Economics for Engineers	L	P	C
	2		2

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
All	5	HS/MS	HS	HS-301

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To explain the basic micro and macro economics concepts.
2.	To analyze the theories of production, cost, profit and break even analysis.
3.	To evaluate the different market structures and their implications for thebehavior of the firm.
4.	To apply the basics of national income accounting and business cycles toIndian economy.

Course Outcomes (CO)

CO 1	Analyze the theories of demand, supply, elasticity and consumer choicein the market.
CO 2	Analyze the theories of production, cost, profit and break even analysis.
CO 3	Evaluate the different market structures and their implications for thebehavior of the firm.
CO 4	Apply the basics of national income accounting and business cycles toIndian economy.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	1	2	1	2	1	-	1	-	1	1	3	1
CO 2	1	2	1	2	1	-	1	-	1	1	3	1
CO 3	1	2	1	2	1	-	1	-	1	1	3	1
CO 4	1	2	1	2	1	-	1	-	1	1	3	1

UNIT-I

Introduction: Economics Definition, Basic economic problems, Resource constraints and welfare maximization. Microand Macro economics. Production Possibility Curve.Circular flow of economic activities.

Basics of Demand, Supply and Equilibrium: Demand side and supply side of the market. Factors affecting demand & supply. Elasticity of demand & supply – price, income and cross-price elasticity. Market equilibrium price.

UNIT-II

Theory of Consumer Choice: Theory of Utility and consumer's equilibrium.Indifference Curve analysis, Budget Constraints, Consumer Equilibrium.

Demand forecasting: Regression Technique, Time-series, Smoothing Techniques: Exponential, Moving AveragesMethod

UNIT-III

Cost Theory and Analysis: Nature and types of cost, Cost functions- short run and long run, Economies and diseconomies of scale
Market Structure: Market structure and degree of competitionPerfect competition, Monopoly, Monopolistic competition, Oligopoly

UNIT - IV

National Income Accounting: Overview of Macroeconomics, Basic concepts of NationalIncome Accounting
Macro Economics Issues: Introduction to Business Cycle, Inflation-causes,consequences and remedies: Monetary and Fiscal policy.

Textbook(s):
1. H.C. Petersen, W.C. Lewis, Managerial Economics, 4th ed., Pearson Education 2001.

References:
1. S.K. Misra& V. K. Puri, Indian Economy, 38th ed., Himalaya Publishing House, 2020.
2. D.N. Dwivedi, Managerial Economics, 8th Edition, Vikas Publishing house
3. D. Salvatore, Managerial Economics in a Global Economy, 8th ed., Oxford University Press, 2015.
4. S. Damodaran, Managerial Economics, 2 nd ed., Oxford University Press, 2010.
5. M. Hirschey, Managerial Economics, 12th ed., Cengage India, 2013.
6. P.A. Samuelson, W.D. Nordhaus, S. Nordhaus,Economics,18th ed., Tata Mc-Graw Hill, 2006.

Electrical and Electronics Measuring Instruments	L	P	C
	4		4

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EE/EEE	5	PC	PC	EEC-305

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	Introduce how to measure power and energy
2.	Understand working and applications of potentiometers and bridges
3.	Knowledge to use printers and recorders
4.	Selection of proper type and specification of transducers

Course Outcomes (CO)

CO 1	Identify and classify various types of instruments for power and energy measurement
CO 2	Develop the knowledge of working and applications of potentiometers and bridges
CO 3	Ability to apply proper recorder and printer in measurement
CO 4	Describe working principle selection criteria and application of various transducers in measurement system.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	2	3	2	3	3	2	2	1	1	1	1	3
CO 2	3	3	2	3	3	2	2	1	1	1	1	3
CO 3	3	3	3	3	3	2	2	1	1	1	1	3
CO 4	3	3	3	3	3	2	2	1	1	1	1	3

UNIT I

Power and Energy Measurement

Instrument transformers:, CT and PT, Ratio and phase angle errors.

Measurement of Power: Single phase and three phase dynamometer wattmeter, LPF and UPF, expression for deflecting and control torques. Type of P.F. Meters, dynamometer and moving iron type, Frequency meters, Resonance type and Weston type, synchoroscopes.

Measurement of Energy: single phase and three phase induction type energy meter, driving and braking torques, errors and compensations, testing by phantom loading, trivector meter, maximum demand meters.

