics	3	-	-	3
PEC-14	HVDC Transmission Systems	3	-	-	3

Open Elective Course

COURSE CODE	Course	Lecture	Tutorial	Practical	Credits
OEC-01	Biomedical Instrumentation (PEC)	3	-	-	3
OEC-02	Artificial Intelligence And Machine Learning	3	-	-	3
OEC-03	Robotics and Automation	3	-	-	3
OEC-04	Microcontroller based System Design	3	-	-	3
OEC-05	Optimization Techniques	3	-	-	3
OEC-06	Communication Engineering	3	-	-	3
OEC-07	Electric Vehicle Mechanics and Control	3	-	-	3
OEC-08	Computer Architecture	3	-	-	3
OEC-09	Embedded Systems	3	-	-	3
OEC-10	Electrical Materials	3	-	-	3

OEC-11	Applied Soft computing	3	-	-	3
OEC-12	Principles of Management and professional Ethics	3	-	-	3
OEC-13	Total Quality Management	3	-	-	3
OEC-14	Organizational Behavior	3	-	-	3

Project Work

Code No	**Course**	**Hours/Week**			**Credits**
		Lecture	**Tutorial**	**Practical**	
Project	Project Phase I	-	-	4	5
Project	Project Phase II	-	-	6	12

SEMESTER I

BSC-01	NUMERICAL METHODS	3	1	0	4

Course Objective:

- Using appropriate numerical methods determine approximate solutions to ordinary differential equations.
- Analyze the errors obtained in the numerical solution of problems.

UNIT I SOLUTION OF EQUATIONS 12 hours

Solution of algebraic and transcendental equations – Newton Raphson method –Regulafalsi method – Solution of linear system of equations- Gauss elimination method – Gauss-Jordon method–Gauss Seidel Method–Gauss Jacobi Method–Matrix Inversion by Gauss Jordon method.

UNIT II INTERPOLATION AND APPROXIMATION 12 hours

Interpolation with unequal intervals-Lagrange's interpolation–Inverse Lagrange's interpolation–Newton's divided difference interpolation– Interpolation with equal intervals– Newton's forward and backward difference formulae

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION 12 hours

Numerical Differentiation: Approximation of derivatives using interpolation polynomials-Numerical integration: Trapezoidal–Simpson's 1/3 and 3/8 rule – Romberg's method – Double integral of Trapezoidal –Simpson's Rule

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 12 hours

Single step methods: Taylor series method – Euler's method–Modified Euler's method– Second order Runge –Kutta method and Fourth order Runge–Kutta method for solving first order equations.

UNIT V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 12 hours

Finite difference methods for solving two-point linear boundary value problems– Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain

TOTAL : 60 hours

Text Books:

T1:Grewal,B.S. and Grewal,J.S., "Numerical methods in Engineering and Science", 9th Edition, Khanna Publishers, New Delhi, 2012.

T2:Gerald,C.F. and Wheatley,P.O., "Applied Numerical Analysis",6th Edition, Pearson Education, Asia, New Delhi, 2006.

T3:Sivaramakrishna Das.P and Vijayakumari.C, Numerical Analysis, Pearson Education Limited in South Asia, First edition 2014.

Reference Books:

R1:Chapra, S. C and Canale, R. P., "Numerical Methods for Engineers", Tata McGraw-Hill, New Delhi, 5th Edition, 2007.

R2:Sankara Rao K, "Numerical Methods for Scientists and Engineers", Prentice Hall of India, New Delhi, 3rd Edition, 2007.

Course Outcome

CO1:	Apply numerical methods to obtain approximate solutions to mathematical problems.	**K3**
CO2:	Understand numerical methods for various mathematical interpolation problems.	**K2**
CO3:	Evaluated if fermentation and integration solutions using numerical methods.	**K3**
CO4:	Understand the initial value problem for ordinary differential equations.	**K4**
CO5:	Understand the boundary value problem for Ordinary differential equations and Partial	**K4**

Mapping of Program Outcomes with Course Outcomes

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

Assessment Methods:

CAT1	CAT2	Model Exam	End Semester Exams	Assignments
✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/Presentatio**
			✓	

ESC-01	BASIC CIVIL AND MECHANICAL ENGINEERING	3	0	0	3

Course Objectives

- To provide the students an illustration of the significance of the Civil and Mechanical Engineering Profession in satisfying the societal needs.
- To help students acquire knowledge in the basics of surveying and the materials used for Construction.
- To provide an insight to the essentials of components of a building and the infrastructure Facilities.
- To explain the component of power plant units and detailed explanation to IC engines their Working principles.
- To explain the Refrigeration & Air-conditioning system.

UNIT I PART A: OVERVIEW OF CIVIL ENGINEERING 5 hours

Civil Engineering contributions to the welfare of Society - Specialized sub disciplines in Civil Engineering – Structural, Construction, Geotechnical, Environmental, Transportation and Water Resources Engineering – National building code – terminologists: Plinth area, Carpet area, Floor area, Buildup area, Floor space index - Types of buildings: Residential buildings, Industrial buildings

UNIT I PART B : OVERVIEW OF MECHANICAL ENGINEERING 4 hours

Surveying: Objects – Classification – Principles – Measurements of Distances and angles – Leveling – Determination of areas– Contours. Civil Engineering Materials: Bricks – Stones – Sand – Cement – Concrete – Steel - Timber – Modern Materials, Thermal and Acoustic Insulating Materials, Decorative Panels, Water Proofing Materials. Modern uses of Gypsum, Pre-fabricated Building component (brief discussion only)

UNIT II SURVEYING AND CIVIL ENGINEERING MATERIALS 9 hours

Surveying: Objects – Classification – Principles – Measurements of Distances and angles – Leveling – Determination of areas– Contours. Civil Engineering Materials: Bricks – Stones – Sand – Cement – Concrete – Steel - Timber – Modern Materials, Thermal and Acoustic Insulating Materials, Decorative Panels, Water Proofing Materials. Modern uses of Gypsum, Pre-fabricated Building component (brief discussion only)

UNIT III BUILDING COMPONENTS AND INFRASTRUCTURE 9 hours

Building plans – Setting out of a Building - Foundations: Types of foundations - Bearing capacity and settlement – Brick masonry – Stone Masonry – Beams – Columns – Lintels – Roofing – Flooring – Plastering. Types of Bridges and Dams – Water Supply Network - Rain Water Harvesting – Solid Waste Management - Introduction to Highways and Railways - Introduction to Green Buildings.

UNIT IV INTERNAL COMBUSTION ENGINES AND POWER PLANTS 9 hours

Classification of Power Plants- Working principle of steam, Gas, Diesel, Hydro -electric and Nuclear Power plants- Internal combustion engines as automobile power plant – Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison of four stroke and two stroke engines. Working principle of Boilers-Turbines, Reciprocating Pumps (single acting and double acting) and Centrifugal Pumps, Concept of hybrid engines. Industrial safety practices and protective devices

UNIT V REFRIGERATION AND AIR CONDITIONING SYSTEM 9 hours

Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and absorption system–Layout of typical domestic refrigerator–Window and Split type room Air conditioner. Properties of air - water mixture, concepts of psychometric and its process.

TOTAL : 45 hours

TEXT BOOKS:

T1. G Shanmugam, M S Palanichamy, Basic Civil and Mechanical Engineering, McGraw Hill Education; First edition, 2018

REFERENCE BOOKS:

R1: Palanikumar, K. Basic Mechanical Engineering, ARS Publications, 2018.
R2: Ramamrutham S., “Basic Civil Engineering”, Dhanpat Rai Publishing Co.(P) Ltd, 2013.
R3: V Seetharaman S., “Basic Civil Engineering”, Anuradha Agencies, 2005.
R4: Shantha Kumar SRJ., “Basic Mechanical Engineering”, Hi-tech Publications, Mayiladuthurai, 2000.

Web Links:

1. https://nptel.ac.in/courses/105106201
2. https://geekztrainerblog.wordpress.com/basic-civil-and-mechanical-engineering/

COURSE OUTCOMES

CO1	Understanding profession of Civil and Mechanical engineering.	K2
CO2	Summarize the planning of building, infrastructure and working of Machineries.	K2
CO3	Apply the knowledge gained in respective discipline	K3
CO4	Illustrate the ideas of Civil and Mechanical Engineering applications.	K2
CO5	Appraise the material, Structures, machines and energy.	K3

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓		✓		✓	

PCC-01	ELECTRIC CIRCUIT ANALYSIS	3	0	0	3

Course Objectives

- To impart knowledge on solving circuit equations using network theorems and to understand the phenomenon of resonance in coupled circuits.
- To develop skill on obtaining the transient response of circuit and analyse three phase circuits to work in the field of electrical engineering.

UNIT I NETWORK THEOREMS 9 hours

Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem. Analysis with dependent current and voltage sources. Concept of duality and dual networks

UNIT II RESONANCE AND COUPLED CIRCUITS 9 hours

Series and parallel resonance – their frequency response – Quality factor and Bandwidth – Self and mutual inductance – Coefficient of coupling – Dot Rule – Conductively Coupled coils - Analysis of coupled circuits - Tuned circuits – Single tuned circuits – Doubled tuned Circuits

UNIT III TRANSIENT RESPONSE ANALYSIS 9 hours

L and C elements -Transient response of RL, RC and RLC Circuits using Laplace transform for DC input and A.C. sinusoidal input

UNIT IV THREE PHASE CIRCUITS 9 hours

Analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced& un balanced – phasor diagram of voltages and currents – power measurement in three phase circuits.

UNIT V TWO PORT NETWORK AND NETWORK FUNCTIONS 9 hours

Two Port Networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections oftwo port networks.

TOTAL : 45 hours

TEXT BOOKS:

T1: William H. HaytJr, Jack E. Kemmerly and Steven M. Durbin, “Engineering Circuits

T2: Analysis”, McGraw Hill publishers, edition, New Delhi, 2013.

T3: Charles K. Alexander, Mathew N.O. Sadiku, “Fundamentals of Electric Circuits”,

T4: Second Edition, McGraw Hill, 2013.

T5: Allan H. Robbins, Wilhelm C. Miller, “Circuit Analysis Theory and Practice”, Cengage Learning India, 2013.

REFERENCE BOOKS:

R1: Chakrabarti A, “Circuits Theory (Analysis and synthesis), DhanpathRai& Sons, New Delhi, 1999.

R2: Jegatheesan, R., “Analysis of Electric Circuits,” McGraw Hill, 2015.

R3: Joseph A. Edminister, MahmoodNahri, “Electric circuits”, Schaum’s series, McGraw- Hill, New Delhi, 2010.

R4: M E Van Valkenburg, “Network Analysis”,Prentice-Hall of India Pvt Ltd, New Delhi,2015.

R5: Mahadevan, K., Chitra, C., “Electric Circuits Analysis,” Prentice-Hall of India Pvt Ltd., New Delhi, 2015.

R6: Richard C. Dorf and James A. Svoboda, “Introduction to Electric Circuits”, 7th Edition, John Wiley & Sons, Inc. 2015.

R7: Sudhakar A and Shyam Mohan SP, “Circuits and Network Analysis and Synthesis”, McGraw Hill, 2015.

WEB LINKS:

1. https://www.khanacademy.org/science/electrical-engineering/ee-circuit-analysis-topic
2. https://www.circuitbasics.com/circuit-analysis/

COURSE OUTCOMES

CO1:	Apply network theorems to reduce the AC and DC network	K 3
CO2:	Understand resonance and coupled circuits	K 2
CO3:	Analyse the transient response for DC and AC circuits	K4
CO4:	Examine 3- phase circuits for calculating impedance, voltage, current, power, phase shift and power factor.	K 4
CO5:	Analyze two port networks and its parameters	K 4

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		

PCC-02	ANALOG ELECTRONICS	3	0	0	3

Course Objectives

- Be familiar with the structure of basic electronic devices.
- Understand the working principle and applications of electronic devices.
- Exposed to the working of amplifiers and oscillators

UNIT I DIODE CIRCUITS 9 hours

PN junction diode –structure, operation and V-I characteristics, diffusion and transition capacitance - Rectifiers – Half Wave and Full Wave Rectifier, Display devices- LED, Laser diodes,Zener Diode characteristics - Zener Reverse characteristics – Zener as regulator

UNIT II BJT CIRCUITS 9 hours

Structure and I-V characteristics of a BJT; BJT as a switch. BJT as an amplifier: small-signal model, biasing circuits; common-emitter, common-base and common collector configuration; Power Transistors, opto couplers

UNIT III MOSFET CIRCUITS 9 hours

MOSFET structure and I-V characteristics. MOSFET as a switch. MOSFET as an amplifier: small-signal model and biasing circuits, common-source, common-gate and common-drain amplifiers; small signal equivalent circuits - gain, input and output impedances, transconductance, high frequency equivalent circuit.

UNIT IV DIFFERENTIAL, MULTI-STAGE AND OPERATIONAL AMPLIFIERS 9 hours

Differential amplifier; power amplifier; direct coupled multi-stage amplifier; internal structure of an operational amplifier, ideal op-amp, non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product)

UNIT V FEEDBACK AMPLIFIERS AND OSCILLATORS 9 hours

Advantages of negative feedback – voltage / current, series, Shunt feedback –positive feedback – Condition for oscillations, phase shift – Wien Bridge, Hartley, Colpitts and Crystal oscillators.

TOTAL : 45 hours

TEXT BOOKS:

T1: J. V. Wait, L. P. Huelsman and G. A. Korn, “Introduction to Operational Amplifier theory and applications”, McGraw Hill U. S., 1992.

T2: J. Millman and A. Grabel, “Microelectronics”, McGraw Hill Education, 1988.

T3: P. Horowitz and W. Hill, “The Art of Electronics”, Cambridge University Press, 1989.

T4: P. R. Gray, R. G. Meyer and S. Lewis, “Analysis and Design of Analog Integrated Circuits”, John Wiley & Sons, 2001.

T5: S. Sedra and K. C. Smith, “Microelectronic Circuits”, New York, Oxford University Press, 1998.

REFERENCE BOOKS:

R1: TheodreF.Boghert, “Electronic Devices & Circuits” Pearson Education, VI Edition, 2003

R2: Rashid, “Microelectronic circuits” Thomson Publication, 1999.

R3: Singh, B.P. and Rekha Sing, “Electronic Devices and Integrated Circuits” Pearson Education, 2006.

R4: Salivahanan.S,Sureshkumar.N “Electronic Devices & Circuits” Tata McGraw-Hill Education, 2011.

WEB LINKS:

1. https://www.electronics-tutorials.ws/transistor/tran_1.html
2. https://www.electronics-tutorials.ws/oscillator/oscillators.html

COURSE OUTCOMES

CO1:	Understand the working principle of basic electronic devices and their applications	K2
CO2:	Analyse the characteristics of various configurations of transistors	K4
CO3:	Understand the characteristics of MOSFET and model its small signal equivalent circuits.	K2
CO4:	Explain the working of multistage amplifier and operational amplifier	K2
CO5:	Understand the working and analyse various types of feedback amplifiers and oscillator circuits.	K2,K4

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓		✓		

PCC-03	ELECTRICAL MACHINES – I	3	0	0	3

Course Objectives

- To impart the knowledge on magnetic circuits and the concepts of induced emfs in both stationary and rotating machines
- Imparting knowledge on Electrical machines and transformers will improve the skills required to work in the field of Electrical Engineering

UNIT I MAGNETIC FIELDS AND MAGNETIC CIRCUITS 9 hours

Review of magnetic circuits - MMF, flux, reluctance, inductance; review of Ampere Law and Biot Savart Law; Visualization of magnetic fields produced by a bar magnet and a current carrying coil - through air and through a combination of iron and air; influence of highly permeable materials on the magnetic flux lines

UNIT II ELECTROMAGNETIC FORCE AND TORQUE 9 hours

B-H curve of magnetic materials; flux-linkage vs current characteristic of magnetic circuits; linear and nonlinear magnetic circuits; energy stored in the magnetic circuit; force as a partial derivative of stored energy with respect to position of a moving element; torque as a partial derivative of stored energy with respect to angular position of a rotating element. Examples - galvanometer coil, relay contact, lifting magnet, rotating element with eccentricity or saliency

UNIT III DC MACHINES 9 hours

Basic construction of a DC machine, magnetic structure - stator yoke, stator poles, pole-faces or shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per pole, induced EMF in an armature coil. Armature winding and commutation – Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation Derivation of back EMF equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction.

UNIT IV DC MACHINE - MOTORING AND GENERATION 9 hours

Armature circuit equation for motoring and generation, Types of field excitations – separately excited, 61 shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. V-I

characteristics and torque-speed characteristics of separately excited, shunt and series motors. Speed control through armature voltage. Losses, load testing and back-to-back testing of DC machines

UNIT V TRANSFORMERS 9 hours

Principle, construction and operation of single-phase transformers, equivalent circuit, phasor diagram, voltage regulation, losses and efficiency Testing - open circuit and short circuit tests polarity test, back-to-back test, separation of hysteresis and eddy current losses Three-phase transformer- construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers, Autotransformers – construction principle, applications and comparison with two winding transformer - Scott connection, Tap-changing transformers - No-load and on-load tap-changing of transformers, Three-winding transformers, Cooling of transformers.

TOTAL : 45 hours

TEXT BOOKS:

T1: Stephen J. Chapman, 'Electric Machinery Fundamentals'4th edition, McGraw Hill Education Pvt. Ltd, 2010.

T2: P.C. Sen'Principles of Electric Machines and Power Electronics' John Wiley & Sons; 3rd Edition 2013.

T3: Nagrath, I.J. and Kothari.D.P., Electric Machines', McGraw-Hill Education, 2004

REFERENCE BOOKS:

R1: Theodore Wildi, "Electrical Machines, Drives, and Power Systems", PearsonEducation., (5th Edition)**,** 2002**.**

R2: B.R. Gupta ,'Fundamental of Electric Machines' New age International Publishers,3rdEdition ,Reprint 2015.

R3: S.K. Bhattacharya, 'Electrical Machines' McGraw - Hill Education, New Delhi, 3rdEdition,2009.

R4: Vincent Del Toro, 'Basic Electric Machines' Pearson India Education, 2016.Surinder Pal Bali, 'Electrical Technology Machines & Measurements, Vol.II, Pearson,2013.

R5: Fitzgerald. A.E., Charles Kingsely Jr, Stephen D.Umans, 'Electric Machinery', Sixthedition, McGraw Hill Books Company, 2003.

WEB LINKS:

1. https://www.electricaltechnology.org/2020/04/dc-machine-types-working.
2. https://circuitglobe.com/

COURSE OUTCOMES

CO1:	Understand the operation of magnetic circuits	K 2
CO2:	Understand the principles of induced emfs and torque in stationary and rotating machines	K 2
CO3:	Analyze the operation of dc machines.	K4
CO4:	Analyze the differences in operation of different dc machine configurations	K 2
CO5:	Analyze the single phase and three phase transformers circuits.	K 4

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓		✓		

PCC-04	ELECTRIC CIRCUITS LABORATORY	0	0	2	1

COURSE OBJECTIVE:

- To simulate various electric circuits using Simulation Software
- To gain practical experience on electric circuits and verification of theorems.

LIST OF EXPERIMENTS

1. Simulation and experimental verification of electrical circuit problems using Kirchhoff's voltage and current laws.
2. Simulation and experimental verification of electrical circuit problems using Thevenin's theorem.
3. Simulation and experimental verification of electrical circuit problems using Norton's theorem.
4. Simulation and experimental verification of electrical circuit problems using Superposition theorem.
5. Simulation and experimental verification of Maximum Power transfer Theorem.
6. Study of oscilloscopes and measurement of sinusoidal voltage, frequency and time period.
7. Simulation of R- L and R-C electric circuit transients.
8. Design and Simulation of series resonance and parallel resonance circuit.
9. Experimental determination of power in three phase circuits by two-watt meter method
10. Simulation of three phase balanced and unbalanced star, delta networks circuits

COURSE OUTCOMES

CO1:	Analyze the various electrical circuits using circuit laws	K4
CO2:	Understand and apply network theorems to various electrical circuits	K2
CO3:	Determine transient response of RL and RC electrical circuit	K5
CO4:	Determine power and power factor in three phase circuits	K5
CO5:	Design and Simulate series resonance, parallel resonance and three phase balanced, unbalanced, star and delta circuits.	K6

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2
CO1	3	3	2	3	3	-	-	-	-	-	-	-	3	3
CO2	3	3	2	3	3	-	-	-	-	-	-	-	3	3
CO3	3	3	2	3	3	-	-	-	-	-	-	-	3	3
CO4	3	3	2	3	3	-	-	-	-	-	-	-	3	3
CO5	3	3	2	3	3	-	-	-	-	-	-	-	3	3

ASSESSMENT METHODS

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
		✓	✓		
Quiz	MCQ	Projects	Seminars	Demonstration/ Presentation	Open book test

PCC-05	ELECTRICAL MACHINES - I LABORATORY	0	0	2	1

COURSE OBJECTIVE:

- To have knowledge about the working of various types of motors using loads.
- To understand the operation of transformer with and without applying load and determine its efficiency. To gain knowledge in the operation of three phase transformer.
- To perform Hopkinson's and sumpner's test to determine the efficiency of the motor.