UNIT II

Potentiometers and Bridges: Basics of DC potentiometers, laboratory type potentiometer, multi range potentiometer, applications of DC potentiometers, AC potentiometer; polar and coordinate type,, Drydale polar potentiometer, Gall Trinsley potentiometer, applications of AC potentiometer, Bridges for measuring

low, medium and high resistance; Carey Foster's bridge, Kelvin's double bridge, Mega ohm bridge, Megger.
A.C. Bridges: Measurement of inductance and capacitance, Maxwell's bridge, Hay's bridge, Anderson's bridge, Owen's bridge, Heaviside Bridge and its modifications, Desauty bridge. Wien's bridge, Schering Bridge..

UNIT III

Display Devices and Recorders: Introduction of various display devices, LCD, LED and plasma display, CRO & its applications, measurement of frequency (lissajous patterns), sampling oscilloscope, DSO. Recorders: requirement of recording data, selection of recorder for a particular application, analog, graphic, strip chart, galvanometeric, circular chart, XY, digital recorders, single point and multipoint recorders.
Printers: Types of Printers, Drum type printer, dot matrix type printer, Ink-jet and Laser jet printers

UNIT IV

Transducers: Introductionon and Classification of Transducers. Primary and secondary sensing elements, Basic Working principle and applications of resistive, inductive and capacitive transducers. Working principle and applications of. LVDT, RTD, Thermistor, piezoresistors, strain gauze, angular velocity transducers, opto electronic transducers, inverse tranducers

Textbook(s):
1. D. Patranabis, "Sensors and Transducers", PHI Learning Pvt. Ltd., 2nd edition
2. D V S Murty, "Transducers and Instrumentation", PHI Learning Pvt. Ltd.
3. E. W. Golding and F. C. Widdis - Electrical Measurements and measuring Instruments, Wheeler Publishing, 5^{th} Ed..
4. A. K. Sahwney - Electrical & Electronic Measurement & Instrumention, Dhanpat Rai & Co., 2000

Reference Books:
1. Buckingham and Price - Principles of Electrical Measurements, Prentice Hall, 1970
2. Reissland, M. U. - Electrical Measurements: Fundamentals, Concepts, Applications New Age.
3. W. D. Cooper, "Modern Electronic Instrumentation & Measurement Technique" PHI, 1998

Electrical and Electronics Measuring Instruments Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EE/EEE	5	PC	PC	EEC-353

Marking Scheme:

1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:

1. The course objectives and course outcomes are identical to that of (Electrical and Electronics Measuring Instruments) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. Testing of single phase and three phase electromechanical and electronic energy meters.
2. Measurement of three phase power by two watt meters using instrument transformer.
3. Study and demonstration of Trivector Meter.
4. Calibration of D.C. and A.C. potentiometers.
5. Measurement of low resistance using Kelvin's double bridge.
6. Measurement of inductance using Maxwell's bridge/ Hay's bridge/ Anderson's bridge/ Owen's bridge.
7. Study and use of different types of Recorders / Printers.
8. Study of different types of transducers.
9 Study of LVDT and RTD.

Introduction to Control Systems	L	P	C
	3		3

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
ECE/EE/EEE/ICE/EE-VDT/ EC-ACT	5	PC	PC	EEC-307

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To provide an understanding about the concepts of transfer unction and its evaluation.
2.	To expose the students to time response of control systems
3.	To understand the frequency response of control systems
4.	To study compensators and controllers

Course Outcomes (CO)

CO 1	Ability to define, understand various terms related to control system and evaluation of transfer function
CO 2	Ability to apply knowledge of various types of signals in time response of systems
CO 3	Ability to analyse frequency response of systems
CO 4	Ability to design compensators and controllers

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	3	2	1	1	1	1	-	1	3	-	3
CO 2	3	2	1	3	2	1	1	-	1	3	-	1
CO 3	3	2	1	2	3	1	1	-	1	3	-	3
CO 4	3	3	2	1	1	1	1	-	1	3	-	3

UNIT I

Control Systems: Basics & Components Introduction to basic terms, classifications & types of Control Systems, Mathematical modelling of real life systems, block diagrams & signal flow graphs. Transfer function, determination of transfer function using Block diagram reduction techniques and Mason's Gain formula. Control system components: Electrical/ Mechanical/Electromechanical/A.C./D.C. Servo Motors, Stepper Motors, Tacho Generators, Synchros, Magnetic Amplifiers, Servo Amplifiers.