LIST OF EXPERIMENTS

1. Load test on DC shunt Motor
2. Load test on DC series Motor
3. Load test on DC compound Motor
4. Open circuit and load characteristics of DC shunt Generator
5. Load test on single-phase Transformer
6. Speed control of DC shunt Motor
7. Load characteristics of DC compound Generator
8. Open circuit and short circuit test on single phase Transformer
9. Swinburne's test on DC Motor
10. Hopkinson's test on DC Machine

COURSE OUTCOMES

CO1	Select range of apparatus based on the rating of single phase transformers and machines	K3
CO2	Understand steady state performance characteristics of DC machines	K2
CO3	Determine the performance characteristics of DC machines and transformers	K5
CO4	Demonstrate the speed control of DC shunt motors	K2
CO5	Determine the efficiency of DC machines by conducting variable tests	K5

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
		✓	✓		
Quiz	MCQ	Projects	Seminars	Demonstration/ Presentation	Open book test

SEMESTER II

BSC- 02	ENVIRONMENTAL SCIENCE AND ENGINEERING	3	0	0	3

Course Objectives

- To inculcate the importance of environmental pollution, preservation of nature and environmental management for human welfare.
- To understand what constitutes the environment, what are precious resources in the environment, how to conserve these resources, what is the role of a human being in maintaining a clean environment and useful environment for the future generations and how to maintain ecological balance and preserve bio-diversity. The role of government and non – governmental organization in environmental managements

UNIT I ENVIRONMENT, ECOSYSTEM AND BIODIVERSITY 9 hours

Definition – Scope and importance – Need for public awareness – Concepts of an Ecosystem – Structure and Function of an Ecosystem –Producers, Consumers and Decomposers – Energy Flow in the Ecosystem – Ecological Succession – Food Chains, Food Webs and Ecological Pyramids – Introduction, Types, Characteristic Features, Structure and Function of the (A) Forest Ecosystem (B) Grassland Ecosystem (C) Desert Ecosystem (D) Aquatic Ecosystems (Ponds, Streams, Lakes, Rivers, Oceans, Estuaries) – Introduction to Biodiversity – Definition: Genetic, Species and Ecosystem Diversity – Bio geographical Classification of India – Value of Biodiversity: Consumptive Use, Productive Use, Social, Ethical, Aesthetic and Option Values – Biodiversity at Global, National and Local Levels – India as a Mega-Diversity Nation – Hot-Spots of Biodiversity – Threats to Biodiversity: Habitat Loss, Poaching of Wildlife, Man-Wildlife Conflicts – endangered and Endemic Species of India – Conservation of Biodiversity: In-Situ and Ex-Situ conservation of Biodiversity. Field Study of Common Plants, Insects and Birds. Field study of simple ecosystems - pond, river, hill slopes, etc.

UNIT II ENVIRONMENTAL POLLUTION 9 hours

Definition – Causes, Effects and Control Measures of (A) Air Pollution (B) Water Pollution (C) Soil Pollution (D) Marine Pollution (E) Noise Pollution (F) Thermal Pollution (G) Nuclear Hazards – Solid Waste Management:- Causes, Effects and Control Measures of municipal solid Wastes – Role of an Individual in Prevention of Pollution – Pollution Case Studies – disaster Management - Floods, Earthquake, Cyclone and Landslides. Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES 9 hours

Forest resources -Use and over – Exploitation – Deforestation – Case studies – Timber extraction – Mining – Dams and their ground water – Floods – Drought – Conflicts over water –Dams – Benefits and Problems – Mineral Resources- Use and Exploitation, Environmental Effects of Extracting and Using Mineral Resources, Case Studies – Food Resources: World Food Problems, Changes caused by Agriculture and Overgrazing, Effects of Modern Agriculture, Fertilizer- Pesticide Problems, Water Logging, salinity, Case Studies – Energy Resources:- Growing Energy Needs, Renewable and Non Renewable Energy Sources, Use of Alternate Energy Sources, Case Studies – Land Resources - Land as a Resource, Land Degradation, Man Induced Landslides, Soil Erosion and Desertification – Role of an Individual in Conservation of Natural Resources – Equitable use of Resources for Sustainable Lifestyles. Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 9 hours

From Unsustainable To Sustainable Development – Urban Problems Related to energy – Water conservation, Rain Water Harvesting, Watershed Management – Resettlement and Rehabilitation of People, its Problems and Concerns, Case Studies Role of non – governmental organization - Environmental Ethics- Issues and Possible Solutions – Climate Change, Global Warming, Acid Rain, Ozone Layer Depletion, Nuclear Accidents and Holocaust, Case Studies –Wasteland Reclamation – Consumerism and Waste Products – Environment Production Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and Control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act –enforcement machinery involved in environmental Legislation – Central and state pollution control boards - Public Awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 9 hours

Population Growth, Variation among Nations – Population Explosion Family Welfare Programme – environment and Human Health – Human Rights –Value Education – HIV /AIDS – Women and Child Welfare – Role of Information Technology in Environment and Human Health – Case Studies.

TOTAL : 45 hours

Text Books:

T1: De AK, Environmental Chemistry, Wiley Eastern Ltd. Bharucha Erach, 2003. The Biodiversity of India, Mapin Publishing Pvt. Ltd, India.

T2: Brunner RC, 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480pgs.

T3: Clark RS, Marine Pollution, Clanderson Press, Oxofrd (TB).

Reference Books:

R1: E Agarwal KC, 2001. Environmental Biology, Nidi Publishers Ltd. Bikaner.

R2: Gleick HP, 1993. Water in Crisis, Pacific Institute for Studies in Development, Environment and Security. Stockholm Environmental Institute, Oxford University Press, 473pgs.

R3: Heywood VH, and Watson RT, 1995. global Biodiversity Assessment. Cambridge University Press 1140pgs

R4: B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.

Web Links:

1. https://www.udemy.com/course/environmental-science/

COURSE OUTCOMES

CO1:	Understanding of issues related to environment and their impact on the human life.	K2
CO2:	Analyze the solutions related to the environmental problem	K4
CO3:	Analyze the pollution impacts due to Natural resources	K4
CO4:	Create the awareness about different component of environment and their function and sustainable development	K6
CO5:	Create awareness about human population in worldwide and their causes effect and role of information technology on control measures for sustainable	K6

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		

ESC-02	ENGINEERING MECHANICS	3	0	0	3

Course Objectives

- At the end of this course the student should be able to understand the vectorial and scalar representation of forces and moments, static equilibrium of particles and rigid bodies both in two dimensions and also in three dimensions. Further, he should understand the principle of work and energy.
- He should be able to comprehend the effect of friction on equilibrium. He should be able to understand the laws of motion, the kinematics of motion and the interrelationship. He should also be able to write the dynamic equilibrium equation. All these should be achieved both conceptually and through solved examples.

UNIT I BASICS AND STATICS OF PARTICLES 9 hours

Introduction – Units and Dimensions – Laws of Mechanics – Lame's theorem, Parallelogram and triangular Law of forces – Vectors – Vectorial representation of forces and moments – Vector operations: additions, subtraction, dot product, cross product – Coplanar Forces – Resolution and Composition of forces – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility – Single equivalent force.

UNIT II EQUILIBRIUM OF RIGID BODIES 9 hours

Free body diagram – Types of supports and their reactions – requirements of stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions – Examples

UNIT III PROPERTIES OF SURFACES AND SOLIDS 9 hours

Determination of Areas and Volumes – First moment of area and the Centroid of sections – Rectangle, circle, triangle from integration – T section, I section, Angle section, Hollow section by using standard formula – second and product moments of plane area – Rectangle, triangle, circle from integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem – Polar moment of inertia – Principal moments of inertia of plane areas – Principal axes of inertia – Mass moment of inertia – Derivation of mass moment of inertia for rectangular section, prism, sphere from first principle – Relation to area moments of inertia.

UNIT IV DYNAMICS OF PARTICLES 9 hours

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion – Newton's law – Work Energy Equation of particles – Impulse and Momentum – Impact of elastic bodies

UNIT V FRICTION AND ELEMENTS OF RIGID BODY DYNAMICS 9 hours

Frictional force – Laws of Coulomb friction – simple contact friction – Rolling resistance – Belt friction. Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion.

TOTAL : 45 hours

TEXT BOOKS:

T1: Beer, F.P and Johnson Jr. E.R. "Vector Mechanics for Engineers", Vol. 1 Statics and Vol. 2 Dynamics, McGraw-Hill International Edition, 1997.

T2: Rajasekaran. S, Sankarasubramanian. G., "Fundamentals of Engineering Mechanics", Vikas Publishing House Pvt. Ltd., 2000.

REFERENCE BOOKS:

R1: Hibbeller, R.C., "Engineering Mechanics", Vol. 1 Statics, Vol. 2 Dynamics, Pearson Education Asia Pvt. Ltd., 2000.

R2: Palanichamy, M.S., Nagam, S., "Engineering Mechanics – Statics and Dynamics", Tata McGraw-Hill, 2001.

R3: Irving H. Shames, "Engineering Mechanics – Statics and Dynamics", IV Edition – Pearson Education Asia Pvt. Ltd., 2003.

R4: Ashok Gupta, "Interactive Engineering Mechanics – Statics – A Virtual Tutor (CDROM)", Pearson Education Asia Pvt., Ltd., 2002.

WEB LINKS:

1. https://nptel.ac.in/courses/112103109
2. https://www.real-world-physics-problems.com/engineering-mechanics-

COURSE OUTCOMES

CO1:	Solve engineering problems dealing with force, displacement, velocity and acceleration.	K6
CO2:	Evaluate problems on equilibrium of rigid bodies	K5
CO3:	Determine the areas and volumes of surface and solids	K5
CO4:	Explain dynamics of particles and their relationships between motions	K5
CO5:	Analyze friction and elements of rigid body dynamics	K4

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓		✓		✓	

PCC-06	MEASUREMENTS AND INSTRUMENTATION	3	0	0	3

Course Objectives

- To develop the skill on functional aspects of measuring instruments.
- To educate the fundamental concepts and characteristics of measurement and errors.
- To educate the fundamental working of sensors and transducers and their applications.

UNIT I CONCEPTS OF MEASUREMENTS 9 hou

Instruments: classification, applications – Elements of a generalized measurement system - Static and dynamic characteristics - Errors in measurement -Statistical evaluation of measurement data, Standards and calibration.

UNIT II MEASUREMENT OF PARAMETERS IN ELECTRICAL SYSTEMS 9 hours

Classification of instruments – moving coil and moving iron meters – Induction type, dynamometer type wattmeter – Energy meter – Megger – Instrument transformers (CT & PT).

UNIT III AC/DC BRIDGES AND INSTRUMENTATION AMPLIFIERS 9 hours

Wheatstone bridge, Kelvin double bridge - Maxwell, Hay, Wien and Schering – Errors and compensation in A.C. bridges - Instrumentation Amplifiers.

UNIT IV STORAGE AND DISPLAY DEVICES 9 hours

Magnetic disk and tape – Recorders, digital plotters and printers, CRT display, digital CRO, LED, LCD & Dot matrix display – Data Loggers.

UNIT V TRANSDUCERS AND DATA ACQUISITION SYSTEMS 9 hours

Classification of transducers – Selection of transducers – Resistive, capacitive & inductive transducers – Piezoelectric, optical and digital transducers – Elements of data acquisition system - A/D, D/A converters – Smart sensors.

TOTAL : 45 hours

TEXT BOOKS:

T1: A.K. Sawhney, 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2010.

T2: J. B. Gupta, 'A Course in Electronic and Electrical Measurements', S. K. Kataria & Sons, Delhi, 2013.

T3: Doebelin E.O. and Manik D.N., Measurement Systems – Applications and Design, Special Indian Edition, McGraw Hill Education Pvt. Ltd., 2007

REFERENCE BOOKS:

R1: H.S. Kalsi, 'Electronic Instrumentation', McGraw Hill, III Edition 2010

R2: D.V.S. Murthy, 'Transducers and Instrumentation', Prentice Hall of India Pvt. Ltd, 2015

R3: David Bell, 'Electronic Instrumentation & Measurements', Oxford University Press, 2013

WEB LINKS:

1. https://www.tutorialsduniya.com/notes/electronic-instrumentation-notes/

COURSE OUTCOMES

CO1	Understand the functional elements of an instrument and analyze the static and dynamic characteristics of an instrument.	K2
CO2	Classify the measuring instruments based on the measuring quantity and explain its working principle.	K4
CO3	Determine the unknown component value using the bridge circuits.	K5
CO4	Classify the display devices and to explain their working principle and uses.	K4
CO5	Classify different types of transducers and their principle of operation.	K4

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**CAT 3**
✓	✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓	✓	

PCC-07	CONTROL SYSTEMS	3	1	0	4

Course Objectives

- To make the students familiarize various representations of systems and analyze the stability of linear systems in time domain and frequency domain.
- To develop linear models mainly state variable model and Transfer function model
- To make the students design compensator based on the time and frequency domain Specifications

UNIT I INTRODUCTION TO CONTROL SYSTEM 12 hours

Control system: Open loop and Closed loop – Feedback control system characteristics – First principle modeling: Mechanical, Electrical and Electromechanical systems – Transfer function representations: Block diagram and Signal flow graph.

UNIT II TIME DOMAIN ANALYSIS 12 hours

Standard test inputs – Time responses – Time domain specifications – Stability analysis: Concept of stability – Routh Hurwitz stability criterion – Root locus: Construction and Interpretation.

UNIT III FREQUENCY-RESPONSE ANALYSIS 12 hours

Bode plot, Polar plot and Nyquist plot: – Frequency domain specifications Introduction to closed loop Frequency Response. Relationship between time and frequency response

UNIT IV STATE VARIABLE ANALYSIS 12 hours

State variable formulation – Non uniqueness of state space model – State transition matrix –Eigen values – Eigen vectors-Free and forced responses for Time Invariant and Time Varying Systems – Controllability – Observability

UNIT V DESIGN OF FEED BACK CONTROL SYSTEM 12 hours

Design specifications – Lead, Lag and Lag-lead compensators using Root locus and Bode plot techniques –PID controller-Design using reaction curve and Ziegler-Nichols technique- PID control in State Feedback form.

TOTAL : 45 hours

TEXT BOOKS:

T1: Benjamin C. Kuo, “Automatic Control Systems”, 7th edition PHI Learning Private Ltd, 2010.
T2: Nagarath, I.J. and Gopal, M., “Control Systems Engineering”, New Age International Publishers 2010.

REFERENCE BOOKS:

R1: Richard C.Dorf and Bishop, R.H., “Modern Control Systems”, Education Pearson, 3
R2: John J.D., Azzo Constantine, H. and Houpis Sttuart, N Sheldon, “Linear Control System
R3: Katsuhiko Ogata, “Modern Control Engineering”, PHI Learning Private Ltd, 5thEdition, 2010

WEB LINKS:

1. NPTEL Video Lecture Notes on “Control Engineering” by Prof.S.D.Agashe, IIT Bombay
2. https://www.electronicshub.org

COURSE OUTCOMES

CO1:	Develop the mathematical model of physical system and represent the system in transfer function	K3
CO2:	Analyse the system in time-domain	K4
CO3:	Analyse the system in frequency domain	K4
CO4:	Infer the stability of systems in time and frequency domain.	K2
CO5:	Choose appropriate compensator for the given specifications.	K3

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO1	**PO 2**	**PO3**	**PO4**	**PO 5**	**PO6**	**PO 7**	**PO8**	**PO9**	**PO1 0**	**PO1 1**	**PO 12**	**PSO1**	**PSO 2**
CO1	3	3	2	2	1	-	-	-	-	-	-	1	3	1
CO2	3	3	2	2	1	-	-	-	-	-	-	1	3	1
CO3	3	3	2	2	1	-	-	-	-	-	-	1	3	1
CO4	3	3	2	2	1	-	-	-	-	-	-	1	3	1
CO5	3	3	2	2	1	-	-	-	-	-	-	1	3	1

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓		✓		

PCC-08	ELECTRICAL MACHINES – II	3	0	0	3

Course Objectives

- To impart the knowledge on construction and operation of AC machines

Analyze the starting and speed control of three phase induction motor

UNIT I SYNCHRONOUS GENERATOR 9 hours

Constructional details – Types of rotors –winding factors- emf equation – Synchronous reactance – Armature reaction – Phasor diagrams of non salient pole synchronous generator connected to infinite bus--Synchronizing and parallel operation – Synchronizing torque -Change of excitation and mechanical input- Voltage regulation – EMF, MMF, ZPF and A.S.A methods – steady state power angle characteristics– Two reaction theory –slip test -short circuit transients - Capability Curves

UNIT II SYNCHRONOUS MOTOR 9 hours

Principle of operation – Torque equation – Operation on infinite bus bars - V and Inverted V curves – Power input and power developed equations – Starting methods – Current loci for constant power input, constant excitation and constant power developed-Hunting – natural frequency of oscillations –damper windings- synchronous condenser.

UNIT III THREE PHASE INDUCTION MOTOR 9 hours

Constructional details – Types of rotors –- Principle of operation – Slip –cogging and crawling-Equivalent circuit – Torque-Slip characteristics - Condition for maximum torque – Losses and efficiency – Load test - No load and blocked rotor tests - Circle diagram – Separation of losses –Double cage induction motors –Induction generators – Synchronous induction motor.

UNIT IV STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR 9 hours

Need for starting – Types of starters – DOL, Rotor resistance, Autotransformer and Star-delta starters– Speed control – Voltage control, Frequency control and pole changing – Cascaded connection-V/f control – Slip power recovery scheme-Braking of three phase induction motor: Plugging, dynamic braking and regenerative braking

UNIT V SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES 9 hours

Constructional details of single phase induction motor – Double field revolving theory and operation – Equivalent circuit – No load and blocked rotor test – Performance analysis – Starting methods of single-

phase induction motors – Capacitor-start capacitor run Induction motor- Shaded pole induction motor - Linear induction motor – Repulsion motor - Hysteresis motor - AC series motor- Servo motors-Stepper motors - introduction to magnetic levitation systems.

TOTAL : 45 hours

TEXT BOOKS:

1. A.E. Fitzgerald, Charles Kingsley, Stephen. D.Umans, 'Electric Machinery', Tata Mc Graw Hill publishing Company Ltd, 2003.
2. D.P. Kothari and I.J. Nagrath, 'Electric Machines', Tata McGraw Hill Publishing Company Ltd, 2002.
3. P.S. Bhimbhra, 'Electrical Machinery', Khanna Publishers, 2003.

REFERENCE BOOKS:

R1:M.N.Bandyopadhyay, Electrical Machines Theory and Practice, PHI Learning PVT LTD.,New Delhi, 2009.
R2:Charless A. Gross, "Electric /Machines, "CRC Press, 2010.
R3:K. Murugesh Kumar, 'Electric Machines', Vikas Publishing House Pvt. Ltd, 2002.
R4:Syed A. Nasar, Electric Machines and Power Systems: Volume I, Mcgraw -Hill College; International ed Edition, January 1995.
R5:Alexander S. Langsdorf, Theory of Alternating-Current Machinery, Tata McGraw Hill Publications, 2001.

WEB LINKS:

1. https://electricalvoice.com/
2. https://www.tlclam.net/synchronous-motor-vs-induction-motor/

COURSE OUTCOMES

CO1:	Analyze the performance characteristics of synchronous generator and compute the emf ,mmf equation ,voltage regulation by different methods	K 4
CO2:	Analyze the performance characteristics of synchronous motor by conducting suitable tests	K 4
CO3:	Analyze the performance characteristics of three phase Induction motor	K 4
CO4:	Analyze the starting and speed control of three phase Induction motors	K 4
CO5:	Understand the construction of single phase Induction motors and special machines	K 2

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
	✓		✓		✓

PCC-09	MEASUREMENTS AND CONTROL SYSTEMS LABORATORY	0	0	2	1

Course Objectives

- To provide knowledge development on analysis and design of control system along with basics of instrumentation

LIST OF EXPERIMENTS:

1. Calibration of 1-Phase Energy Meter
2. Measurement of linear displacement using LVDT
3. Measurement of strain using strain gauge
4. Measurement of resistance using Wheatstone bridge.
5. Measurement of capacitance using Schering bridge
6. Measurement of inductance using Maxwell's bridge
7. Transfer function of AC Servomotor
8. Stability analysis of a given system using Root locus
9. Frequency response analysis using Bode and Polar for given transfer function
10. Frequency response analysis of Nyquist plot for given transfer function
11. Study of response of 2nd order system with PID Controller using Simulink
12. Design of Lag, Lead and Lag-Lead Compensators

Web Links:

1. https://nptel.ac.in/courses/103105064
2. https://nptel.ac.in/courses/112102011

COURSE OUTCOMES

CO1:	Test the calibration of energy meter and determine the linear displacement and strain using LVDT and strain gauge respectively	K6
CO2:	Experiment with various bridges and determine the unknown quantity.	K3
CO3:	Experiment with AC servo Motor to determine its Transfer Function	K3
CO4:	Analysis of given system using Root locus, Bode plot, Polar plot and Nyquist Plot.	K4
CO5:	Develop and analyze the response of 2nd order system with PID Controller using Simulink and also develop lag, lead and lag-lead compensators using simulink.	K6

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

Observation	attendance	Model Exam	End Semester Exams	Record work
✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**
				✓

PCC-10	ELECTRICAL MACHINES –II LABORATORY	0	0	2	1

Course Objectives

- To provide hands on experience with the working and operational control of both DC and AC motors

LIST OF EXPERIMENTS:

1. Load test on three phase Induction Motor.
2. No load and blocked rotor test on three phase Induction Motor.
3. Load test on single phase Induction Motor
4. No load and blocked rotor test on a single phase Induction Motor
5. Load test on three phase Synchronous Motor
6. Regulation of three phase Alternator by EMF and MMF methods
7. Regulation of three phase Alternator by ZPF Method
8. Load test on three phase Alternator
9. Separation of no load losses of three phase Induction Motor.
10. V and inverted V curves of three phase Synchronous Motor

TOTAL :30hours

COURSE OUTCOME:

CO1	Analyze the load characteristics of Induction motor	K3
CO2	Analyze the characteristics of Synchronous motor under loading condition	K4
CO3	Analyze the characteristics of three phase Alternator under loading condition	K4
CO4	Analyze the regulation of Alternator by different methods	K4
CO5	Determine the equivalent circuit of Induction motors	K5

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
		✓	✓		
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
				✓	

SEMESTER III

PCC-12	POWER ELECTRONICS	3	1	0	4

Course Objectives

- To introduce students to the basic theory of power semiconductor devices and passive components, their practical applications in power electronics.
- To provide strong foundation for further study of power electronic circuits and systems.

UNIT I POWER SEMI-CONDUCTOR DEVICES 12 hours

Study of switching devices, SCR, TRIAC, GTO, BJT, MOSFET, IGBT and IGCT- Static characteristics: SCR, MOSFET and IGBT - Triggering and commutation circuit for SCR. Introduction to Driver and snubber circuits

UNIT II PHASE-CONTROLLED CONVERTERS 12 hours

2-pulse, 3-pulse and 6-pulseconverters– performance parameters –Effect of source inductance— Firing Schemes for converter–Dual converters, Applications-light dimmer

UNIT III DC TO DC CONVERTERS 12 hours

Step-down and step-up chopper-control strategy– Introduction to types of choppers-A, B, C, D and E - Switched mode regulators- Buck, Boost, Buck- Boost regulator, Introduction to Resonant Converters, Applications-Battery operated vehicles.

UNIT IV INVERTERS 12 hours

Single phase and three phase voltage source inverters (both1200 mode and 1800 mode)– Voltage & harmonic control--PWM techniques: Multiple PWM, Sinusoidal PWM, modified sinusoidal PWM – Introduction to space vector modulation –Current source inverter, Applications-Induction heating, UPS.

UNIT V AC TO AC CONVERTERS 12 hours

Single phase and Three phase AC voltage controllers–Control strategy- Power Factor Control – Multistage sequence control -single phase and three phase cyclo converters – Introduction to Matrix converters, Applications –welding .

TOTAL : 60 hours

TEXT BOOKS:

T1: M.H. Rashid, 'Power Electronics: Circuits, Devices and Applications', Pearson Education, Third Edition, New Delhi, 2004.

T2: P.S.Bimbra "Power Electronics" Khanna Publishers, third Edition, 2003.

REFERENCE BOOKS:

R1. N. Mohan, T. M. Undeland, W.M. Robbins, "Power Electronics: Converters, Applications and Design", Wiley India Edition, 2007.

R2. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2007.

WEB LINKS:

1**.** https://www.springer.com/journal/43236

2. https://nptel.ac.in/courses/108102145

COURSE OUTCOMES

CO1:	Relate basic semiconductor physics to properties of power devices, and combine circuit mathematics and characteristics of linear and non-linear devices.	K 4
CO2:	Describe basic operation and compare performance of various power semiconductor devices, passive components and switching circuits	K 2
CO3:	Design and Analyze power converter circuits and learn to select suitable power electronic devices by assessing the requirements of application fields.	K4
CO4:	Formulate and analyze a power electronic design at the system level and assess the performance	K4
CO5:	Identify the critical areas in application levels and derive typical alternative solutions, select suitable power converters to control Electrical Motors and other industry grade apparatus.	K2

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	**2**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**
CO2	**1**	**1**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**
CO3	**1**	**2**	**2**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**1**	**3**	**3**
CO4	**1**	**1**	**1**	**2**	**1**	**-**		**1**	**-**	**1**	**-**	**1**	**3**	**3**
CO5	**1**	**1**	**2**	**2**	**-**	**1**	**1**	**-**	**1**	**-**	**1**	**1**	**3**	**3**

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
	✓		✓		✓

PCC-12	LINEAR INTEGRATED CIRCUITS	3	0	0	3

Course Objectives

- Be familiar with the fundamentals of IC fabrication.
- Understand the internal structure of opamp and its characteristics.
- Exposed to various applications of opamp.
- Impart Knowledge on the working of special and application ICs.

UNIT I IC FABRICATION 9 hours

IC classification, fundamental of monolithic IC technology, epitaxial growth, masking and etching, diffusion of impurities- Realization of monolithic ICs and packaging. Fabrication of diodes, capacitance, resistance, FETs.

UNIT II CHARACTERISTICS OF OPAMP 9 hours

Ideal OP-AMP characteristics, DC characteristics, AC characteristics, differential amplifier; frequency response of OP-AMP; Basic applications of op-amp – Inverting and Non-inverting Amplifiers, summer, differentiator and integrator-V/I & I/V converters.

UNIT III APPLICATIONS OF OPAMP 9 hours

Instrumentation amplifier, first and second order active filters, V/I & I/V converters, comparators,multivibrators, waveform generators, clippers, clampers, peak detector, S/H circuit, D/A converter (R-2R ladder and weighted resistor types), A/D converter - Dual slope, successive approximation and flash types.

UNIT IV SPECIAL ICs 9 hours

Functional block, characteristics of 555 Timer and its PWM application - IC-566 voltagecontrolled oscillator IC, 565-phase locked loop IC, AD633 Analog multiplier ICs.

UNIT V APPLICATION ICs 9 hours

AD623 Instrumentation Amplifier and its application as load cell weight measurement – ICvoltage regulators - LM78XX, LM79XX- Fixed voltage regulators its application as Linearpower supply - LM317, 723 Variable voltage regulators, switching regulator- SMPS – ICL8038 function generator IC.

TOTAL : 45 hours

TEXT BOOKS:

T1:David A. Bell, 'Op-amp & Linear ICs', Oxford, 2013.

T2:D. Roy Choudhary, Sheil B. Jani, 'Linear Integrated Circuits', II edition, New Age,2003.

T3:RamakantA.Gayakward, 'Op-amps and Linear Integrated Circuits', IV edition,Pearson Education, 2003 / PHI. 2000.

REFERENCE BOOKS:

R1:Fiore,"Opamps& Linear Integrated Circuits Concepts & applications", Cengage,2010.

R2:Floyd ,Buchla,"Fundamentals of Analog Circuits, Pearson, 2013.

R3:Jacob Millman, Christos C.Halkias, 'Integrated Electronics - Analog and Digital circuits system', McGraw Hill, 2003.

R4:Robert F.Coughlin, Fredrick F. Driscoll, 'Op-amp and Linear ICs', Pearson, 6th edition,2012.

R5Sergio Franco, 'Design with Operational Amplifiers and Analog Integrated Circuits', Mc Graw Hill, 2016.

R6:Muhammad H. Rashid,' Microelectronic Circuits Analysis and Design' Cengage Learning, 2011

WEB LINKS:

1.https://www.electrical4u.com/applications-of-op-amp/

2.https://www.electronicsforu.com/technology-trends/learn-electronics/555-timer-working-specifications

3.https://www.eeeguide.com/ic-565-pll/

COURSE OUTCOMES

CO1:	Understand the basic process involved in the Fabrication of ICs	K2
CO2:	Analyse the characteristics of Op-amp and perform basic arithmetic functions.	K4
CO3:	Apply Op-amp circuits to perform various applications and choose appropriate ADCs& DACs for different applications	K3
CO4:	Explain the working of special function ICs and its applications	K2
CO5:	Understand and explain the working of voltage regulators, linear and switched power supplies	K2

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓		✓		

PCC-13	ELECTRICAL MACHINE DESIGN	3	0	0	3

Course Objectives

- To understand the design of various parts of DC machines
- To understand the design of stator and rotor of induction and synchronous machines

UNIT I INTRODUCTION

9 hours

Contents – Major considerations in Machine design Limitations in design Standard specifications Electrical Engineering materials High conductivity materials Insulating materials Magnetic circuit calculations mmf for air gap and iron path real and apparent flux densities in rotating machines- Choice of specific electric and magnetic loadings.

UNIT II DC MACHINES

9 hours

Contents- Output equation - Main Dimensions - Choice of number of poles - Armature design - Estimation of number of conductors / turns – Coil armature slots- Conductor dimensions - Slot dimension - Design of field poles and field coil (shunt field) - Design of Commutators and Brushes

UNIT III TRANSFORMERS

9 hours

Contents – Output equation - Design of core and winding of single- phase shell and core type transformer and three phase transformers -Temperature rise in transformers - Design of tank, cooling tubes and Ducts

UNIT IV INDUCTION MOTORS 9 hours

Contents – Output equation, Main dimensions, Design of stator, Choice of L/D ratio - Air gap length - Design of rotor - squirrel cage and slip ring rotor.

UNIT V SYNCHRONOUS MACHINES 9 hours

Contents – Output equation - Design of salient pole rotor machine - Dimensions - Short circuit ratio - Effect of Short Circuit ratio – Air gap length - Armature design - Slot dimensions - Rotor design - Design of damper winding - Design of cylindrical rotors

TOTAL : 45 hours

TEXT BOOKS:

T1: Sawhney, A.K., 'A Course in Electrical Machine Design', Dhanpat Rai & Sons, New Delhi, Fifth Edition, 1984.
T2: M V Deshpande 'Design and Testing of Electrical Machines' PHI learning Pvt Lt, 2011
T3: Sen, S.K., 'Principles of Electrical Machine Designs with Computer Programmes', Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, Second Edition, 2009.

REFERENCES:

R1: A.Shanmugasundaram, G.Gangadharan, R.Palani 'Electrical Machine Design Data Book', New Age International Pvt. Ltd., Reprint 2007.
R2: Electrical Machine Design', Balbir Singh, Vikas Publishing House Private Limited, 1981
R3: K.M.Vishnumurthy 'Computer aided design of electrical machines' B S Publications,2008

WEB LINKS:

1. https://cusp.umn.edu/electric-machine-design-videos
2. https://electricalattitude.com/2021/10/03/major-consideration-in-electrical-machine-design/

COURSE OUTCOMES

CO1:	Understand the important consideration in the design of electric machine and various factors which influence the design.	K 2
CO2:	Design the armature and field of DC machines	K 6
CO3:	Design yoke ,windings and cooling system of transformers	K 6
CO4:	Design the stator and rotor of Induction motors	K 6
CO5:	Design the stator and rotor of synchronous machines	K 6

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**

PCC-14	ANALOG AND DIGITAL ELECTRONICS LABORATORY	0	0	2	1

Course Objectives

- Understand the behavior of semiconductor devices based on experimentation
- Learn the circuit behaviors of various circuits with digital and analog ICs

List of Experiments

1. Characteristics of Semiconductor diode and Zener diode.
2. Characteristics of a NPN Transistor.
3. Study of Logic Gates.
4. Implementation of Adder and Subtractor circuits.
5. Code converters: Binary to Gray code converter and vice-versa
6. Encoders and Decoders.
7. Multiplexers and Demultiplexers
8. Counters: Design and implementation of 3-bit synchronous and Asynchronous counters.
9. Timer IC application: Study of NE/SE 555 timer in Astability, Monostability operation.
10. Operational Amplifier: Inverting and Non Inverting.

TOTAL :30hours

COURSE OUTCOMES

CO1:	Understand the characteristics of semiconductor devices.	K5
CO2:	Understand and apply boolean functions to implement adder, subtractor and Code Conversion Circuits.	K3,K4
CO3:	Experiment with logic gates, Encoder and Decoder as well as Multiplexer and Demultiplexer	K3
CO4:	Examine the working of synchronous and asynchronous counters	K4
CO5:	Understand the working of 555 timer, inverting and non-inverting amplifiers	K2

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
		✓	✓		
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
				✓	

PCC-15	POWER ELECTRONICS LABORATORY	0	0	2	1

Course Objectives

- To expose students to operation and characteristics of power semiconductor devices and passive components, their practical application in power electronics
- To provide a practical exposure to operating principles, design and synthesis of different power electronic converters.

List of Experiments

1. Static Characteristics of SCR and TRIAC.
2. Static Characteristics of MOSFET and IGBT.
3. Single phase controlled half wave rectifier with R load and R –L load
4. Single phase controlled full wave rectifier with R load and R –L load
5. Step down and step up MOSFET based choppers
6. IGBT based single-phase PWM inverter
7. IGBT based three-phase PWM inverter
8. AC Voltage controller with R and RL Load
9. Study of performance of a Cycloconverter

COURSE OUTCOMES

CO1:	Set up testing strategies and select proper instruments to evaluate performance characteristics of Power devices and power electronics circuits and analyze their operation under different loading conditions.	K3
CO2:	Practice different types of wiring and devices connections keeping in mind technical, economical, safety issues.	K5
CO3:	Realize the limitations of computer simulations for verification of circuit behavior, apply these techniques to different power electronic circuits and evaluate possible causes of discrepancy in practical experimental observations in comparison to theory	K2
CO4:	Prepare professional quality textual and graphical presentations of laboratory data and computational results, incorporating accepted data analysis and synthesis methods, mathematical software, and word-processing tools.	K2
CO5:	Primarily via team-based laboratory activities, students will demonstrate the ability to interact effectively on a social and interpersonal level with fellow students, and will demonstrate the ability to divide up and share task responsibilities to complete assignments.	K3

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

Observation	attendance	Model Exam	End Semester Exams	Record work
✓	✓	✓	✓	✓
Quiz	MCQ	Projects	Seminars	Demonstration/ Presentation
				✓

SEMESTER IV

PCC-16	POWER SYSTEM ANALYSIS	3	1	0	4

Course Objectives

- To model the power system under steady state operating condition. To apply efficient numerical methods to solve the power flow problem.
- To model and analyse the power systems under abnormal (or) fault conditions to acquired knowledge based on employability skill. To model and analyse the transient behaviour of power system when it is subjected to a fault.

UNIT I INTRODUCTION 12 hours

Need for system planning and operational studies – basic components of a power system.-Introduction to restructuring - Single line diagram – per phase and per unit analysis – Generator - transformer – transmission line and load representation for different power system studies.- Primitive network - construction of Y-bus using inspection and singular transformation methods – z-bus.

UNIT II POWER FLOW ANALYSIS 12 hours

Importance of power flow analysis in planning and operation of power systems - statement of power flow problem - classification of buses - development of power flow model in complex variables form -iterative solution using Gauss-Seidel method - Q-limit check for voltage controlled buses – power flow model in polar form - iterative solution using Newton-Raphson method .

UNIT III FAULT ANALYSIS – BALANCED FAULTS 12 hours

Importance of short circuit analysis - assumptions in fault analysis - analysis using Thevenin's theorem- Z-bus building algorithm - fault analysis using Z-bus – computations of short circuit capacity, postfault voltage and currents

UNIT IV FAULT ANALYSIS – UNBALANCED FAULTS 12 hours

Introduction to symmetrical components – sequence impedances – sequence circuits of synchronous machine, transformer and transmission lines - 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.

UNIT V STABILITY ANALYSIS 12 hours

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.

TOTAL : 60 hours

TEXT BOOKS:

T1: Nagrath I.J. and Kothari D.P., 'Modern Power System Analysis', Tata McGraw-Hill, Fourth Edition,2011.

T2: John J. Grainger and W.D. Stevenson Jr., 'Power System Analysis', Tata McGraw-Hill, Sixth reprint, 2010.

T3: P. Venkatesh, B.V. Manikandan, S. Charles Raja, A. Srinivasan, 'Electrical Power Systems-Analysis, Security and Deregulation', PHI Learning Private Limited, New Delhi, 2012.

REFERENCE BOOKS:

R1: HadiSaadat, 'Power System Analysis', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010.

R2: Kundur P., 'Power System Stability and Control, Tata McGraw Hill Education Pvt. Ltd., New Delhi,10th reprint, 2010.

R3: Pai M A, 'Computer Techniques in Power System Analysis', Tata McGraw-Hill Publishing Company Ltd., New Delhi, Second Edition, 2007.

R4: J. Duncan Glover, Mulukutla S. Sarma, Thomas J. Overbye, ' Power System Analysis & Design',Cengage Learning, Fifth Edition, 2012.

WEB LINKS:

1. https://onlinecourses.nptel.ac.in/noc22_ee17/unit?unit=94&lesson=95
2. www.electrical4u.com

COURSE OUTCOMES

CO1:	Understand the nature of the modern power system, including the behavior of the components and sub-systems	K2
CO2:	Apply load flow analysis to an electrical power network and interpret the results for analysis	K3
CO3:	Analyze a network under balanced fault conditions and interpret the results	K4
CO4:	Analyze a network under unbalanced fault conditions and interpret the results	K4
CO5:	Analyze the transient stability of a single machine/infinite bus system using both analytical and time simulation methods	K4

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
	✓		✓		

PCC-17	TRANSMISSION AND DISTRIBUTION	3	0	0	3

Course Objectives

- To develop expressions for the computation of transmission line parameters. To obtain the equivalent circuits for the transmission lines based on distance and operating voltage for determining voltage regulation and efficiency. Also to improve the voltage profile of the transmission system.
- To analyses the voltage distribution in insulator strings and cables and methods to improve the same. To understand the operation of the different distribution schemes.

UNIT I GENERATION AND TRANSMISSION SYSTEMS 9 hours

Generation, Transmission & Distribution Scenario of India - Types of generation: Conventional and Non-conventional, Thermal Power Plant, Hydro Power Plant, Gas Power Plant, Nuclear Power Plant, Non-conventional Energy Sources - Load capacity factor - Connected load factor - Load duration curve - Selection of units. Various systems of transmission – Advantages of high transmission voltages - Comparison of conductor materials required for various overhead systems.