UNIT II

Time: Domain Analysis of real life problems, Time domain performance specifications, transient response of first & second order systems, steady state errors and static error constants in unity feedback control systems, response with P, PI and PID controllers, limitations of time domain analysis.

UNIT III

Frequency Domain Analysis frequency domain specifications and performance of LTI systems, minimum/non minimum phase systems, Polar and inverse polar plots, Logarithmic plots (Bode plots), gain and phase margins, relative stability. Correlation with time domain performance, closed loop frequency responses from open loop response. Limitations of frequency domain analysis.

UNIT IV

Stability & Compensation Techniques Concepts, absolute, asymptotic, conditional and marginal stability, Routh–Hurwitz and Nyquist stability criterion, Root locus technique and its application. Concepts of compensation, series/parallel/ series-parallel/feedback compensation, Lag/Lead/Lag-Lead networks for compensation, compensation using P, PI, PID controllers.

Textbooks:

1. B. C. Kuo, "Automatic control system", Prentice Hall of India, 7th edition 2001.
2. Nagrath Gopal, "Control Systems Engineering -Principles and Design" New Age Publishers

References:

1. Norman S. Nise, "Control systems engineering" John Wiley & Sons (Asia) Singapore.
2. B. S. Manke, Linear Control System, Khanna publication.
3. K. Ogata, "Modern control engineering", Pearson 2002.
4. A. K. Jaurath , Problems And Solutions Of Control Systems: With Essential Theory (CBS Problems and Solutions Series)

Introduction to Control Systems Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
ECE/EE/EEE/ICE/EE-VDT/ EC-ACT	5	PC	PC	EEC-355

Marking Scheme:
1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:
1. The course objectives and course outcomes are identical to that of (Introduction to Control Systems) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. Determination of step & impulse response for a second-order unity feedback system.
2. To study the speed-torque characteristics of SERVO MOTOR.
3. Experiment to draw synchro pair characteristics.
4. To determine the Transfer Function of the DC Machine.
5. Plot unit step response of the given transfer function and finds delay time, rise time, and peak overshoot.
6. Plot the pole-zero configuration in the s-plane for the given transfer function.
7. To determine the characteristics of Magnetic Amplifiers.
8. Linear System Analysis (Time Domain Analysis, Error Analysis) Using MATLAB.
9. To observe the effect of P, PI, PID, and PD Controller for open loop and closed loop of second order system.
10. To analyze the frequency response of a system by plotting Root locus, Bode plot, and Nyquist plot using MATLAB software.
11. Experiment to draw the frequency response characteristics of the lag–lead compensator network and determination of its transfer function.
12. Temperature Controller Using PID Controller.
13. Study of operation of a stepper motor interface with a microprocessor.

Microprocessors and Microcontrollers	**L**	**P**	**C**
	3		**3**

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
ECE	4	PC	PC	ECC-210
EE/EEE/ICE	5	PC	PC	ECC-313

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To impart knowledge about architecture and instruction set of 8085 microprocessor so that students can implement 8085 assembly language programs.
2.	To impart knowledge about architecture and instruction set of 8086 microprocessor so that students can implement 8086 assembly language programs.
3.	To impart knowledge about interfacing of 8255, 8254/8253, 8251, 8259 and I/O devices with 8086 microprocessor.
4.	To impart knowledge about architecture and operation of 8051 microcontroller and their interfacing with memory and I/O.

Course Outcomes (CO)

CO 1	Ability to understand and distinguish the use of different 8085 instructions, timing diagram, addressing modes, interrupts and apply those instructions for implementing assembly language programs.
CO 2	Ability to analyse the timing diagrams, understand its instruction set, assess its memory organisation and will implement the assembly language programs , interfacing of memory with 8086 successfully
CO 3	Understand and realize the interfacing of 8255 (PPI), 8254/8255 (PIT), 8251 (USART), 8259 (PIC), 8279 (Keyboard and display), Sample and hold circuit, DAC/ADC, LCD & Stepper motor with 8086 microprocessor.
CO 4	Understand the architecture and operation of 8051 microcontroller and ability to use them for designing various applications based on 8051 by implementing the elaborate instruction set.

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	3	3	2	-	1	1	-	-	-	-	1
CO 2	3	3	3	2	3	1	1	-		-		1
CO 3	3	3	3	2	3	1	1	-	1	-	-	1
CO 4	3	3	3	2	3	1	1	-	-	-	-	1

UNIT - I

Introduction to Microprocessor Systems: Architecture and PIN diagram of 8085, Timing Diagram, memory organization, addressing modes, interrupts. Assembly Language Programming.