UNIT II OVERHEAD LINES PARAMETERS 9 hours

Electrical constants - Resistance, Inductance and capacitance of Single and 3 Phase lines - Effects of earth on capacitance - Skin effect - Proximity effect - Transposition - Bundled conductors - Corona – Factors affecting corona - Line supports.

UNIT III OVERHEAD LINES PERFORMANCE 9 hours

Short and medium transmission lines - Phasor diagrams - Nominal T and Pi methods - Line regulation - Efficiency. Rigorous solution for long line - ABCD constants - Ferranti effect - Tuned power lines - Surge impedance and surge impedance loading.

UNIT IV LINE INSULATORS AND UNDERGROUND CABLES 9 hours

Types of overhead line insulators- Potential distribution over a string of suspension insulators - Methods of increasing string efficiency. Types of cables- Capacitance and insulation resistance - Sheath effects - Grading - Stresses - Loss angle – Power loss - Breakdown voltage - Optimum cable length - Comparison between overhead lines and underground cables.

UNIT V DISTRIBUTION SYSTEMS 9 hours

Classification, functions and major components of substations - Feeders, distributors and service mains - Radial and ring main systems - Calculation of voltage in distributors with concentrated and distributed loads, AC 1-phase and 3-phase distribution systems.

TOTAL : 45 hours

TEXT BOOKS:

T1: Mehta V K, Rohit Mehta , "Principles of Power Systems", S.Chand & Co. Pvt. Ltd., New Delhi, 2004.

T2: Singh S N," Electric Power Generation, Transmission and Distribution", Prentice-Hall of India Pvt., Ltd, Delhi, 2003.

REFERENCE BOOKS:

R1:Soni M L, Gupta P V, Bhatnagar U S and Chakrabarthi A, "A Text Book on Power System Engineering", Dhanpat Rai & Co., New Delhi, 1997.

R2: S L, "Electrical Power", Khanna Publishers, New Delhi, Thirteenth Edition, 1995.

R3:Wadhwa C L, "Electrical Power Systems", New Age International Publishers, Delhi, 2006 Fourth Edition Reprint Aug, 2007.

R4:Gupta J B, "A Course in Electrical Power", S. K. Kataria & Sons, 2003.

R5:Gupta B R, "Generation of Electrical Energy", S.Chand & company New Delhi, Revised edition 2006

R6:Kothari D P and Nagrath J," Power System Engineering", Tata McGraw-Hill Publishing Company New Delhi, second Edition, 2007.

R7:Despande M V, 'Electrical Power Systems Design', Tata McGraw-Hill Publishing Company New Delhi, 2004

WEB LINKS:

1. https://circuitglobe.com/
2. https://eepower.com/technical-articles/utility-power-transmission-and-distribution-systems/#

COURSE OUTCOMES

CO1:	Analyze the parameters of transmission lines and explain the structure of electric power system.	K4
CO2:	Illustrate and Estimate the transmission lines parameters.	K2,K5
CO3:	Classify the Nominal T and PI model of transmission lines and explain ABCD constants	K4
CO4:	Determine the voltage distribution in insulators string and explain types and construction of underground cables	K5
CO5:	Classify the types of sub-stations and calculate the voltage in distributors with concentrated and distributed loads	K4

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESMENT METHODS

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
	✓		✓		

PCC-18	MICROPROCESSORS AND MICROCONTROLLERS LABORATORY	0	0	2	1

Course Objectives

- Provide training on programming of microprocessors and microcontrollers
- Understand the interface requirements

LIST OF EXPERIMENTS:

1. Simple arithmetic operations: addition / subtraction / multiplication / division using 8085
2. Multibyte BCD addition &subtraction in 8085.
3. Programming with control instructions using microprocessor
    i. Ascending / Descending order, Maximum / Minimum of numbers.
    ii. Hex / BCD code conversions.
4. Table Processing using 8085
5. Traffic light controller.
6. Interfacing and Programming of 8255 using 8085
7. Interfacing and Programming of 8279 using 8085
8. Programming basic instructions with 8051 Micro controller execution including Conditional jumps & looping.
9. Study on interface with A/D & D/A
10. Interfacing stepper motor using 8051

TOTAL :30hours

COURSE OUTCOMES

CO1:	Explain the concepts of 8085 Microprocessors and 8051 Microcontrollers	K2
CO2:	Apply 8085 Microprocessor algorithm to develop simple programs	K3
CO3:	Examine the interfacing of Microprocessors with various peripheral devices using Assembly Language Programs	K4
CO4:	Apply 8051 Microcontroller algorithm to develop simple programs	K3
CO5:	Examine the interfacing of Microcontrollers with various peripheral devices using Assembly Language Programs	K4

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
		✓	✓		
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**

PCC-19	POWER SYSTEMS LABORATORY	0	0	2	1

Course Objectives

- To expose the students to the simulation and modelling using matlab software.
- To expose the students to the simulation and modelling using of transmission lines power flow analysis, fault and stability analysis and give them experimental skill

LIST OF EXPERIMENTS:

1. Computation of parameters and modelling of transmission lines
2. Formation of bus admittance and solution of networks
3. Formation of bus impedance and solution of networks
4. Load flow anaysis 1: solution of load flow and related problems using gauss-seidel method
5. Load flow anaysis 2: solution of load flow and related problems using load newton-raphson methods
6. Load flow anaysis iii: solution of load flow and related problems using fast decoupled method
7. Symmetrical fault analysis
8. Unsymmetrical fault analysis
9. Transient and small signal stability analysis – single machine infinite bus system
10. Transient stability analysis of multimachine power systems
11. Load – frequency dynamics of single area and two area power systems
12. Economic dispatch in power systems

TOTAL :30h

TEXT BOOKS:

T1: Nagrath I.J. and Kothari D.P., 'Modern Power System Analysis', Tata McGraw-Hill, Fourth Edition,2011.

T2: John J. Grainger and W.D. Stevenson Jr., 'Power System Analysis', Tata McGraw-Hill, Sixth reprint, 2010.

T3: P. Venkatesh, B.V. Manikandan, S. Charles Raja, A. Srinivasan, 'Electrical Power Systems-Analysis, Security and Deregulation', PHI Learning Private Limited, New Delhi, 2012.

REFERENCE BOOKS:

R1: HadiSaadat, 'Power System Analysis', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010.

R2: Kundur P., 'Power System Stability and Control, Tata McGraw Hill Education Pvt. Ltd., New Delhi,10th reprint, 2010.

R3: Pai M A, 'Computer Techniques in Power System Analysis', Tata McGraw-Hill Publishing Company Ltd., New Delhi, Second Edition, 2007.

R4: J. Duncan Glover, Mulukutla S. Sarma, Thomas J. Overbye, ' Power System Analysis & Design',Cengage Learning, Fifth Edition, 2012.

WEB LINKS:

1. https://onlinecourses.nptel.ac.in/noc22_ee17/unit?unit=94&lesson=95
2. www.electrical4u.com

COURSE OUTCOMES

CO1:	Understand the nature of the modern power system, including the behavior of the components and sub-systems	K2
CO2:	Apply load flow analysis to an electrical power network and interpret the results for analysis	K3
CO3:	Analyze a network under balanced fault conditions and interpret the results	K4
CO4:	Analyze a network under unbalanced fault conditions and interpret the results	K4
CO5:	Analyze the transient stability of a single machine/infinite bus system using both analytical and time simulation methods	K4

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESMENT METHODS

Observation	**attendance**	**Model Exam**	**End Semester Exams**	**Record work**
✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**
				✓

SEMESTER V

PCC-20	SOLID STATE DRIVES	3	1	0	4

Course Objectives

- To understand the steady sate behavior and select the motor according to the requirement of the load
- To design the current and speed controller for closed loop operation of drives

UNIT I DRIVE CHARACTERISTICS 12 hours

Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, starting & stopping – typical load torque characteristics – Selection of motor

UNIT II CONVERTER / CHOPPER FED DC MOTOR DRIVE 12 hours

Steady state analysis of the single and three phase converter fed separately excited DC motor drive– continuous and discontinuous conduction– Time ratio and current limit control – 4 quadrant operation of converter / chopper fed drive

UNIT III INDUCTION MOTOR DRIVES 12 hours

Stator voltage control–energy efficient drive–v/f control–constant airgap flux–field weakening mode 68 – voltage / current fed inverter – closed loop control.

UNIT IV SYNCHRONOUS MOTOR DRIVES 12 hours

V/F control and self control of synchronous motor: Margin angle control and power factor control – permanent magnet synchronous motor.

UNIT V DESIGN OF CONTROLLERS FOR DRIVES 12 hours

Transfer function for DC motor / load and converter – closed loop control with Current and speed feedback–armature voltage control and field weakening mode – Design of controllers; current controller and speed controller- converter selection and characteristics.

TOTAL : 60 hours

TEXT BOOKS:

T1: Gopal K.Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, 1992.
T2: Bimal K.Bose. Modern Power Electronics and AC Drives, Pearson Education, 2002.
T3: R.Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Prentice Hall of India, 2001.

REFERENCEBOOKS:

R1:John Hindmarsh and Alasdain Renfrew, “Electrical Machines and Drives System,” Elsevier 2012.

R2:Shaahin Felizadeh, “Electric Machines and Drives”, CRC Press(Taylor and Francis Group), 2013.

R3:S.K.Pillai, A First course on Electrical Drives, Wiley Eastern Limited, 1993.

R4:S. Sivanagaraju, M. Balasubba Reddy, A. Mallikarjuna Prasad “Power semiconductor drives” PHI, 5th printing, 2013.

R5:N.K.De., P.K.SEN”Electric drives” PHI, 2012. 6. Vedam Subramanyam, ”Thyristor Control of Electric Drives”, Tata McGraw Hill, 2007.

WEB LINKS:

1. https://www.electrical4u.com/electrical-drives/
2. https://www.electricaltechnology.org/2015/10/electrical-drives-ac-drives-vfd-dc-drives.html

COURSE OUTCOMES

CO1:	Understand the steady state behaviour, dynamics of a motor load system and selection of suitable motor for different load profiles	K 2
CO2:	Analyze the operation of the converter and chopper fed dc drive.	K 4
CO3:	Analyze the operation of the induction motor drives	K 4
CO4:	Analyze the operation of the synchronous motor drives	K 4
CO5:	Develop the controller for Electrical Drives	K 3

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
	✓		✓		

PCC-21	ELECTRICAL DRIVES LABORATORY	0	0	2	1

Course Objectives

- To develop the skill in working with AC and DC drives

LIST OF EXPERIMENTS:

1. Simulation of closed loop control of converter fed DC Motor
2. Simulation of closed loop control of chopper fed DC Motor
3. Simulation of VSI fed 3 phase induction Motor
4. Speed control of PMDC motor using 3 phase fully controlled converter
5. Speed control of 3 phase induction motor using PWM inverter
6. DSP based closed loop drive for Induction motor
7. DSP based chopper fed DC drive
8. PLC based drives
9. Speed control of DC shunt Motor using chopper
10. Speed control of BLDC motor using inverter

TOTAL :30h

COURSE OUTCOME:

CO1	Analyze closed loop control of converter and chopper fed DC Motor	K4
CO2	Analyze the characteristics of induction motor drives	K4
CO3	Analyze closed loop speed control of ac and dc drives using converters	K4
CO4	Experiment with DSP based AC drive and DC drive	K3
CO5	Experiment with PLC based drives	K3

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESMENT METHODS

Observation	**attendance**	**Model Exam**	**End Semester Exams**	**Record work**
✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**
				✓

PCC-22	POWER SYSTEM PROTECTION LAB	0	0	2	1

Course Objectives

- Ability to learn Modeling and simulation tool for Protection systems.
- Ability to learn ETAP software

LIST OF EXPERIMENTS:

1. Introduction to MATLAB and Electrical Transients Analyzer Program (ETAP)
2. Introduction to Power System Protection
3. Impact of induction motor starting on power system
4. Selection of circuit breaker for different branches of a given power system using ETAP
5. Introduction to Ground Grid Modeling in ETAP
6. Ground Grid Modeling of a Given System using ETAP
7. Modeling of Single-Phase Instantaneous Over-Current Relay using MATLAB
8. Modeling of a Differential Relay Using MATLAB
9. Comparison between the Step and Touch Potential of a T-Model and Square Model of Ground Grids under Tolerable and Intolerable in ETAP
10. Modeling of an Over-Current Relay using ETAP
11. Modeling of a Differential Relay Using ETAP
12. Modeling of Single-Phase Definite Time Over-Current Relay using MATLAB
13. Short-Circuit & Motor Acceleration Analysis in ETAP Software

TOTAL :30h

TEXT BOOKS:

1. Soni, M.L. , P.V. Gupta, V.S. Bhatnagar, A. Chakrabarti, 'A Text Book on Power System Engineering', DhanpatRai& Co., 1998
2. R.K.Rajput, "A Text book of Power System Engineering", Laxmi Publications, First Edition Reprint 2007.

REFERENCE BOOKS:

1. Wadhwa, C.L. 'Electrical Power Systems', New Age International (P) Ltd., 2000.
2. Badri Ram, Vishwakarma, 'Power System Protection and Switchgear', Tata McGraw Hill, 2001.

COURSE OUTCOMES

CO1:	To understand power system protection	K2
CO2:	Apply selection of circuit breaker	K3
CO3:	Modeling and simulate differential relay using MATLAB	K5
CO4:	Modeling of an Over-Current Relay using ETAP	K5
CO5:	Design of Ground Grid Modeling of a Given System using ETAP	K6

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

Observation	**attendance**	**Model Exam**	**End Semester Exams**	**Record work**
✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**
				✓

SEMESTER VI

PROJ 01	PROJECT PHASE I	0	0	4	5

Course Objectives

- To enable the students to understand basic concepts and broad principles of Industrial projects and apply the theoretical concepts to solve industrial problems with teamwork and multidisciplinary approach
- To demonstrate professionalism with ethics; present effective communication skills and relate engineering issues to broader societal context

The object of Project Work I is to enable the student to take up investigative study in the broad field of Electrical &Electronics Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

1. Survey and study of published literature on the assigned topic;

2. Working out a preliminary Approach to the Problem relating to the assigned topic;

3. Conducting preliminary Analysis/Modelling/Simulation/Experiment/Design/Feasibility;

4. Preparing a Written Report on the Study conducted for presentation to the Department;

5. Final Seminar, as oral Presentation before a departmental committee.

COURSE OUTCOME:

CO1	Identify a topic in advanced field of Electrical and Electronics Engineering.	K3
CO2	Understand and Study the problems in selected field through literature survey and reviews.	K2
CO3	Able to analyze the existing methodology and identify ways to develop solution for proposed methodology	K3,K4
CO4	Able to design engineering solution for the problem identified in proposed methodology	K6
CO5	Able to demonstrate the prototype, communicate effectively and present the work as team to achieve the goal.	K2,K5

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
		✓			

SEMESTER VII

PROJECT	PROJECT PHASE II	0	0	6	12

Course Objectives

- To enable the students to understand basic concepts and broad principles of Industrial projects and apply the theoretical concepts to solve industrial problems with teamwork and multidisciplinary approach
- To demonstrate professionalism with ethics; present effective communication skills and relate engineering issues to broader societal context

The object of Project Work II and Dissertation is to enable the student to extend further the investigative study taken up under Project phase I, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

1. In depth study of the topic assigned in the light of the Report prepared under phase 1;

2. Review and finalization of the Approach to the Problem relating to the assigned topic;

3. Preparing an Action Plan for conducting the investigation, including team work;

4. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed;

5. Final development of product/process, testing, results, conclusions and future directions;

6. Preparing a paper for Conference presentation/Publication in Journals, if possible;

7. Preparing a Dissertation in the standard format for being evaluated by the Department.

8. Final Seminar Presentation before a Departmental Committee.

COURSE OUTCOMES

CO1:	Identify a topic in advanced field of Electrical and Electronics Engineering.	K3
CO2:	Understand and Study the problems in selected field through literature survey and reviews.	K2
CO3:	Able to analyze the existing methodology and identify ways to develop solution for proposed methodology	K3,K4
CO4:	Able to design engineering solution for the problem identified in proposed methodology	K6
CO5:	Able to demonstrate the prototype, communicate effectively and present the work as team to achieve the goal.	K2,K5

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
		✓		✓	

PROFESSIONAL ELECTIVE COURSES

PEC-01	POWER PLANT ENGINEERING	3	0	0	3

Course Objectives

- To understand components; layout of Steam power plant, diesel power plant , components; different cycles ; methods to improve thermal efficiency of gas power plant
- To study the working principle, construction of power generation from non-conventional sources of energy.
- To learn the different instrumentation in power plant and basics of economics of power generation.

UNIT I COAL BASED THERMAL POWER PLANTS 9 hours

Rankine cycle - improvisations, Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, Steam & Heat rate, Subsystems of thermal power plants – Fuel and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems

UNIT II DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS 9 hours

Otto, Diesel, Dual & Brayton Cycle - Analysis & Optimisation. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems

UNIT III NUCLEAR POWER PLANTS 9 hours

Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors : Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium-Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.

UNIT IV POWER FROM RENEWABLE ENERGY 9 hours

Hydro Electric Power Plants – Classification, Typical Layout and associated components including Turbines. Principle, Construction and working of Wind, Tidal, Solar Photo Voltaic (SPV), Solar Thermal, Geo Thermal, Biogas and Fuel Cell power systems.

UNIT V ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS 9 hours

Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria,relative merits & demerits, Capital & Operating Cost of different power plants. Pollution controltechnologies including Waste Disposal Options for Coal and Nuclear Power Plants.

TOTAL : 45 hours

TEXT BOOK:

T1:P.K. Nag, Power Plant Engineering, Tata McGraw – Hill Publishing Company Ltd., Third Edition, 2008

REFERENCE BOOKS

R1:M.M. El-Wakil, Power Plant Technology, Tata McGraw – Hill Publishing Company Ltd., 2010.

R2:Black & Veatch, Springer, Power Plant Engineering, 1996.

R3:Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, Standard Handbook of Power Plant Engineering, Second Edition, McGraw – Hill, 1998.

COURSE OUTCOMES

CO1:	Explain the construction, Layout and components of a Thermal power plant.	K3
CO2:	Explain the layout, construction and working of the components inside a Diesel, Gas and Combined cycle power plants.	K4
CO3:	Explain the layout, construction and working of the components inside nuclear power plants	K4
CO4:	Interpret the construction , layout of renewable energy power plants and its components	K2
CO5:	Explain the knowledge to power plant economics and estimate the cost of electrical energy production	K3

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**

PEC-02	HIGH VOLTAGE ENGINEERING	3	0	0	3

Course Objectives

- To understand the various types of over voltages in power system and protection methods. To know about the generation of over voltages in laboratories.
- To understand the measurement of over voltage, Nature of Breakdown mechanism in solid, liquid and gaseous dielectrics

UNIT I OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS 9hours

Causes of over voltages and its effects on power system – Lightning, switching surges and temporary Over voltages, Corona and its effects – Reflection and Refraction of Travelling waves- Protection against over voltages.

UNIT II DIELECTRIC BREAKDOWN 9hours

Gaseous breakdown in uniform and non-uniform fields – Corona discharges – Vacuum breakdown – Conduction and breakdown in pure and commercial liquids, Maintenance of oil Quality – Breakdown Mechanisms in solid and composite dielectrics

UNIT III GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS 9hours

Generation of High DC, AC, impulse voltages and currents - Triggering and control of impulse generators.

UNIT IV MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS 9hours

High Resistance with series ammeter – Dividers, Resistance, Capacitance and Mixed dividers – PeakVoltmeter, Generating Voltmeters - Capacitance Voltage Transformers, Electrostatic Voltmeters – Sphere Gaps - High current shunts- Digital techniques in high voltage measurement

UNIT V HIGH VOLTAGE TESTING OF ELECTRICAL APPARATUS AND HIGH VOLTAGE LABORATORIES 9hours

Various standards for HV Testing of electrical apparatus, IS, IEC standards, Testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, power transformers and some high voltage equipment, High voltage laboratory layout, indoor and outdoor laboratories, testing facility requirements, safety precautions in H. V. Labs

TOTAL : 45 hours

TEXT BOOKS:

T1: M. S. Naidu and V. Kamaraju, “High Voltage Engineering”, McGraw Hill Education, 2013

T2: C. L. Wadhwa, “High Voltage Engineering”, New Age International Publishers, 2007.

T3: D. V. Razevig (Translated by Dr. M. P. Chourasia), “High Voltage Engineering Fundamentals”, Khanna Publishers, 1993

REFERENCE BOOKS:

R1: E. Kuffel, W. S. Zaengl and J. Kuffel, “High Voltage Engineering Fundamentals”, Newnes Publication, 2000.

R2: R. Arora and W. Mosch “High Voltage and Electrical Insulation Engineering”, John Wiley & Sons, 2011.

R3: L.L. Alston, ‘High Voltage Technology’, Oxford University Press, First Indian Edition, 2011.

WEB LINKS:

1. https://nptel.ac.in/courses/108104048

COURSE OUTCOMES

CO1:	Understand the over voltage phenomenon and Protection against over voltages in electrical Power systems	K2
CO2:	Understand and Analyse the various breakdown mechanisms of different dielectrics	K4
CO3:	Understand and Analyze the generation of high voltage and high currents	K4
CO4:	Understand and Analyse the measurement techniques of high voltages & currents with their relative merits and demerits	K4
CO5:	Analyze and test the power apparatus and insulation coordination	K4

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		

PEC-03	SPECIAL ELECTRICAL MACHINES	3	0	0	3

Course Objectives

- To impart knowledge on Construction, principle of operation and performance of synchronous reluctance motors. To impart knowledge on the Construction, principle of operation, control and performance of stepping motors.
- To impart knowledge on the Construction, principle of operation, control and performance of switched reluctance motors.
- To impart knowledge on the Construction, principle of operation, control and performance of permanent magnet brushless D.C. motors.
- To impart knowledge on the Construction, principle of operation and performance of permanent magnet synchronous motors.

UNIT I SYNCHRONOUS RELUCTANCE MOTORS 9 hours

Constructional features – Types – Axial and Radial flux motors – Operating principles – VariableReluctance Motors – Voltage and Torque Equations - Phasor diagram - performance characteristics –Applications.

UNIT II STEPPER MOTORS 9 hours

Constructional features – Principle of operation – Variable reluctance motor – Hybrid motor – Single and multi stack configurations – Torque equations – Modes of excitation – Characteristics – Drive circuits – Microprocessor control of stepper motors – Closed loop control-Concept of lead angle–Applications.

UNIT III SWITCHED RELUCTANCE MOTORS 9 hours

Constructional features – Rotary and Linear SRM - Principle of operation – Torque production –Steady state performance prediction- Analytical method -Power Converters and their controllers –Methods of Rotor position sensing – Sensor less operation – Characteristics and Closed loop control– Applications.

UNIT IV PERMANENT MAGNET BRUSHLESS D.C. MOTORS 9 hours

Permanent Magnet materials – Minor hysteresis loop and recoil line-Magnetic Characteristics – Permeance coefficient -Principle of operation – Types – Magnetic circuit analysis – EMF and torque equations –Commutation - Power Converter Circuits and their controllers – Motor characteristics and control– Applications.

UNIT V PERMANENT MAGNET SYNCHRONOUS MOTORS 9 hours

Principle of operation – Ideal PMSM – EMF and Torque equations – Armature MMF – Synchronous Reactance – Sine wave motor with practical windings - Phasor diagram – Torque/speed characteristics - Power controllers - Converter Volt-ampere requirements– Applications.

TOTAL : 45 hours

TEXT BOOKS:

T1: K.Venkataratnam, 'Special Electrical Machines', Universities Press (India) Private Limited, 2008.

T2: T.J.E. Miller, 'Brushless Permanent Magnet and Reluctance Motor Drives', Clarendon Press, Oxford, 1989.

T3. Kenjo, 'Stepping Motors and Their Microprocessor Controls', Clarendon Press London, 1984.

REFERENCE BOOKS:

R1:R.Krishnan, 'Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design and Application', CRC Press, New York, 2001.

R2:P.P. Aearnley, 'Stepping Motors – A Guide to Motor Theory and Practice', Peter Perengrinus London, 1982.

R3:T. Kenjo and S. Nagamori, 'Permanent Magnet and Brushless DC Motors', Clarendon Press,London, 1988.

R4:E.G. Janardanan, 'Special electrical machines', PHI learning Private Limited, Delhi, 2014.

WEB LINKS:

1. https://circuitglobe.com/
2. https://eepower.com/

COURSE OUTCOMES

CO1:	Understand and explain the construction, operation and performance characteristics of synchronous reluctance motor	K2
CO2:	Understand the construction and principle of operation of stepper motor	K2
CO3:	Analyze the operation of switched reluctance motor with and without sensors and control of SRM drive using controllers	K4
CO4:	Analyze the magnetic circuit and understand the operation, characteristics and control of PMBLDC motor	K4
CO5:	Understand the construction, operation ,performance characteristics of PMSM and its power controllers	K2

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
CO 1	3	2	2	2	3	2	-	-	-	-	3	2	3	3
CO 2	3	2	2	2	3	2	-	-	-	-	3	2	3	3
CO 3	3	2	2	2	3	2	-	-	-	-	3	2	2	3
CO 4	3	3	2	2	3	2	-	-	-	-	3	2	2	3
CO 5	3	2	2	2	3	2	-	-	-	-	3	2	2	3

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
	✓		✓		

PEC-04	POWER SYSTEM OPERATION AND CONTROL	3	0	0	3

Course Objectives

- To model reactive power-voltage interaction and the control actions to be implemented for maintaining the voltage profile against varying system load.
- To study the economic operation of power system to create knowledge for employability skill.

UNIT I INTRODUCTION **9 hours**

System load – variation - load characteristics - load curves and load-duration curve (daily, weekly and annual) - load factor - diversity factor. Importance of load forecasting and simple techniques of forecasting. An overview of power system operation and control and the role of computers in the implementation. (Qualitative treatment with block diagram).

UNIT II ACTIVE POWER - FREQUENCY CONTROL **9 hours**

Basics of speed governing mechanism and modelling - speed-load characteristics – load sharing between two synchronous machines in parallel. Control area concept LFC control of a single-area system. Static and dynamic analysis of uncontrolled and controlled cases. Integration of economic dispatch control with LFC. Two-area system – modelling - static analysis of uncontrolled case - tie line with frequency bias control of two-area system - state variable model.

UNIT III REACTIVE POWER–VOLTAGE CONTROL **9 hours**

Basics of reactive power control. Excitation systems – modelling. Static and dynamic analysis - stability compensation - generation and absorption of reactive power. Relation between voltage, power and reactive power at a node - method of voltage control – tap changing transformer. System level control using generator voltage magnitude setting, tap setting of OLTC transformer and MVAR injection of switched capacitors to maintain acceptable voltage profile and to minimize transmission loss.

UNIT IV COMMITMENT AND ECONOMIC DISPATCH **9 hours**

Statement of economic dispatch problem – cost of generation – incremental cost curve - co-ordination equations without loss and with loss, solution by direct method and λ- iteration method. (No derivation of loss coefficients). Statement of Unit Commitment problem – constraints; spinning reserve, thermal unit constraints, hydro constraints, fuel constraints and other constraints. Solution

methods - Priority-list methods - forward dynamic programming approach. Numerical problems only in priority-list method using full-load average production cost.

UNIT V COMPUTER CONTROL OF POWER SYSTEMS 9 hours

Need of computer control of power systems. Concept of energy control centre (or) load dispatch centre and the functions - system monitoring - data acquisition and control. System hardware configuration – SCADA and EMS functions. Network topology – state estimation - security analysis and control. Various operating states (Normal, alert, emergency, in-extremis and restorative). State transition diagram showing various state transitions and control strategies.

TOTAL : 45 hours

TEXT BOOKS:

T1: Allen. J. Wood and Bruce F. Wollenberg, 'Power Generation, Operation and Control', John Wiley & Sons, Inc., 2003.

T2: Chakrabarti & Halder, "Power System Analysis: Operation and Control", Prentice Hall of India, 2004.

REFERENCE BOOKS:

R1: Kothari, D.P. and I.J. Nagrath, 'Modern Power System Analysis', Tata McGraw Hill Publishing Company Limited, New Delhi, Third Edition, 2003.

R2: Grigsby, L.L. 'The Electric Power Engineering, Hand Book', CRC Press & IEEE Press, 2001.

R3: Hadi Saadat, "Power System Analysis", 11th Reprint 2007.

R4: Kundur, P. 'Power System Stability and Control' MC Craw Hill Publisher, USA, 1994.

R5: Olle.I.Elgerd, 'Electric Energy Systems theory An introduction' Tata McGraw Hill Publishing Company Ltd. New Delhi, Second Edition 2003.

R6: Wadhwa, C.L."Electric Power System", New Age International Publications, 4th Edition,2005.

WEB LINKS:

1. www.electrical4u.com
2. https://electrical-engineering-portal.com/

COURSE OUTCOMES

CO1:	Understand the importance of load forecasting and other factors in the power system operation	K2
CO2:	Analyze the modeling of single area and two area system.	K4
CO3:	Understand and analyze the methods of voltage control	K2
CO4:	Solve the key issues related to economic dispatch and unit commitment.	K3
CO5:	Understand the importance and usage of computer control for monitoring and data acquisition in power systems.	K2

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**

PEC-05	MICROPROCESSORS AND MICROCONTROLLERS	3	0	0	3

Course Objectives

- Impart knowledge on architecture of 8085 microprocessors and 8051 microcontrollers.
- Exposed to the interfacing of processors with peripheral ICs
- Develop an algorithm for various electrical and automation systems
-

UNIT I 8085 MICROPROCESSOR 9 hours

Hardware Architecture, pinouts – Functional Building Blocks of Processor – Memory organization – I/O ports and data transfer concepts– Timing Diagram – Interrupts.

UNIT II PROGRAMMING OF 8085 PROCESSOR 9 hours

Instruction format and addressing modes – Assembly language Program – Data transfer, data manipulation & control instructions – Programming: Loop structure with counting & Indexing – Look up table - Subroutine instructions - stack.

UNIT III 8051 MICROCONTROLLER 9 hours

Hardware Architecture, pinouts – Functional Building Blocks of Controller – Memory organization – I/O ports and data transfer concepts–Interrupts- Data Transfer, Manipulation, Control Algorithms & I/O instructions, Programming on Microcontrollers

UNIT IV PERIPHERAL INTERFACING 9 hours

Architecture, configuration and interfacing with ICs: 8255, 8259, 8254, 8279, - A/D and D/A converters &Interfacing with 8085 and 8051. Case studies: Traffic light control, Keyboard and display interface

UNIT V DESIGN OF CONTROLLERS FOR DRIVES 9 hours

Simple programming exercises- key board and display interface - Control of servo motor, stepper motor control- Application to automation systems.

TOTAL : 45 hours

TEXT BOOKS:

T1: Sunil Mathur & Jeebananda Panda, “Microprocessor and Microcontrollers”, PHI Learning Pvt. Ltd, 2016.

T2: R.S. Gaonkar, ‘Microprocessor Architecture Programming and Application’, with 8085, Wiley Eastern Ltd., New Delhi, 2013.

T3: Muhammad Ali Mazidi & Janice Gilli Mazidi, R.D.Kinely 'The 8051 Micro Controller and Embedded Systems', PHI Pearson Education, 5th Indian reprint, 2003

REFERENCE BOOKS:

R1: Krishna Kant, "Microprocessor and Microcontrollers", Eastern Company Edition,Prentice Hall of India, New Delhi, 2007.

R2: B.RAM," Computer Fundamentals Architecture and Organization" New age International Private Limited, Fifth edition, 2017.

R3: Soumitra Kumar Mandal, Microprocessor & Microcontroller Architecture, Programming & Interfacing using 8085,8086,8051,McGraw Hill Edu,2013.

R4: Ajay V.Deshmukh, 'Microcontroller Theory &Applications', McGraw Hill Edu,20165. Douglas V.Hall, 'Microprocessor and Interfacing', McGraw Hill Edu, 2016

WEB LINKS:

1. https://www.tutorialspoint.com/microprocessor/microprocessor_8085_architecture.htm
2. https://www.elprocus.com/8051-microcontroller-architecture-and-applications/

COURSE OUTCOMES

CO1:	Explain the architecture of 8085, its I/O port and memory organisation	K2
CO2:	Develop assembly language programming using count, loop and look up table concepts.	K3
CO3:	Explain the architecture of 8051 and write the assembly language programme in 8051	K2
CO4:	Identify the peripheral interfacing ICs for different applications	K3
CO5:	Understand the interfacing of controllers with various electrical and automation systems.	K2

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
CO1	2	1	2	1	2	-	-	-	-	-	-	-	2	2
CO2	3	3	2	3	2	-	-	-	-	-	-	-	3	3
CO3	3	3	2	3	2	-	-	-	-	-	-	-	3	3

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓		✓		

PEC-06	POWER SYSTEM PROTECTION AND SWITCH GEAR	3	0	0	3

Course Objectives

- To educate the causes of abnormal operating conditions (faults, lightning and switching surges) of the apparatus and system. To introduce the characteristics and functions of relays and protection schemes.
- To impart knowledge on apparatus protection. To introduce static and numerical relays. To impart knowledge on functioning of circuit breakers.

UNIT I INTRODUCTION **9 hours**

Importance of protective schemes for electrical apparatus and power system – Qualitative review of faults and fault currents - relay terminology – definitions – essential qualities of protection. Protection against over voltages due to lightning and switching - arcing grounds - Peterson Coil - ground wires - surge absorber and diverters, Power System earthing – Neutral earthing - basic ideas of insulation coordination

UNIT II OPERATING PRINCIPLES AND RELAY CHARACTERISTICS **9 hours**

Electromagnetic relays – over current, directional and non-directional, distance, negative sequence, differential and under frequency relays – Introduction to static relays.

UNIT III APPARATUS PROTECTION **9 hours**

Main considerations in apparatus protection - transformer, generator and motor protection - protection of bus-bars - Transmission line protection - zones of protection – CTs, PTs and their applications in protection schemes.

UNIT IV THEORY OF CIRCUIT INTERRUPTION **9 hours**

Physics of arc phenomena and arc interruption. DC and AC circuit breaking – restriking voltage and recovery voltage - rate of rise of recovery voltage - resistance switching - current chopping - interruption of capacitive current.

UNIT V CIRCUIT BREAKERS **9 hours**

Types of circuit breakers – air blast, air break, oil, SF6 and vacuum circuit breakers – comparative merits of different circuit breakers – testing of circuit breakers.

TOTAL : 45 hours

TEXT BOOKS:

T1: Soni, M.L. , P.V. Gupta, V.S. Bhatnagar, A. Chakrabarti, 'A Text Book on Power System Engineering', Dhanpat Rai & Co., 1998.

T2: R.K.Rajput, "A Text book of Power System Engineering", Laxmi Publications, First Edition Reprint 2007.

REFERENCE BOOKS:

R1: Sunil S. Rao, 'Switchgear and Protection', Khanna publishers, New Delhi, 1986.

R2: Wadhwa, C.L. 'Electrical Power Systems', New Age International (P) Ltd., 2000.

R3:Ravindranath, B. and N. Chander, 'Power System Protection & Switchgear', Wiley Eastern Ltd., 1977.

R4: Badri Ram, Vishwakarma, 'Power System Protection and Switchgear', Tata McGraw Hill, 2001.

R5: Paithankar Y.G. and S.R. Bhide, 'Fundamentals of Power System Protection', Prentice Hall of India Pvt. Ltd., New Delhi, 2003

WEB LINKS:

1. https://circuitglobe.com/
2. https://electrical4u.com/

COURSE OUTCOMES

CO1:	Understand the requirement of protective relaying in power system.	K2
CO2:	Understand the principles of different types of protective relays	K2
CO3:	Analyze the functioning of various protective systems.	K4
CO4:	Analyze the protective system for the given power system components.	K4
CO5:	Compare the working, merit and demerits of different type of circuit breakers.	K4

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓			✓		

PEC-07	ELECTRICAL ENERGY CONSERVATION AND AUDITING	3	0	0	3

Course Objectives

- To facilitate the students to achieve a clear conceptual understanding of technical and commercial aspects of energy conservation and energy auditing.
- To enable the students to develop managerial skills to assess feasibility of alternative approaches and drive strategies regarding energy conservation and energy auditing.

UNIT I BASICS OF ENERGY AND ITS VARIOUS FORMS 9 hours

Electricity tariff, load management and maximum demand control, power factor improvement, selection & location of capacitors, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.

UNIT II ENERGY MANAGEMENT & AUDIT 9 hours

Definition, energy audit, need, types of energy audit. Energy management (audit) approach understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.

UNIT III ENERGY EFFICIENCY IN ELECTRICAL SYSTEMS 9 hours

Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

UNIT IV ENERGY EFFICIENCY IN INDUSTRIAL SYSTEMS 9 hours

Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities in HVAC, Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Cooling Tower: Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities, assessment of cooling towers.

UNIT V ENERGY EFFICIENT TECHNOLOGIES IN ELECTRICAL SYSTEMS 9 hours

Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.,industrial and electrical systems.

TOTAL : 45 hours

TEXT BOOKS:

T1: S. C. Tripathy, "Utilization of Electrical Energy and Conservation", McGraw Hill, 1991.
T2: Wadhwa, C.L. 'Generation, Distribution and Utilization of Electrical Energy', New Age International Pvt. Ltd, 2003

REFERENCE BOOKS:

R1: Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online).
R2: Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online).

WEB LINKS:

1. https://www.alternative-energy-tutorials.com/green-energy/energy-saving-tips.html
2. https://www.coursera.org/lecture/electric-power-systems/generation-transmission-distribution-substations-transformers-x97Oo

COURSE OUTCOMES

CO1:	Explain about the energy management and auditing process.	K5
CO2:	Explain about the basic concepts of economic analysis and load management	K5
CO3:	Explain the effective load management system	K5
CO4:	Able to improve the efficiency in compressed air system	K5
CO5:	Explain the design concepts in the field of lighting systems, light sources	K5

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		

PEC-08	POWER QUALITY AND FACTS	3	0	0	3

Course Objectives

- To introduce the power quality problem , To educate on production of voltages sags, over voltages and harmonics and methods of control, To study overvoltage problems ,To study the sources and effect of harmonics in power system .
- To impart knowledge on various methods of power quality monitoring, To introduce the reactive power control techniques, To educate on static VAR compensators and their applications.

UNIT I TRANSMISSION LINES AND SERIES/SHUNT REACTIVE POWER COMPENSATION **9hours**

Basics of AC Transmission. Analysis of uncompensated AC transmission lines. Passive Reactive Power Compensation, Shunt and series compensation at the mid-point of an AC line, Comparison of Series and Shunt Compensation.

UNIT II THYRISTOR-BASED FLEXIBLE AC TRANSMISSION CONTROLLERS (FACTS) **9hours**

Description and Characteristics of Thyristor-based FACTS devices: Static VAR Compensator (SVC), Thyristor Controlled Series Capacitor (TCSC), Thyristor Controlled Braking Resistor and Single Pole Single Throw (SPST) Switch, Configurations/Modes of Operation, Harmonics and control of SVC and TCSC, Fault Current Limiter.

UNIT III VOLTAGE SOURCE CONVERTER BASED (FACTS) CONTROLLERS **9hours**

Voltage Source Converters (VSC): Six Pulse VSC, Multi-pulse and Multi-level Converters, Pulse-Width Modulation for VSCs. Selective Harmonic Elimination, Sinusoidal PWM and Space Vector Modulation. STATCOM: Principle of Operation, Reactive Power Control: Type I and Type II controllers, Static Synchronous Series Compensator (SSSC) and Unified Power Flow Controller (UPFC): Principle of Operation and Control, Working principle of Interphase Power Flow Controller, Other Devices: GTO Controlled Series Compensator, Fault Current Limiter.