UNIT – II

8086 Microprocessor: 8086 Architecture, difference between 8085 and 8086 architecture, generation of physical address, PIN diagram of 8086, Minimum Mode and Maximum mode, Bus cycle, Memory Organization, Memory Interfacing, Addressing Modes, Assembler Directives, Instruction set of 8086, Assembly Language Programming, Hardware and Software Interrupts.

UNIT – III

Interfacing of 8086 with 8255, 8254/8253, 8251, 8259: Introduction, Generation of I/O Ports, Programmable Peripheral Interface (PPI)-Intel 8255, Sample-and-Hold Circuit and Multiplexer, Keyboard and Display Interface, Keyboard and Display Controller (8279), Programmable Interval timers (Intel 8253/8254), USART (8251), PIC (8259), DAC, ADC, LCD, Stepper Motor.

UNIT – IV

Overview of Microcontroller 8051: Introduction to 8051 Micro-controller, Architecture, Memory organization, Special function registers, Port Operation, Memory Interfacing, I/O Interfacing, Programming 8051 resources, interrupts, Programmer's model of 8051, Operand types, Operand addressing, Data transfer instructions, Arithmetic instructions, Logic instructions, Control transfer instructions, Timer & Counter Programming, Interrupt Programming.

Textbook(s):

4. Muhammad Ali Mazidi, "Microprocessors and Microcontrollers", Pearson, 2006
5. Douglas V Hall, "Microprocessors and Interfacing, Programming and Hardware" Tata McGraw Hill, 2006.
6. Ramesh Gaonkar, "MicroProcessor Architecture, Programming and Applications with the 8085", PHI

References:

5. Muhammad Ali Mazidi, Janice GillispieMazidi, Rolin D. MCKinlay "The 8051 Microcontroller and Embedded Systems",2nd Edition, Pearson Education 2008.
6. Kenneth J. Ayala, "The 8086 Microprocessor: Programming & Interfacing The PC", Delmar Publishers, 2007.
7. A K Ray, K M Bhurchandi, "Advanced Microprocessors and Peripherals", Tata McGraw Hill, 2007.
8. Vaneet Singh, Gurmeet Singh, "Microprocessor and Interfacing", Satya Prakashan, 2007.

Microprocessors and Microcontrollers Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
ECE	4	PC	PC	ECC-210
EE/EEE/ICE	5	PC	PC	ECC-363

Marking Scheme:

1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:

1. The course objectives and course outcomes are identical to that of (Microprocessors and Microcontrollers as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. Write a program to add and subtract two 16-bit numbers with/ without carry using 8086.

2. Write a program to multiply two 8 bit numbers by repetitive addition method using 8086.

3. Write a Program to generate Fibonacci series.

4. Write a Program to generate Factorial of a number.

5. Write a Program to read 16-bit Data from a port and display the same in another port.

6. Write a Program to generate a square wave using 8254.

7. Write a Program to generate a square wave of 10 kHz using Timer 1 in mode 1(using 8051).

8. Write a Program to transfer data from external ROM to internal (using 8051).

9. Design a Minor project using 8086 Microprocessor (Ex: Traffic light controller/temperature controller etc)

10. Design a Minor project using 8051 Micro controller

Power Electronics	L	P	C
	4		4

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EE/EEE	5	PC	PC	EEC-309

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To learn the operation characteristics and firing circuits of power electrons devices.
2.	To acquire knowledge of controlled rectifier and choppers control DC Motors
3.	To get the exposure of square wave, Quashi square wave PWM and multilevel inverters there use to control AC drives
4.	apply AC controllers cycloconverter and matrix converter to control induction motors

Course Outcomes (CO)

CO 1	Understand the operation characteristics and firing circuits of power electronic devices
CO 2	Gained the knowledge of controlled rectifier, choppers and their use to control DC Motors
CO 3	Analyse and design square wave, quashi wave, and multilevel inverters to control AC drive
CO 4	Design AC converter, AC controller, cyclo converter and matrix converter to control induction motor

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	2	3	3	2	3	3	1	1	1	2	3
CO 2	3	3	3	3	3	3	3	1	1	1	2	3
CO 3	3	3	3	3	3	3	3	1	1	1	2	3
CO 4	3	3	3	3	3	3	3	1	1	1	2	3

UNIT- I

Introduction: Characteristics and switching behaviour of Power Diode, SCR, UJT, TRIAC, DIAC, GTO, MOSFET, IGBT, MCT and power BJT, two-transistor analogy of SCR, firing circuits of SCR and TRIAC, SCR gate characteristics, SCR ratings. Protection of SCR against over current, over voltage, high dV/dt, high dI/dt, thermal protection, Snubber circuits, Methods of commutation, series and parallel operation of SCR, Driver circuits for BJT/MOSFET.