UNIT IV POWER QUALITY PROBLEMS IN DISTRIBUTION SYSTEMS **9hours**

Power Quality problems in distribution systems: Transient and Steady state variations in voltage and frequency. Unbalance, Sags, Swells, Interruptions, Wave-form Distortions: harmonics, noise, notching, dc-offsets, fluctuations. Flicker and its measurement. Tolerance of Equipment: CBEMA curve**.**

UNIT V DYNAMIC VOLTAGE RESTORER AND UNIFIED POWER QUALITY CONDITIONER AND DSTATCOM **9hours**

Voltage Sag/Swell mitigation: Dynamic Voltage Restorer – Working Principle and Control Strategies. Series Active Filtering. Unified Power Quality Conditioner (UPQC): Working Principle. Capabilities and Control Strategies. Reactive Power Compensation, Harmonics and Unbalance mitigation in Distribution

Systems using DSTATCOM and Shunt Active Filters. Synchronous Reference Frame Extraction of Reference Currents. Current Control Techniques in for DSTATCOM.

TOTAL : 45hours

TEXT BOOKS:

T1: N. G. Hingorani and L. Gyugyi, “Understanding FACTS: Concepts and Technology of FACTS Systems”, Wiley-IEEE Press, 1999.

T2: K. R. Padiyar, “FACTS Controllers in Power Transmission and Distribution”, New Age International (P) Ltd. 2007.

REFERENCE BOOKS:

R1: R. C. Dugan, “Electrical Power Systems Quality”, McGraw Hill Education, 2012.

R2: G. T. Heydt, “Electric Power Quality”, Stars in a Circle Publications, 1991

WEB LINKS:

1. https://www.udemy.com/course/introduction-to-power-quality

COURSE OUTCOMES

CO1:	Analysis of uncompensated AC transmission lines	K4
CO2:	Understand the configuration and modes of operation of thyristor based controllers	K2
CO3:	Analyse the facts controllers	K4
CO4:	Analyze the Power Quality problems in distribution systems	K4
CO5:	Evaluating the Capabilities and Control Strategies of distribution systems	K5

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
		✓	✓		

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PEC-09	WIND AND SOLAR ENERGY SYSTEMS	3	0	0	3

Course Objectives

- To study the physics of wind power and energy
- To understand the principle of operation of wind generators
- To know the solar power resources
- To analyze the solar photo-voltaic cells
- To discuss the solar thermal power generation

UNIT I PHYSICS OF WIND POWER 9 hours

History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions

UNIT II WIND GENERATOR TOPOLOGIES: 9 hours

Review of modern wind turbine technologies, Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent-Magnet Synchronous Generators, Power electronics converters. Generator-Converter configurations, Converter Control

UNIT III THE SOLAR RESOURCE AND THERMAL POWER GENERATION 9 hours

Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability. Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.

UNIT IV SOLAR PHOTOVOLTAIC 9 hours

Technologies-Amorphous, monocrystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) algorithms. Converter Control.

UNIT V NETWORK INTEGRATION ISSUES 9 hours

Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.

TOTAL : 45 hours

TEXT BOOKS:

T1: T. Ackermann, “Wind Power in Power Systems”, John Wiley and Sons Ltd., 2005.

T2: G. M. Masters, “Renewable and Efficient Electric Power Systems”, John Wiley and Sons, 2004. \

REFERENCE BOOKS:

R1: S. P. Sukhatme, “Solar Energy: Principles of Thermal Collection and Storage”, McGraw Hill, 1984.

R2: H. Siegfried and R. Waddington, “Grid integration of wind energy conversion systems” John Wiley and Sons Ltd., 2006.

R3: G. N. Tiwari and M. K. Ghosal, “Renewable Energy Applications”, Narosa Publications, 2004.

R4: J. A. Duffie and W. A. Beckman, “Solar Engineering of Thermal Processes”, John Wiley & Sons, 1991.

COURSE OUTCOMES

CO1:	Understand the fundamentals of wind energy system.	K3
CO2:	Understand and select the drive system in the wind energy generation.	K4
CO3:	Understand the concept of solar energy and equipments for the power generation.	K4
CO4:	Apply the control techniques in the solar power generation.	K2
CO5:	Understand the issues related to the grid-integration of solar and wind energy systems	K3

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**

PEC-10	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	3	0	0	3

Course Objectives

- To Provide knowledge about the stand alone and grid connected renewable energy systems. To equip with required skills to derive the criteria for the design of power converters for renewable energy applications.
- To analyze and comprehend the various operating modes of wind electrical generators and solar energy systems.
- To design different power converters namely AC to DC, DC to DC and AC to AC converters for renewable energy systems. To develop maximum power point tracking algorithms.

UNIT I INTRODUCTION 9 hours

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems

UNIT II ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION 9 hours

Reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG.

UNIT III POWER CONVERTERS 9 hours

Solar: Block diagram of solar photo voltaic system -Principle of operation: line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing Wind: Three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.

UNIT IV ANALYSIS OF WIND AND PV SYSTEMS 9 hours

Stand alone operation of fixed and variable speed wind energy conversion systems and solar system Grid connection Issues -Grid integrated PMSG, SCIG Based WECS, grid Integrated solar system

UNIT V HYBRID RENEWABLE ENERGY SYSTEMS 9 hours

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV Maximum Power Point Tracking (MPPT).

TOTAL : 45 hours

TEXT BOOKS:

T1: S. N. Bhadra, D.Kastha, S.Banerjee, “Wind Electrical Systems”, Oxford University Press, 2005.

T2: B.H.Khan Non-conventional Energy sources Tata McGraw-hill Publishing Company, New Delhi,2009.

REFERENCE BOOKS:

R1: Rashid .M. H “power electronics Hand book”, Academic press, 2001.

R2: Ion Boldea, “Variable speed generators”, Taylor & Francis group, 2006.

R3: Rai. G.D, “Non conventional energy sources”, Khanna publishes, 1993.

R4: Gray, L. Johnson, “Wind energy system”, prentice hall linc, 1995.

R5: Andrzej M. Trzynnadlowski, ‘Introduction to Modern Power Electronics’, Second edition, wiley India Pvt. Ltd, 2012.

COURSE OUTCOMES

CO1:	Able to understand the fundamentals of electric energy conversion systems.	K2
CO2:	Able to analyze the fundamental and principles of electrical machine operation in renewable energy	K4
CO3:	Able to understand the design and operation of solar and wind power converters	K4
CO4:	Able to examine the variable speed in wind energy conversion system	K2
CO5:	Able to identify the need for hybrid systems.	K3

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**

PEC-11	SMART GRID	3	0	0	3

Course Objectives

- To learn the Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To know about the power quality management issues in Smart Grid. The high performance computing for Smart Grid applications.

UNIT I INTRODUCTION TO SMART GRID 9 hours

Evolution of Electric Grid, Concept-Definitions and Need for Smart Grid-Smart grid drivers-functions, opportunities -challenges and benefits -Difference between conventional & Smart Grid -National and International Initiatives in Smart Grid.

UNIT II SMART GRID TECHNOLOGIES 9 hours

Technology Drivers -Smart energy resources -Smart substations -Substation Automation -Feeder Automation -Transmission systems: EMS, FACTS and HVDC -Wide area monitoring -Protection and control -Distribution systems: DMS, Volt/VAR control -Fault Detection -Isolation and service restoration -Outage management -High-Efficiency Distribution Transformers -Phase Shifting Transformers -Plug-in Hybrid Electric Vehicles(PHEV).

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9 hours

Introduction to Smart Meters – Advanced Metering infrastructure(AMI) drivers and benefits- AMI protocols -standards and initiatives -AMI needs in the smart grid -Phasor Measurement Unit(PMU) -Intelligent Electronic Devices(IED) & their application for monitoring & protection.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9 hours

Power Quality & EMC in Smart Grid -Power Quality issues of Grid connected Renewable Energy Sources -Power Quality Conditioners for Smart Grid -Web based Power Quality monitoring -Power Quality Audit.

UNIT V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9 hours

Local Area Network(LAN) -House Area Network(HAN) -Wide Area Network(WAN) -Broad band over Power line(BPL) -IP based Protocols -Basics of Web Service and CLOUD Computing to make Smart Grids smarter -Cyber Security for Smart Grid.

TOTAL : 45 hours

TEXT BOOKS:

T1: Stuart Borlase “Smart Grid: Infrastructure, Technology and Solutions”, CRC Press 2012.
T2: Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage,Jian zhong Wu,Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley 2012.

REFERENCE BOOKS:

R1: Vehbi C. Güngör ,Dilan Sahin, Taskin Kocak, Salih Ergüt, Concettina Buccella, Carlo Cecati, and Gerhard P. Hancke, “Smart Grid Technologies: Communication Technologies and Standards” IEEE Transactions On Industrial Informatics, Vol.7,No.4, November2011.
R2: Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang“SmartGrid –The New and Improved Power Grid: A Survey” ,IEEE Transaction on Smart Grids,vol.14,2012.
R3: James Momohe “Smart Grid: Fundamentals of Design and Analysis,”, Wiley-IEEE Press , 2012.

WEB LINKS:

1. https://www.techopedia.com/definition/692/smart-grid

COURSE OUTCOMES

CO1:	Develop more understanding on the concepts of Smart Grid and its present developments.	K3
CO2:	Examine different Smart Grid technologies.	K4
CO3:	Explain about different smart meters and advanced metering infrastructure.	K5
CO4:	Explain power quality management in Smart Grids.	K5
CO5:	Develop more understanding on LAN, WAN and Cloud Computing for Smart Grid applications.	K3

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
	✓		✓		

PEC-12	SCADA AND DCS	3	0	0	3

Course Objectives

- This course focuses on basic concepts of implementation of digital controllers for industrial process, components of SCADA and DCS, architecture of DCS.

UNIT I INTRODUCTION TO DIGITAL CONTROLLERS 9hours

Introduction - Computer in process control - Data loggers, Data acquisition systems (DAS) – Data storage with time stampings - Direct Digital Control (DDC), Supervisory Digital Control (SCADA) - Controller software -Man machine interface- Management Information System.

UNIT II COMPUTER CONTROLLED SYSTEMS AND COMPONENTS OF SCADA 9hours

Basic building blocks of Computer controlled systems – SCADA – Data Acquisition System – Supervisory Control – Direct digital Control. SCADA: - Hardware and software, Remote terminal UNITs, Master Station and Communication architectures.

UNIT III DISTRIBUTED CONTROL SYSTEM 9hours

DCS – Various Architectures – Comparison – Local control unit – Process interfacing issues – Communication facilities.

UNIT IV INTERFACES IN DCS 9hours

Operator interfaces - Low level and high level operator interfaces – Displays - Engineering interfaces – Low level and high level engineering interfaces – Factors to be considered in selecting DCS.

UNIT V APPLICATIONS OF SCADA & DCS IN INDUSTRIES 9hours

Applications of SCADA & DCS in Thermal power plant, Cement manufacturing Industries, Sugar Industries, paper manufacturing Industries and Water Treatment plant.

TOTAL : 45hours

TEXT BOOKS:

T1: Krishna kant, “Computer based industrial control”, PHI, second edition, 2010.
T2: Michael P. Lukas, “Distributed Control System”, Van Nostrand Reinhold Co., Canada, 1995.
T3: David Bailey & Edwin Wright, “Practical SCADA for Industry”, Elsevier 2003.

REFERENCE BOOKS:

R1: Krishna Kant, “Digital control systems”, ISTE learning materials centre, First edition 2001.
R2: Clarke, G., Reynders, D. and Wright, E., “Practical Modern SCADA Protocols: “DNP3, 60870.5 and Related Systems”, Newnes, 1st Edition, 2004.

WEB LINKS:

1. https://www.elprocus.com/distributed-control-system-features-and-element

COURSE OUTCOMES

CO1:	To understand the basics of digital controllers	K2
CO2:	To understand the concepts of computer controlled systems	K2
CO3:	To understand the architecture of distributed control system	K2
CO4:	To know the basics of operator interfaces in DCS	K2
CO5:	To understand the applications of SCADA and DCS in industries	K2

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	✓
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
		✓	✓		

PEC-13	DIGITAL ELECTRONICS	3	0	0	3

Course Objectives

- To familiarize with the different number systems, logic gates, and combinational and sequential circuits utilized in the different digital circuits and systems.
- To acquire the basic knowledge of digital logic levels and apply the knowledge to understand the digital logic families.

UNIT I NUMBER SYSTEMS, BOOLEAN ALGEBRA AND COMBINATIONAL CIRCUITS **9 hours**

Number system, error detection, corrections & codes conversions, Boolean algebra: De-Morgan's theorem, switching functions and minimization using K-maps & Quine McCluskey method

UNIT II COMBINATIONAL LOGIC CIRCUITS **9 hours**

Design of adder, subtractor, comparators, code converters, encoders, decoders, multiplexers and demultiplexers, Realization of Boolean Functions using MSI devices, memories and PLA

UNIT III SYNCHRONOUS SEQUENTIAL CIRCUITS **9 hours**

Flip flops - SR, D, JK and T, shift registers, counters, state assignments analysis and design of synchronous sequential circuits, state diagram; state reduction

UNIT IV ASYNCHRONOUS SEQUENCTIAL CIRCUITS **9 hours**

Latches - SR - D ,Asynchronous sequential logic circuits-Transition table, flow table – race conditions – circuits with latches, analysis of asynchronous sequential logic circuits – introduction to design – implication table

UNIT V LOGIC FAMILIES AND VHDL **9 hours**

Logic families: RTL ad DTL Circuits, TTL ECL NMOS and CMOS : Introduction to VHDL :Design – combinational logic – Types – Operators – Packages – Sequential circuit – Sub programs – Test benches. (Examples: adders, counters, flip flops, FSM, Multiplexers / Demultiplexers).

TOTAL : 45 hours

TEXT BOOKS:

T1: Morris Mano.M, 'Digital Logic and Computer Design', Prentice Hall of India, 3rd Edition, 2005.
T2: Donald D. Givone, 'Digital Principles and Design', Tata McGraw Hill, 1st Edition, 2003
T3: Thomas L Floyd, 'Digital fundamentals', Pearson Education Limited, 11 th Edition, 2015

REFERENCE BOOKS:

R1: Tocci R.J., Neal S. Widmer, 'Digital Systems: Principles and Applications', Pearson Education Asia, 2014.

R2: Donald P Leach, Albert Paul Malvino, Goutam Sha, 'Digital Principles and Applications', Tata McGraw Hill, 7th Edition, 2010.

WEB LINKS:

1. https://www.tutorialspoint.com › digital circuits
2. https://www.javatpoint.com › digital-electronics

COURSE OUTCOMES

CO1:	Understand and examine the structure of various number systems and its application in digital design to solve real world problems	K2,K4
CO2:	Analyze and design combinational logic circuits using gates and MSI devices.	K4
CO3:	Analyze and Design synchronous sequential logic circuits using Flip flops and gates	K4
CO4:	Analyze and Design asynchronous sequential logic circuits using latches and gates	K4
CO5:	Selection of logic families and skill development for application specific digital circuit design using VHDL	K3

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**

PEC-14	HIGH VOLTAGE DIRECT CURRENT TRANSMISSION SYSTEMS	3	0	0	3

Course Objectives

- To understand the concept, planning of DC power transmission and compare with AC Power transmission.
- To study about the HVDC system control and to analyze harmonics and develop the skill of designing filters

UNIT I INTRODUCTION **9 hours**

DC Power transmission technology – Comparison of AC and DC transmission – Application of DC transmission – Description of DC transmission system – Planning for HVDC transmission – Modern trends in HVDC technology – DC breakers – Operating problems – HVDC transmission based on VSC – Types and applications of MTDC systems.

UNIT II ANALYSIS OF HVDC CONVERTERS **9 hours**

Line commutated converter - Analysis of Graetz circuit with and without overlap - Pulse number – Choice of converter configuration – Converter bridge characteristics – Analysis of a 12 pulse converters – Analysis of VSC topologies and firing schemes.

UNIT III CONVERTER AND HVDC SYSTEM CONTROL **9 hours**

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 HARMONICS CONTROL **9 hours**

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 IN AC/DC SYSTEMS **9 hours**

Per unit system for DC quantities – DC system model – Inclusion of constraints – Power flow analysis – case study

TOTAL : 45 hours

TEXT BOOKS:

T1:Padiyar, K. R., “HVDC power transmission system”, New Age International (P) Ltd., New Delhi, Second Edition, 2010.

T2:Edward Wilson Kimbark, “Direct Current Transmission”, Vol. I, Wiley interscience, New York, London, Sydney, 1971.

T3:Rakosh Das Begamudre, “Extra High Voltage AC Transmission Engineering”, New Age International (P) Ltd., New Delhi, 1990.

REFERENCE BOOKS:

R1:Kundur P., “Power System Stability and Control”, McGraw-Hill, 1993.

R2:Colin Adamson and Hingorani N G, “High Voltage Direct Current Power Transmission”, Garraway Limited, London, 1960.

R3:Arrillaga, J., “High Voltage Direct Current Transmission”, Peter Pregrinus, London, 1983.

R4:S. Kamakshaiah, V. Kamaraju, ‘HVDC Transmission’, Tata McGraw Hill Education Private Limited, 2011.

Web Links:

1. https://www.electrical4u.com/high-voltage-direct-current-transmission/
2. https://circuitglobe.com/hvdc-high-voltage-direct-current.html

COURSE OUTCOMES

CO1:	Understand and explain the benefits, types and application of HVDC Transmission system.	K 2
CO2:	Analyze the configuration and characteristics of HVDC converter.	K 4
CO3:	Examine the Converter control characteristics, Firing angle control and extinction angle control schemes.	K 4
CO4:	Identify the requirements in HVDC for reactive power and harmonics control	K 3
CO5:	Analyze the power flow control in AC and DC system	K 4

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		

OPEN ELECTIVE COURSES

0EC-01	BIOMEDICAL INSTRUMENTATION	3	0	0	3

Course Objectives

- To impart knowledge of the principle of operation and design of biomedical instruments.
- To render a broad and modern account of biomedical instruments.

UNIT I FUNDAMENTALS OF BIOMEDICAL ENGINEERING 9 hours

Cell and its structure – Resting and Action Potential – Nervous system and its fundamentals - Basic components of a biomedical system- Cardiovascular systems- Respiratory systems -Kidney and blood flow - Biomechanics of bone - Biomechanics of soft tissues -Physiological signals and transducers - Transducers – selection criteria – Piezo electric, ultrasonic transducers - Temperature measurements - Fibre optic temperature sensors

UNIT II NON ELECTRICAL PARAMETERS MEASUREMENT AND DIAGNOSTIC PROCEDURES 9 hours

Measurement of blood pressure - Cardiac output - Heart rate - Heart sound - Pulmonary function measurements – spirometer – Photo Plethysmography, Body Plethysmography – Blood Gas analysers, pH of blood –measurement of blood pCO2, pO2, finger-tip oxymeter - ESR, GSR measurements.

UNIT III ELECTRICAL PARAMETERS ACQUISITION AND ANALYSIS 9 hours

Electrodes – Limb electrodes –floating electrodes – pregelled disposability electrodes - Micro, needle and surface electrodes – Amplifiers, Preamplifiers, differential amplifiers, chopper amplifiers – Isolation amplifier - ECG – EEG – EMG – ERG – Lead systems and recording methods – Typical waveforms - Electrical safety in medical environment, shock hazards – leakage current-Instruments for checking safety parameters of biomedical equipment.

UNIT IV IMAGING MODALITIES AND ANALYSIS 9 hours

Radio graphic and fluoroscopic techniques – Computer tomography – MRI – Ultrasonography – Endoscopy – Thermography –Different types of biotelemetry systems - Retinal Imaging - Imaging application in Biometric systems.

UNIT V LIFE ASSISTING, THERAPEUTIC AND ROBOTIC DEVICES 9 hours

Pacemakers – Defibrillators – Ventilators – Nerve and muscle stimulators – Diathermy – Heart – Lung machine – Audio meters – Dialysers – Lithotripsy - ICCU patient monitoring system - Nano Robots - Robotic surgery –Orthopedic prostheses fixation.

TOTAL : 45 hours

TEXT BOOKS:

T1: Leslie Cromwell, “Biomedical Instrumentation and Measurement”, Prentice Hall of India, New Delhi, 2007
T2: Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw-Hill, New Delhi,2nd edition, 2003

REFERENCE BOOKS:

R1. Ed. Joseph D. Bronzino, The Biomedical Engineering Hand Book, Third Edition, Boca Raton, CRC Press LLC, 2006.
R2. . M.Arumugam, ‘Bio-Medical Instrumentation’, Anuradha Agencies, 2003.

WEB LINKS:

1**.** https://onlinecourses.nptel.ac.in/noc22_md01/preview

2. https://www.journals.elsevier.com/biomedical-journal

COURSE OUTCOMES

CO1:	Understand the bioelectric potentials,the electrode theory, different types of electrodes and transducers.	K 2
CO2:	Explain pulmonary measurements, respiratory rate measurement, artificial respirator, oximeter, hearing aids, functional neuromuscular simulation, physiotherapy, diathermy, nerve stimulator, artificial kidney machine.	K 4
CO3:	Explain the working and concepts of ECG,EMG,EEG, plethysmography, impedance cardiology, cardiac arrhythmia’s, pace makers, defibrillators	K2
CO4:	Analyze Clinical Flame photometer ,spectrophotometer ,Colorimeter,chromatography, Blood Gas Analyz, Blood pH Measurement, Blood Cell Counters	K4
CO5:	Explain Medical imaging, Xrays, laser applications, ultrasound scanner, echo cardiography, CT Scan MRI/NMR, cine angiogram, colour doppler systems, Holter monitoring, endoscopy.	K4

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
	✓		✓		✓

OEC-02	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	3	0	0	3

Course Objectives

- To imparts the knowledge of basic concepts of artificial intelligence and expert systems
- To introduce students to the basic concepts and techniques of Machine Learning

UNIT I INTRODUCTION TO AI **9 hours**

Introduction–Definition – Future of Artificial Intelligence – Characteristics of Intelligent Agents– Typical Intelligent Agents – Problem Solving Approach to Typical AI problems.

UNIT II PROBLEM SOLVING METHODS **9 hours**

Problem solving Methods – Search Strategies- Uninformed – Informed – Heuristics – Local Search Algorithms and Optimization Problems -Searching with Partial Observations – Constraint Satisfaction Problems – Constraint Propagation – Backtracking Search – Game Playing – Optimal Decisions in Games – Alpha – Beta Pruning – Stochastic Games.

UNIT III KNOWLEDGE REPRESENTATION **9 hours**

First Order Predicate Logic – Prolog Programming – Unification – Forward Chaining-Backward Chaining – Resolution – Knowledge Representation – Ontological Engineering-Categories and Objects – Events – Mental Events and Mental Objects – Reasoning Systems for Categories - Reasoning with Default Information

UNIT IV MACHINE LEARNING BASICS **9 hours**

Learning – Types of Machine Learning – Supervised Learning – The Brain and the Neuron – Design a Learning System – Perspectives and Issues in Machine Learning – Concept Learning Task – Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm – Linear Discriminants – Perceptron – Linear Separability – Linear Regression.

UNIT V LINEAR MODELS **9 hours**

Multi-layer Perceptron – Going Forwards – Going Backwards: Back Propagation Error – Multilayer Perceptron in Practice – Examples of using the MLP – Overview – Deriving Back Propagation – Radial Basis Functions and Splines – Concepts – RBF Network – Curse of Dimensionality – Interpolations and Basis Functions – Support Vector Machines.

TOTAL : 45 hours

Text Books:

T1: Deepak Khemani “Artificial Intelligence”, Tata Mc Graw Hill Education 2013.
T2: Bratko, —Prolog: Programming for Artificial Intelligence‖, Fourth edition, Addison Wesley Educational Publishers Inc., 2011.

Reference Books:

R1: S. Russell and P. Norvig, “Artificial Intelligence: A Modern Approachǁ, Prentice Hall, Third Edition 2009.
R2: M. Tim Jones, —Artificial Intelligence: A Systems Approach(Computer Science)ǁ, Jones and Bartlett Publishers, Inc.; First Edition, 2008

Web Links:

1. https://onlinecourses.nptel.ac.in/noc22_cs56/preview
2. https://nptel.ac.in/courses/106102220

COURSE OUTCOMES

CO1:	Learn and develop a basic understanding of the building blocks of AI as presented in terms of intelligent agents	K5
CO2:	Understand about fundamental areas of Local Search Algorithms, Adversarial Searching and Neural Networks.	K2
CO3:	Understand knowledge of the world using logic and infer new facts from that Knowledge.	K2
CO4:	Understand different techniques related to Machine Learning.	K2
CO5:	Construct algorithms to learn linear models	K3

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	0	0	0	0	0	0	0	0	3	2
CO2	3	2	2	2	1	0	0	0	0	0	0	0	3	2
CO3	3	2	2	2	1	0	0	0	0	0	0	0	3	2
CO4	3	2	2	2	1	0	0	0	0	0	0	0	3	2
CO5	3	2	2	2	1	0	0	0	0	0	0	0	3	2

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**

OEC-03	ROBOTICS AND AUTOMATION	3	0	0	3

Course Objectives

- To impart knowledge on various drive system, sensors and machine vision system
- To understand the programming and specific industrial applications

UNIT I FOUNDATION FOR BEGINNERS 9 hours

Introduction -- brief history, definition, anatomy, types, classification, specification and need based applications; role and need of robots for the immediate problems of the society, future of mankind and automation-ethical issues; industrial scenario local and global, case studies on mobile robot research platform and industrial serial arm manipulator

UNIT II BUILDING BLOCKS OF A ROBOT 9 hours

Types of electric motors - DC, Servo, Stepper; specification, drives for motors - speed & direction control and circuitry, Selection criterion for actuators, direct drives, non-traditional actuators; Sensors for localization, navigation, obstacle avoidance and path planning in known and unknown environments – optical, inertial, thermal, chemical, biosensor, other common sensors; Case study on choice of sensors and actuators for maze solving robot and self driving cars

UNIT III KINEMATICS, DYNAMICS AND DESIGN OF ROBOTS & END-EFFECTORS 9 hours

Robot kinematics - Geometric approach for 2R, 3R manipulators, homogenous transformation using D-H representation, kinematics of WMR, Lagrangian formulation for 2R robot dynamics; Mechanical design aspects of a 2R manipulator, WMR; End-effector -common types and design case study.

UNIT IV NAVIGATION, PATH PLANNING AND CONTROL ARCHITECTURE 9 hours

Mapping & Navigation – SLAM, Path planning for serial manipulators; types of control architectures - Cartesian control, Force control and hybrid position/force control, Behaviour based control, application of Neural network, fuzzy logic, optimization algorithms for navigation problems, programming methodologies of a robot

UNIT V AI AND OTHER RESEARCH TRENDS IN ROBOTICS 9 hours

Application of Machine learning - AI, Expert systems; Tele-robotics and Virtual Reality, Micro &Nanorobots, Unmanned vehicles, Cognitive robotics, Evolutionary robotics, Humanoids

TOTAL : 45 hours

TEXT BOOKS:

T1: Saeed. B. Niku, Introduction to Robotics, Analysis, system, Applications, Pearson educations, 2002
T2: Roland Siegwart, Illah Reza Nourbakhsh, Introduction to Autonomous Mobile Robots, MIT Press, 2011

REFERENCE BOOKS:

R1: K.S. Fu, R.C. Gonzalez and C.S.G. Lee, Robotics: Control, Sensing, Vision and Intelligence, McGraw-Hill, 1987.
R2: Wesley E Snyder R, Industrial Robots, Computer Interfacing and Control, Prentice Hall International Edition, 1988.

WEB LINKS:

1. https://www.mdpi.com/journal/robotics
2. https://nptel.ac.in/courses/112105249

COURSE OUTCOMES

CO1:	Summarize knowledge of basic concepts of robotic systems	K2
CO2:	Analyze the functions of sensors and machine vision system in the robot	K4
CO3:	Categorize the drives, manipulators and grippers	K2
CO4:	Develop the qualitative knowledge of navigation and control of robot	K6
CO5:	Evaluate the recent trends and applications of robotics in various field	K5

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
	✓	✓	✓		

OEC-04	MICROCONTROLLER BASED SYSTEM DESIGN	3	0	0	3

Course Objectives

- To impart knowledge on the architecture of PIC microcontroller its interrupts, timers and the peripheral devices used for data communication and transfer.
- To study about the architecture of ARM processor and its organization

UNIT I INTRODUCTION TO PIC MICROCONTROLLER 9 hours

Introduction to PIC Microcontroller - PIC 16C6x and PIC16C7x Architecture- PIC16cxx - Pipelining - Program Memory considerations – Register File Structure - Instruction Set - Addressing modes – Simple Operations.

UNIT II INTERRUPTS AND TIMER 9 hours

PIC micro controller Interrupts- External Interrupts-Interrupt Programming- Loop time subroutine - Timers-Timer Programming– Front panel I/O-Soft Keys– State machines and key switches– Display of Constant and Variable strings.

UNIT III PERIPHERALS AND INTERFACING 9 hours

I2C Bus for Peripherals Chip Access– Bus operation-Bus subroutines– Serial EEPROM–UART-Baud rate selection–Data handling circuit–Initialization - LCD and keyboard Interfacing -ADC, DAC and Sensor Interfacing - Stepper Motor, DC Motor speed Control using PWM

UNIT IV INTRODUCTION TO ARM PROCESSOR 9 hours

ARM Architecture –ARM programmer's model –ARM Development tools- Memory Hierarchy –ARM Assembly Language Programming–Simple Examples–Architectural Support for Operating systems.

UNIT V ARM ORGANIZATION 9 hours

3-Stage Pipeline ARM Organization– 5-Stage Pipeline ARM Organization–ARM Instruction Execution-ARM Implementation– ARM Instruction Set– ARM coprocessor interface– Architectural support for High Level Languages – Embedded ARM Applications.

TOTAL : 45 hours

TEXT BOOKS:

T1: Peatman,J.B., "Design with PIC Micro Controllers"PearsonEducation,3rdEdition, 2004.

T2: Furber,S., "ARM System on Chip Architecture" Addison Wesley trade Computer Publication, 2000.

REFERENCE BOOKS:

R1: Mazidi, M.A.,"PIC Microcontroller" Rollin Mckinlay, Danny causey Printice Hall of India, 2007.

WEB LINKS:

1. https://microcontrollerslab.com/pic-microcontroller-architecture/
2. https://www.geeksforgeeks.org/pipelining-in-arm/

COURSE OUTCOMES

CO1:	Explain the architecture and pipelining concept of PIC Microcontroller	K2
CO2:	Identify various Interrupts and Timers available in PIC microcontroller.	K2
CO3:	Develop a microcontrollers based system using various peripherals and interfacing them	K3
CO4:	Understand the concepts of ARM Processor and its memory hierarchy	K2
CO5:	Summarise the pipelining concepts and execution of instructions	K2

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓		✓		

OEC-05	OPTIMIZATION TECHNIQUES	3	0	0	3

Course Objectives

- Operation research models using optimization techniques based upon the fundamentals of engineering mathematics (minimization and Maximization of objective function).
- The problem formulation by using linear, dynamic programming, game theory and queuing models.
- The stochastic models for discrete and continuous variables to control inventory and simulation of manufacturing models for the production decision making
- Formulation of mathematical models for quantitative analysis of managerial problems in industry.

UNIT I LINEAR PROGRAMMING 9 hours

Formulation-Graphical and simplex methods-Big-M method-Two phase method-Dual simplex method-Primal Dual problems

UNIT II UNCONSTRAINED ONE DIMENSIONAL OPTIMIZATION TECHNIQUES 9 hours

Necessary and sufficient conditions –Unrestricted search methods-Fibonacci and golden section method-Quadratic Interpolation methods, cubic interpolation and direct root methods.

UNIT III UNCONSTRAINED DIMENSIONAL OPTIMIZATION TECHNIQUES 9 hours

Direct search methods –Random search –pattern search and Rosen brooch's hill claiming method-Descent methods-Steepest descent, conjugate gradient, quasi –Newton method.

UNIT IV CONSTRAINED OPTIMIZATION TECHNIQUES 9 hours

Necessary and sufficient conditions –Equality and inequality constraints-Kuhn-Tucker conditions-Gradient projection method-cutting plane method- penalty function method.

UNIT V DYNAMIC PROGRAMMING 9 hours

Principle of optimality- recursive equation approach-application to shortest route, cargo-loading, allocation and production schedule problems.

TOTAL : 45 hours

TEXT BOOKS:

1. Rao, S.S.,'Optimization: Theory and Application' Wiley Eastern Press, 1978.
2. Taha, H.A., Operations Research –An Introduction, Prentice Hall of India.

REFERENCE BOOKS:

R1: Fox, R.L.,'Optimization methods for Engineering Design', Addition Welsey, 1971

WEB LINKS:

1.https://www.researchgate.net/publication/270091578_Foundation_of_Linear_Programming

2.http://ieeexplore.ieee.org/abstract/document/7546296/

COURSE OUTCOMES

CO1:	Formulate optimization problems.	K6
CO2:	Solve various constrained and unconstrained problem in single variable.	K3
CO3:	Solve various constrained and unconstrained problem in multi variable.	K3
CO4:	Apply constrained optimization methods.	K3
CO5:	Discuss applications of optimization techniques.	K6

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**

OEC-06	COMMUNICATION ENGINEERING	3	0	0	3

Course Objectives

Acquire successful technical and professional careers in the field of communication by

- Learning the various analog and digital modulation techniques
- An ability to develop, analyze and interpret data, by learning the principles behind information theory and coding

UNIT I FUNDAMENTALS OF ANALOG COMMUNICATION 9

Principles of amplitude modulation, AM envelope, frequency spectrum and bandwidth, modulation index and percent modulation, AM Voltage distribution, AM power distribution, Angle modulation - FM and PM waveforms, phase deviation and modulation index, frequency deviation and percent modulation, Frequency analysis of angle modulated waves. Bandwidth requirements for Angle modulated waves.

UNIT II DIGITAL COMMUNICATION 9

Introduction, Shannon limit for information capacity, digital amplitude modulation, frequency shift keying, FSK bit rate and baud, FSK transmitter, BW consideration of FSK, FSK receiver, phase shift keying – binary phase shift keying – carrier recovery – squaring loop, Costas loop, DPSK.

UNIT III SOURCE CODES, LINE CODES & ERROR CONTROL 9

Primary communication – entropy, properties, BSC, BEC, source coding: Shaum, Fao, Huffman coding: noiseless coding theorem, BW – SNR trade off codes: NRZ, RZ, AMI, HDBP, ABQ, MBnB codes: Efficiency of transmissions, error control codes and applications: convolutions & block codes.

UNIT IV MULTIPLE ACCESS TECHNIQUES 9

SS&MA techniques: FDMA, TDMA, CDMA, SDMA application in wire and wireless communication: Advantages (merits).

UNIT V SATELLITE, OPTICAL FIBER 9

Orbits: types of satellites: frequency used link establishment, MA techniques used in satellite communication, earth station; aperture actuators used in satellite – Intelsat and Insat: fibers – types: sources, detectors used, digital filters, optical link.

TOTAL : 45 hours

TEXT BOOKS

T1: Wayne Tomasi, “Advanced Electronic Communication Systems”, 5/e, Pearson Education, 2007.

T2: Haykin, “Digital Communications”, John Wiley, 2006.

Reference Books:

R1 :Kennedy and Davis “Electronic communication systems” Tata McGraw hill, 4th edition, 1993.Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007 Pete Warden, Big Data Glossary, O" Reilly, 2011.

R2: Sklar “Digital communication fundamentals and applications“ Pearson Education, 2001

R3 :Baryle, Memuschmidt, digital Communication, Kluwer Publication, 2004.

R4: B.P.Lathi “Modern digital and analog communication systems” Oxford University Press, 1998.

R5: Dennis Roddy “Satellite Communications” Tata McGraw hill, 4th edition, 2009.

Web Links:

1.https://www.digimat.in/nptel/courses/video/117102059/L33.html
2.https://www.digimat.in/nptel/courses/video/117102059/L08.html

COURSE OUTCOMES

CO1:	Ability to comprehend and interpret the significance and role of analog communication	K 2
CO2:	Ability to comprehend and interpret the significance and role of digital communication	K 2
CO3:	Analyze Source and Error control coding methods	K4
CO4:	Categorize the various Multiple Access Techniques	K 4
CO5:	Understand and analyze about satellites and fiber optic cables in communication system	K 4

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	3	0	0	0	0	0	0	0	3	3
CO2	3	3	2	2	3	0	0	0	0	0	0	0	3	3
CO3	3	3	2	2	3	0	0	0	0	0	0	0	3	3
CO4	2	2	2	1	3	0	0	0	0	0	0	0	3	3
CO5	2	2	1	1	3	0	0	0	0	0	0	0	3	3

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		

OEC-07	ELECTRIC VEHICLE MECHANICS AND CONTROL	3	0	0	3

Course Objectives

- To provide knowledge of Electric Vehicle Mechanics and control mechanism
- Understand about working principle of electronics and sensor less control in electric vehicles.

UNIT I ELECTRIC VEHICLE ARCHITECTURE 9 hours

History of evolution of Electric Vehicles - Series parallel architecture of Hybrid Electric Vehicles (HEV) – Plug-in Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes.

UNIT II MECHANICS OF ELECTRIC VEHICLES 9 hours

Fundamentals of vehicle mechanics - tractive force, power and energy requirements for standard drive cycles of EV's - motor torque and power rating and battery capacity.

UNIT III **CONTROL OF DC AND AC MOTOR DRIVES 9 hours**

Speed control for constant torque, constant HP operation of all electric motors - DC/DC chopper based four quadrant operation of DC motor drives, inverter based V/f Operation (motoring and braking) of induction motor drives, vector control operation of Induction motor and PMSM, Brushless DC motor drives, Switched reluctance motor (SRM) drives.

UNIT IV ENERGY STORAGE SYSTEMS 9 hours

Battery: Principle of operation, types, models, SOC of battery, Traction Batteries and their capacity for standard drive cycles. Alternate sources: Fuel cells, Ultra capacitors, Fly wheels.

UNIT V HYBRID VEHICLE CONTROL STRATEGY 9 hours

HEV supervisory control - Selection of modes - power spilt mode - parallel mode - engine brake mode - regeneration mode - series parallel mode.

TOTAL : 45 hours

TEXT BOOKS:

T1: Iqbal Husain, “Electric and Hybrid Electric Vehicles”, CRC Press, 2011.
T2: Wei Liu, “Hybrid Electric Vehicle System Modeling and Control”, Second Edition, WILEY, 2017.

REFERENCE BOOKS:

R1: James Larminie and John Lowry, “Electric Vehicle Technology Explained”, Second Edition 2012.
R2: Christopher D Rahn, Chao-Yang Wang, “Battery Systems Engineering”, Wiley, 2013.

WEB LINKS:

1. https://nptel.ac.in/courses/108106170
2. https://www.mdpi.com/journal/wevj

COURSE OUTCOMES

CO1:	To identify and describe the history and evolvement of electric & hybrid electric vehicles to emphasize on the need and importance of EV/HEV for sustainable future	K 2
CO2:	To design and select electric propulsion system components for EV/HEV drives suitability for the desirable performance and control.	K6
CO3:	To compare and evaluate various energy sources and energy storage components for EV and HEV applications.	K3
CO4:	To model, analyze and design EV/HEV drive train with energy management strategies.	K5
CO5:	To recognize the need to adapt and engage in operations EV/HEV with the absolute technological change in the transportation system for sustainable future.	K2

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓			✓		✓

OEC-08	COMPUTER ARCHITECHTURE	3	0	0	3

Course Objectives

- To learn the basic structure and operations of a computer to acquire employability skill based knowledge
- To learn the arithmetic and logic unit and implementation of fixed point and floating point arithmetic unit
- To learn the different ways of communication with I/O devices

UNIT I BASIC STRUCTURE OF A COMPUTER SYSTEM 9 hours

Functional Units – Basic Operational Concepts – Performance – Instructions: Language of the Computer – Operations, Operands – Instruction representation – Logical operations – decision making – MIPS Addressing.

UNIT II ARITHMETIC FOR COMPUTERS 9 hours

Addition and Subtraction – Multiplication – Division – Floating Point Representation – Floating Point Operations – Sub word Parallelism

UNIT III PROCESSOR AND CONTROL UNIT 9 hours

A Basic MIPS implementation – Building a Data path – Control Implementation Scheme – Pipelining – Pipelined data path and control – Handling Data Hazards & Control Hazards – Exceptions.