UNIT- II

A.C. to D.C. Converter: Classification of rectifiers, single and three phase controlled rectifiers, fully controlled and half controlled rectifiers and their performance parameters, , single-phase and three phase dual converter.
D.C. to D.C. Converter: Classification of choppers as type A, B, C, D and E, principle of operation, switching mode regulators: Buck, Boost, Buck-Boost, Cuk regulators.
DC Motor Drives: DC motor speed control, , controlled rectifier fed dc drives, chopper controlled dc drives.

UNIT- III

D.C. to A.C. Converter: single phase single pulse inverter: Square wave, quasi square. Three phase single pulse inverters (120̊ and 180̊ conduction) Modulation Techniques and reduction of harmonics, PWM techniques, SPWM techniques, SVM, Carrier less modulation. , PWM Inverter, Bidirectional PWM converters, voltage source inverters and current source inverter, Multi level Inverter: cascaded and NPC Inverters. Introduction of AC drives

UNIT-IV

A.C. to A.C. Converter: AC voltage Controllers**,** Cyclo-converters : single phase to single phase, three phase to single phase, three phase to three phase Cyclo-converter circuit and their operation, Matrix converter.
Induction Motor Drives: Three phase induction motor starting, braking, , speed control from stator and rotor sides, stator voltage control, variable frequency control from voltage sources and current sources

Textbooks:

1. M.H. Rashid, "Power Electronics: Circuits, Devices and Applications" Pearson Publications.
2. Daniel W. Hart, "Power Electronics "Tata McGraw-Hill
3. H.C. Rai, "Power Electronics Devices, Circuits, Systems and Application", Galgotia Publications, 3rd Edition

References Books:

1. Singh, Kanchandani, "Power Electronics", Tata McGraw-Hill.
2. Ned Mohan, Tore M. Undeland and Robbins, "Power Electronics: Converters, Applications and Design" Wiley India Publication
3. V R Moorthi, "Power Electronics: Devices, Circuits and Industrial Applications", Oxford Publication.
4. Kassakian, Schlecht, Verghese, "Principles of Power Electronics" , Pearson Publications
5. M.S. Jamil Asghar, "Power Electronics" PHI Publication
6. P. S. Bimbhra "Power Electronics", Khanna Publishing.

Power Electronics Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EE/EEE	5	PC	PC	EEC-357

Marking Scheme:

1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:

1. The course objectives and course outcomes are identical to that of (Power Electronics) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. To study and analyze V-I characteristics of SCR and TRIAC.
2. To study the switching characteristics of MOSFET and IGBT
3. To study R and RC and UJT based firing circuits using SCR.
4. To study single phase Semi-converter and Full converters feeding R and RL load
5. To study A.C phase control using SCR (half and full wave) using DIAC and TRIAC for dimmer application.
6. To study single-phase cyclo- converter feeding R and RL loads.
7. To study the operation and duty cycle control of buck and boost converter feeding R loads.
8. To study the operation and duty cycle control of Type-C chopper.
9. To study the THD in operation of single phase Square wave and Quasi square wave Inverter.
10. To study the operation of SPWM Inverter.

Power Systems – II	L	P	C
	4		4

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EE/EEE	5	PC	PC	EEC-303

Marking Scheme:

1. Teachers Continuous Evaluation: 25 marks
2. Term end Theory Examinations: 75 marks

Instructions for paper setter:

1. There should be 9 questions in the term end examinations question paper.
2. The first (1st) question should be compulsory and cover the entire syllabus. This question should be objective, single line answers or short answer type question of total 15 marks.
3. Apart from question 1 which is compulsory, rest of the paper shall consist of 4 units as per the syllabus. Every unit shall have two questions covering the corresponding unit of the syllabus. However, the student shall be asked to attempt only one of the two questions in the unit. Individual questions may contain upto 5 sub-parts / sub-questions. Each Unit shall have a marks weightage of 15.
4. The questions are to be framed keeping in view the learning outcomes of the course / paper. The standard / level of the questions to be asked should be at the level of the prescribed textbook.
5. The requirement of (scientific) calculators / log-tables / data – tables may be specified if required.