UNIT IV PARALLELISIM 9 hours

Parallel processing challenges – Flynn‘s classification – SISD, MIMD, SIMD, SPMD, and Vector Architectures – Hardware multithreading – Multi-core processors and other Shared Memory Multiprocessors – Introduction to Graphics Processing Units, Clusters, Warehouse Scale Computers and other Message-Passing Multiprocessors

UNIT V MEMORY & I/O SYSTEMS 9 hours

Memory Hierarchy – memory technologies – cache memory – measuring and improving cache performance – virtual memory, TLB‘s – Accessing I/O Devices – Interrupts – Direct Memory Access – Bus structure – Bus operation – Arbitration – Interface circuits – USB.

TOTAL : 45 hours

TEXT BOOKS:

T1: David A. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, Fifth Edition, Morgan Kaufmann / Elsevier, 2014.

T2: Carl Hamacher, Zvonko Vranesic, Safwat Zaky and Naraig Manjikian, Computer Organization and Embedded Systems, Sixth Edition, Tata McGraw Hill, 2012.

REFERENCE BOOKS:

R1: William Stallings, Computer Organization and Architecture – Designing for Performance, Eighth Edition, Pearson Education, 2010.

R2: John P. Hayes, Computer Architecture and Organization, Third Edition, Tata McGraw Hill, 2012.

R3: John L. Hennessey and David A. Patterson, Computer Architecture – A Quantitative Approachǁ, Morgan Kaufmann / Elsevier Publishers, Fifth Edition, 2012.

COURSE OUTCOMES

CO1:	Understand the basics structure of computers, operations and instructions.	K2
CO2:	Design arithmetic and logic unit.	K4
CO3:	Understand pipelined execution and design control unit.	K2
CO4:	Understand parallel processing architectures.	K2
CO5:	Understand the various memory systems and I/O communication.	K2

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		

OEC-09	EMBEDDED SYSTEMS	3	0	0	3

Course Objectives

- To introduce the Building Blocks of Embedded System and Various Embedded Development Strategies.
- To study about bus Communication in processors, Input/output interfacing.
- To impart knowledge in various processor scheduling algorithms.
- To introduce the basics of Real time operating system and example tutorials to discuss on one real time operating system tool.

UNIT I INTRODUCTION TO EMBEDDED SYSTEMS **9 hours**

Introduction to Embedded Systems – The build process for embedded systems- Structural units in Embedded processor, selection of processor & memory devices - DMA - Memory management methods- Timer and Counting devices, Watchdog Timer, Real Time Clock, In circuit emulator, Target Hardware Debugging.

UNIT II EMBEDDED NETWORKING **9 hours**

Embedded Networking: Introduction, I/O Device Ports & Buses - Serial Bus communication protocols - RS232 standard - RS422 - RS485 - CAN Bus -Serial Peripheral Interface (SPI) - Inter Integrated Circuits (I^2C) - need for device drivers

UNIT III EMBEDDED FIRMWARE DEVELOPMENT ENVIRONMENT **9 hours**

Embedded Product Development Life Cycle- objectives, different phases of EDLC, Modeling of EDLC, issues in Hardware-software Co-design, Data Flow Graph, state machine model, Sequential Program Model, concurrent Model, object oriented Model.

UNIT IV RTOS BASED EMBEDDED SYSTEM DESIGN **9 hours**

Introduction to basic concepts of RTOS- Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Task communicationshared memory, message passing-, Inter process Communication – synchronization between processes-semaphores, Mailbox, pipes, priority inversion, priority inheritance, comparison of Real time Operating systems: Vx Works, чC/OS-II, RT Linux.

UNIT V EMBEDDED SYSTEM APPLICATION DEVELOPMENT **9 hours**

Case Study of Washing Machine- Automotive Application- Smart card System Application-ATM Machine

TOTAL : 45 hours

Text Books:

1. Rajkamal, 'Embedded System-Architecture, Programming, Design', Mc Graw Hill, 2013.
2. Peckol, "Embedded system Design", John Wiley & Sons,2010
3. Lyla B Das," Embedded Systems-An Integrated Approach", Pearson, 2013

Reference Books:

1. Shibu. K.V, "Introduction to Embedded Systems", Tata Mcgraw Hill, 2009.
2. Elicia White," Making Embedded Systems", O' Reilly Series, SPD, 2011.
3. Tammy Noergaard, "Embedded Systems Architecture", Elsevier, 2006.
4. Han-Way Huang,"Embedded system Design Using C8051", Cengage Learning, 2009.
5. Rajib Mall "Real-Time systems Theory and Practice" Pearson Education, 2007

Web Links:

1. http://edutechwiki.unige.ch/en/Embedded_systems_building_blocks
2. https://en.wikipedia.org/wiki/Real-time_operating_system

COURSE OUTCOMES

CO1:	Identify the structural units in embedded processor and memory and the I/O devices	K2
CO2:	Analyse various protocols to establish communication between the embedded devices.	K4
CO3:	Identify the different stages involved in the development of an embedded product and various models in it.	K2
CO4:	Explain the basic concepts of Real Time Operating Systems (RTOS).	K2
CO5:	Understand the working of Embedded system applications like washing machine, smart card and automotive applications	K3

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
CO 1	2	2	2	2	2	0	0	0	0	0	0	0	2	3
CO 2	2	2	2	2	3	0	0	0	0	0	0	0	3	3
CO 3	2	2	2	2	3	0	0	0	0	0	0	0	3	3
CO 4	2	2	2	2	3	0	0	0	0	0	0	0	3	3
CO 5	2	2	2	2	3	0	0	0	0	0	0	0	3	3

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
✓	✓		✓		

OEC-10	ELECTRICAL MATERIALS	3	0	0	3

Course Objectives

- To understand the construction and working principle of various parts of an automobile.
- To have the practice for assembling and dismantling of engine parts and transmission system.

UNIT I ELEMENTARY MATERIALS SCIENCE CONCEPTS 9 hours

Bonding and types of solids, Crystalline state and their defects, Classical theory of electrical and thermal conduction in solids, temperature dependence of resistivity, skin effect, Hall effect.

UNIT II DIELECTRIC PROPERTIES OF INSULATORS IN STATIC AND ALTERNATING FIELD 9 hours

Dielectric constant of mono-atomic gases, poly-atomic molecules and solids, Internal field in solids and liquids, Properties of Ferro-Electric materials, Polarization, Piezoelectricity, Frequency dependence of Electronic and Ionic Polarizability, Complex dielectric constant of non-dipolar solids, dielectric losses

UNIT III MAGNETIC PROPERTIES AND SUPERCONDUCTIVITY 9 hours

Magnetization of matter, Magnetic Material Classification, Ferromagnetic Origin, Curie-Weiss Law, Soft and Hard Magnetic Materials, Superconductivity and its origin, Zero resistance and Meissner Effect, critical current density.

UNIT IV CONDUCTIVITY OF METALS 9 hours

Ohm's law and relaxation time of electrons, collision time and mean free path, electron scattering and resistivity of metals.

UNIT V SEMICONDUCTOR MATERIALS 9 hours

Classification of semiconductors, semiconductor conductivity, temperature dependence, Carrier density and energy gap, Trends in materials used in Electrical Equipment.

TOTAL : 45 hours

TEXT BOOKS:

T1: Electrical Engineering Materials Adrianus J Dekker, Phi Learning Publishers.

T2: Electrical Properties of Materials, 8th Edition by Solymar, L, Oxford University Press

T3: New Delhi.

REFERENCE BOOKS:

R1: Introduction to Electrical Engineering Materials 4th Edn. 2004 Edition by Indulkar C, S. Chand & Company Ltd-New Delhi.

R2: Electrical and Electronic Engineering Materials by SK Bhattacharya, Khanna Publishers, New Delhi

WEB LINKS:

1. https://www.electrical4u.com/dielectric-properties-of-insulation/
2. https://irds.ieee.org/topics/semiconductor-materials

COURSE OUTCOMES

CO1:	Understand the use of bonding and crystallinity in the concept of electrical materials.	K2
CO2:	Make use of the dielectric properties of insulators in static and alternating fields in the related system.	K3
CO3:	Apply the magnetic properties and superconductivity in the electrical system.	K3
CO4:	Explain the behaviour of conductivity of metals.	K5
CO5:	Understand the facts of semiconductor materials by means of carrier density and band gap.	K3

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	CAT 2	Model Exam	End Semester Exams	Assignments	Case Studies
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**

OEC-11	APPLIED SOFT COMPUTING	3	0	0	3

Course Objectives

- To expose the students to the concepts of feed forward neural networks and to provide adequate knowledge about feedback neural networks ,
- To provide adequate knowledge about fuzzy and neuro-fuuzy systems.
- To study about solving optimization problems using genetic algorithm

UNIT I ARCHITECTURES – ANN 9 hours

Introduction – Biological neuron – Artificial neuron – Neuron model – Supervised and unsupervised learning- Single layer – Multi layer feed forward network – Learning algorithm- Back propagation network.

UNIT II NEURAL NETWORKS FOR CONTROL 9 hours

Feedback networks – Discrete time Hopfield networks – Transient response of continuous time system – Applications of artificial neural network - Process identification – Neuro controller for inverted pendulum

UNIT III FUZZY SYSTEMS 9 hours

Classical sets – Fuzzy sets – Fuzzy relations – Fuzzification – Defuzzification – Fuzzy rules - Membership function – Knowledge base – Decision-making logic – Introduction to neuro fuzzy system- Adaptive fuzzy system

UNIT IV APPLICATION OF FUZZY LOGIC SYSTEMS 9 hours

Fuzzy logic control: Home heating system - liquid level control - aircraft landing- inverted pendulum – fuzzy PID control, Fuzzy based motor control.

UNIT V GENETIC ALGORITHMS 9 hours

Introduction-Gradient Search – Non-gradient search – Genetic Algorithms: binary and real representation schemes, selection methods, crossover and mutation operators for binary and real coding - constraint handling methods – applications to economic dispatch and unit commitment problems.

TOTAL : -- 45 hours

Text Books:

T1:Laurance Fausett, Englewood cliffs, N.J., 'Fundamentals of Neural Networks',Pearson Education, 1992.
T2:Timothy J. Ross, 'Fuzzy Logic with Engineering Applications', Tata McGraw Hill, 1997.
T3:S.N.Sivanandam and S.N.Deepa, Principles of Soft computing, Wiley India Edition, 2nd Edition, 2013.

Reference Books:

R1:Simon Haykin, 'Neural Networks', Pearson Education, 2003.
R2:John Yen & Reza Langari, 'Fuzzy Logic – Intelligence Control & Information', Pearson Education, New Delhi, 2003.

Web Links:

1.https://www.classcentral.com/course/swayam-introduction-to-soft-computing-10053
2.https://nptel.ac.in/courses/106105173

COURSE OUTCOMES

CO1:	Understand and study the overview of artificial neural network and training algorithms.	K2
CO2:	Analyze problems to formulate models and develop control schemes using Neuro controller	K4
CO3:	Design fuzzy controller for non-linear systems	K6
CO4:	Apply soft computing techniques for electrical engineering problems	K3
CO5:	Formulate the process and steps in developing a genetic algorithm	K6

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	1	0	0	0	0	0	0	0	3	2
CO2	3	3	2	1	1	0	0	0	0	0	0	0	3	2
CO3	3	3	2	1	1	0	0	0	0	0	0	0	3	2
CO4	3	3	2	1	1	0	0	0	0	0	0	0	3	2
CO5	3	3	2	1	1	0	0	0	0	0	0	0	3	2

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**

OEC – 12	PRINCIPLES OF MANAGEMENT & PROFESSIONAL ETHICS	3	0	0	3

Course Objectives

- To enable the students to study the evolution of Management, its functions and principles of management and alsoto learn the application of the principles to work in an organization.

UNIT I OVERVIEW OF MANAGEMENT 9 hours

Definition - Management - Role of managers - Evolution of Management thought – Organization and the environmental factors – Trends and Challenges of Management in Global Scenario.

UNIT II PLANNING & ORGANIZING 9 hours

Nature and purpose of planning and Organizing - Planning process - Types of plans – Managing by objective (MBO) Strategies - Types of strategies - Policies - Decision Making - Types of decision - Decision Making Process - Rational Decision Making Process - Decision Making under different conditions. - Organization structure - Formal and informal groups I organization - Line and Staff authority - Departmentation - Span of control - Centralization and Decentralization - Delegation of authority - Staffing - Selection and Recruitment - Orientation - Career Development - Career stages – Training - Performance Appraisal.

UNIT III DIRECTING & CONTROLLING 9 hours

Creativity and Innovation - Motivation and Satisfaction - Motivation Theories - Leadership Styles - Leadership theories - Communication - Barriers to effective communication – Organization Culture - Elements and types of culture - Managing cultural diversity. Process of controlling - Types of control - Budgetary and non-budgetary control techniques - Managing Productivity - Cost Control - Purchase Control - Maintenance Control - Quality Control - Planning operations.

UNIT IV ENGINEERING ETHICS & HUMAN VALUES 9 hours

Definition - Societies for engineers – Code of Ethics – Ethical Issues involved in cross border research - Ethical and Unethical practices – case studies – situational decision making - Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT V SAFETY RESPONSIBILITIES AND RIGHTS 9 hours

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination – Global

issues - Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

TOTAL : 45 hours

TEXT BOOKS:

T1: Stephen P. Robbins and Mary Coulter, 'Management', Prentice Hall of India, 8th edition.
T2: Charles W L Hill, Steven L McShane, 'Principles of Management', Mcgraw Hill Education, Special Indian Edition, 2007.
T3: Mike W. Martin and Roland Schinzinger, “Ethics in Engineering”, Tata McGraw Hill, New Delhi, 2003.

REFERENCE BOOKS:

R1: Hellriegel, Slocum & Jackson, ' Management - A Competency Based Approach', Thomson South Western, 10th edition, 2007.
R2: Harold Koontz, Heinz Weihrich and Mark V Cannice, 'Management - A global & Entrepreneurial Perspective', Tata Mcgraw Hill, 12th edition, 2007.
R3: Andrew J. Dubrin, 'Essentials of Management', Thomson Southwestern, 7th edition, 2007.
R4: Charles B. Fleddermann, “Engineering Ethics”, Pearson Prentice Hall, New Jersey, 2004.
R5: John RBoatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003

WEB LINKS:

1. https://education.stateuniversity.com/pages/cw1ev9e9ib/An-Introduction-to-the-Principles-of-Management.html
2. https://ncert.nic.in/textbook/pdf/lebs102.pdf

COURSE OUTCOMES

CO1:	Understand the management roles and skills and evolution of the management.	K2
CO2:	Analyze the planning and organizing system of the management	K4
CO3:	Understand the directing and controlling system of the management	K2
CO4:	Develop engineering ethics in society and improve human values	K6
CO5:	Understand the safety responsibilities, apply ethics in society and discuss the ethical issues related to engineering	K2

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		

OEC-13	TOTAL QUALITY MANAGEMENT	3	0	0	3

Course Objectives

- The course aims to provide an understanding of the process of managing quality, to provide a valuable perspective for future business managers and managing services.

UNIT I INTRODUCTION **9 hours**

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Quality statements - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Costs of quality.

UNIT II TQM PRINCIPLES **9 hours**

Leadership - Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal 106 - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

UNIT III TQM TOOLS AND TECHNIQUES I **9 hours**

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.

UNIT IV TQM TOOLS AND TECHNIQUES II **9 hours**

Control Charts - Process Capability - Concepts of Six Sigma - Quality Function Development (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

UNIT V QUALITY SYSTEMS **9 hours**

Need for ISO 9000 - ISO 9001-2008 Quality System - Elements, Documentation, Quality Auditing - QS 9000 - ISO 14000 - Concepts, Requirements and Benefits - TQM Implementation in manufacturing and service sectors.

TOTAL : 45 hours

TEXT BOOKS:

T1: Dale H. Besterfiled, et at., "Total quality Management", Pearson Education Asia, Third Edition, Indian Reprint,2006.

REFERENCE BOOKS:

R1: James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First IndianEdition, Cengage Learning, 2012.

R2: Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.

R3: Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd.,2006.Charles B. Fleddermann, “Engineering Ethics”, Pearson Prentice Hall, New Jersey, 2004

WEB LINKS:

1. https://www.educba.com/total-quality-management-notes/
2. https://www.academia.edu/37213047/TOTAL_QUALITY_MANAGEMENT_notes

COURSE OUTCOMES

CO1:	Compare the contributions made by Deming, Juran and Crosby to implement TQM concept	K 2
CO2:	Conclude the role of the management and leadership in an organization	K 5
CO3:	Classify various quality improvement tools and techniques to improve the quality of a product.	K 4
CO4:	Value the importance of six sigma concepts and TPM concepts for the growth of an organization.	K 5
CO5:	Explain the need for ISO 9001-2008 and ISO 14000 Quality System in an organization ethical issues related to engineering	K 5

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
			✓		

OEC - 14	ORGANIZATIONAL BEHAVIOUR	3	0	0	3

Course Objectives

- To help the students to develop cognizance of the importance of human behaviour.
- To provide the students to analyse specific strategic human resources demands for future action.

UNIT I FOCUS AND PURPOSE **9 hours**

Definition, need and importance of organizational behaviour – Nature and scope – Frame work – Organizational behaviour models.

UNIT II INDIVIDUAL BEHAVIOUR **9 hours**

Personality – types – Factors influencing personality – Theories – Learning – Types of learners –The learning process – Learning theories – Organizational behaviour modification.Misbehaviour – Types – Management Intervention. Emotions - Emotional Labour – Emotional Intelligence – Theories. Attitudes – Characteristics – Components – Formation – Measurement- Values. Perceptions – Importance – Factors influencing perception – Interpersonal perception- Impression Management. Motivation – importance – Types – Effects on work behavior

UNIT III GROUP BEHAVIOUR **9 hours**

Organization structure – Formation – Groups in organizations – Influence – Group dynamics – Emergence of informal leaders and working norms – Group decision making techniques –Team building - Interpersonal relations – Communication – Control.

UNIT IV LEADERSHIP AND POWER **9 hours**

Meaning – Importance – Leadership styles – Theories – Leaders Vs Managers – Sources of power – Power centers – Power and Politics.

UNIT V DYNAMICS OF ORGANIZATIONAL BEHAVIOUR **9 hours**

Organizational culture and climate – Factors affecting organizational climate – Importance.
Job satisfaction – Determinants – Measurements – Influence on behavior. Organizational change – Importance – Stability Vs Change – Proactive Vs Reaction change – the change process – Resistance to change – Managing change.
Stress – Work Stressors – Prevention and Management of stress – Balancing work and Life.
Organizational development – Characteristics – objectives –. Organizational effectiveness

TOTAL : 45 hours

TEXT BOOKS:

T1: Stephen P. Robins, Organisational Behavior, PHI Learning / Pearson Education, 11th edition, 2008.

T2: Fred Luthans, Organisational Behavior, McGraw Hill, 11th Edition, 2001.

REFERENCE BOOKS:

R1: UdaiPareek, Understanding Organisational Behaviour, 2nd Edition, Oxford Higher Education, 2004.

R2: Mc Shane & Von Glinov, Organisational Behaviour, 4th Edition, Tata Mc Graw Hill, 2007.

WEB LINKS:

1. https://nptel.ac.in/courses/110106145
2. https://onlinelibrary.wiley.com/journal/10991379

COURSE OUTCOMES

CO1:	Demonstrate the applicability of the concept of organizational behavior to understand the behavior of people in the organization.	K2
CO2:	Demonstrate the applicability of analyzing the complexities associated with management of individual behavior in the organization.	K2
CO3:	Analyze the complexities associated with management of the group behavior in the organization.	K4
CO4:	Demonstrate how the organizational behavior can integrate in understanding the motivation (why) behind behavior of people in the organization.	K2
CO5:	Analyze the complexities associated with organizational change and stress	K4

MAPPING OF COURSE OUTCOMES TO PROGRAM OUTCOMES

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

ASSESSMENT METHODS:

CAT 1	**CAT 2**	**Model Exam**	**End Semester Exams**	**Assignments**	**Case Studies**
✓	✓	✓	✓	✓	
Quiz	**MCQ**	**Projects**	**Seminars**	**Demonstration/ Presentation**	**Open book test**
	✓		✓		✓