Course Objectives :

1.	To introduce the concepts and constructional features and operation of relays, and protection of generators and transformers
2.	Familiarise students with various protection schemes of transmission lines
3.	Knowledge of fuse and circuit breakers
4.	Explore stability analysis

Course Outcomes (CO)

CO 1	To analyse construction and operating characteristics of protective relays, and protection of generators and transformers
CO 2	Gain knowledge of various methods of prote, transmission lines,
CO 3	Familiarise with the working and applications of fuse and circuit breakers
CO 4	Able to analyse stability of systems

Course Outcomes (CO) to Programme Outcomes (PO) mapping (scale 1: low, 2: Medium, 3: High)

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	3	3	1	2	3	3	1	1	2	1	3
CO 2	3	3	3	3	3	3	3	3	3	3	2	3
CO 3	3	3	3	3	1	3	1	1	3	3	2	3
CO 4	3	3	3	3	1	1	1	2	3	3	3	3

Unit – I

Classification of Relays: Electromechanical, static and numerical relays: Construction, operating characteristic and their applications.

Protection of Generators and Transformers: Differential Protection, protection of stator windings, rotor earth fault protection, protection against unbalanced loading, loss of excitation and prime mover failure; Protection of motors (induction and synchronous) and bus bars.

Transformer Protection: Types of faults, percentage differential protection, Buchholz relay

Unit – II

Protection of Transmission Lines: Over current protection, Grading of over current relays, distance protection, types of distance relays and their characteristics, carrier current protection, protection against surges, surge diverters, surge absorbers, use of ground wires on transmission lines, methods of grounding

Unit – III

Fuses and Circuit Breakers: Types & Applications of Fuse and MCB, RCCB, ELCB Current interruption theories, types of Circuit Breakers: Air, air-blast, Oil, SF6 and Vacuum circuit breakers-Principle, ratings and applications, HVDC Circuit breaker, Testing of circuit breakers

Unit – IV

Stability and Load Dispatch: Swing equation, steady state stability, equal area criteria, critical clearing angle, point by point method, Load frequency control, load frequency control with GRC, Speed Governor Dead Band and its effects. Load despatch analysis in power system.

Textbooks:

1. Paithanker, Bhide ,"Fundamentals of Power System Protection " PHI 2014
2. BadriRam"Power System Protection and Switchgear" TMH Publications 2nd Edition

References:

1. J. J. Grainger & W.D. Stevenson, "Power System Analysis" TMH Publication, 2003
2. Paul M. Anderson "Power System Protection" IEEE Press.
3. C L Wadhva, "Electrical Power System" Wiley Eastern Ltd., 3rd edition 2000
4. D.P. Kothari and I.J. Nagrath "Modern Power System Analysis " TMH 4th Edition

Power Systems – II Lab	L	P	C
		2	1

Discipline(s) / EAE / OAE	Semester	Group	Sub-group	Paper Code
EE/EEE	5	PC	PC	EEC-351

Marking Scheme:

1. Teachers Continuous Evaluation: 40 marks
2. Term end Theory Examinations: 60 marks

Instructions:

1. The course objectives and course outcomes are identical to that of (Power Systems – II) as this is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under intimation to the office of the Head of Department / Institution in which the paper is being offered from the list of practicals below. Atleast 10 experiments must be performed by the students, they may be asked to do more. Atleast 5 experiments must be from the given list.

1. To study single line to Ground fault as practical application in transmission lines. (Using Experimental setup)
2. To study three phase fault as practical application in transmission lines. (Using Experimental setup)
3. To determine the characteristics of the given differential relay and to apply the relay for the protection of a transformer against internal faults. (Using Experimental setup)
4. To study instantaneous over current relay. (Using Experimental setup)
   a. Study the construction of relay.
   b. Study the operating and deoperating of relay.
   c. Study the current vs. time characteristics.
5. To study over voltage relay static type and draw its characteristics. (Using Experimental setup)
6. To study the characteristics of miniature-circuit breaker. (Using Experimental setup)
7. To study the operating characteristics of HRC fuse. (Using Experimental setup)
8. To obtain the characteristics of thermal bimetallic relay. (Using Experimental setup)
9. To study the characteristics of IDMT Earth fault relay. (Using Experimental setup)
10. Simulation based on Network Reduction.