Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE301**	**Title of the Course**	**CONTROL SYSTEMS**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**5th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To learn the concept of transfer function and mathematical modeling of systems. • To get the knowledge of first order and second order system. • To gain information of the system. • To evaluate the stability of the system using Nyquist stability criterion • To design the compensator and also study of state space analysis.						

Course Outcomes	
CO1	To learn the concept of transfer function and mathematical modeling of systems.
CO2	To get the knowledge of first order and second order system.
CO3	To gain information of the system.
CO4	To evaluate the stability of the system using Nyquist stability criterion
CO5	To design the compensator and also study of state space analysis.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Input/ Output Relationship**	Introduction to control system, Open and closed loop control system, Mathematical modeling of physical systems, Transfer function of electrical and mechanical system, Analogous systems, Block Diagram Reduction Algebra and signal flow graph, Mason's gain formula.	8	CO1
2	**Time Domain Analysis**	Time domain criteria; Test Signals; Transient and steady state response of first and second order feedback systems; Performance indices; Response analysis with proportional, Proportional- Derivative (PD) controller, Proportional-Integral (PI) controller and Proportional- Integral –Derivative (PID) controller.	8	CO2
3	**Stability, Algebraic Criteria and Frequency response Analysis**	Asymptotic and conditional stability, Routh Hurwitz criterion, Frequency response analysis, Correlation between time and frequency domain specifications, Resonant peak, Resonant frequency, Bandwidth, Cutoff frequency, Polar plots, Bode plots.	8	CO3
4	**Root Locus Technique and Stability in Frequency Domain**	The root locus concepts, Construction of root loci, Nyquist stability criterion, Relative stability, Gain margin, Phase margin, Constant M and N circles.	8	CO4
5	**Introduction to Design and State variable technique**	Design through compensation Techniques; Realization of Lag, Lead, And Lag-Lead compensation; Design of closed loop control system using root locus and bode plot compensation. Introduction to State variable analysis, State space representation, State equations, State transfer matrices, Controllability and observability.	8	CO5

Reference Books:

1 .B. C. Kuo, "Automatic Control system", Wiley, 9th Edition, 2014.

2. I. J. Nagrath & M. Gopal, "Control system Engineering", New Age International, 4th Edition, 2015.

3. K. Ogata, "Modern Control Engg.", PHI, 4th Edition, 2002.

4. S. K. Bhattacharya, "Control system Engg.", Pearson Education, 2nd Edition, 2008.

5. S. Hasan Saeed, "Automatic control system", Kataria and sons, New Delhi, 8th Edition, 2016

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	2		1									2	1	2			
CO2	3	2		1									3	2	3			
CO3	3	2										1	3	1	2			
CO4	1	3		2								1		2				
CO5	2	2	3									1	1		2			

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE303**	**Title of the Course**	**POWER ELECTRONICS**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**5th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To learn the concept of transfer function and mathematical modeling of systems. • To get the knowledge of first order and second order system. • To gain information of the system. • To evaluate the stability of the system using Nyquist stability criterion • To design the compensator and also study of state space analysis.						

Course Outcomes	
CO1	Understand and analyze the concept, design, technique, advancement and application of Bipolar junction transistor, Power Metal oxide semiconductor field effect transistor, Insulated gate bipolar junction transistor, operation of Silicon controlled rectifier (SCR), Firing circuits of Thyristor, Turn on methods of a Thyristor and Thyristor turn-off process.
CO2	Understand and analyze the concept, design, technique, advancement and application of Protection of Thyristor, Series and parallel operation of SCR, Gate turn off (GTO) thyristor. Understand and analyze the concept and knowledge advancement in Gate characteristic of an SCR, Dynamic characteristics of SCR, Two transistor analogy, Rating of an SCR
CO3	Understand and analyze the concept, design, technique, advancement and application of single phase half wave and full wave controlled rectifiers with different types of load, Effect of source impedance on the performance of full wave converter, Dual converter, three phase converters and cyclo-converters
CO4	Understand and analyze the concept, design, technique, advancement and application of Single phase bridge inverters (half and full wave), Pulse width modulation (PWM) inverters, Series inverter, Parallel inverter, Mc-Murray half bridge inverter, Three phase inverter.
CO5	Understand and analyze the concept, design, technique, advancement and application of choppers, chopper circuits, Multi quadrant choppers, Commutation of choppers, Switched mode power supplies.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Power Transistors I**	Classification of power transistors, Bipolar junction transistor (BJT), Power Metal oxide semiconductor field effect transistor (MOSFET), Insulated gate bipolar junction transistor (IGBT), Basic principle of operation of Silicon controlled rectifier (SCR), Voltage vs Current characteristics of SCR, Firing circuits of Thyristor, Turn on methods of a Thyristor, Thyristor turn-off process.	8	CO1
2	**Power Transistors II**	Protection of Thyristor, Gate characteristic of an SCR, Dynamic characteristics of SCR, Series and parallel operation of SCR, Two transistor analogy, Rating of an SCR, Gate turn off (GTO) thyristor.	8	CO2
3	**Controlled Rectifiers**	Controlled Rectifiers Analysis of single phase half wave and full wave controlled rectifiers with different types of load, Effect of source impedance on the performance of full wave converter, Dual converter, Introduction to three phase converters and cyclo-converters.	8	CO3
4	**Classification of inverters**	Classification of inverters, Single phase bridge inverters (half and full wave), Pulse width modulation (PWM) inverters, Series inverter, Parallel inverter, Mc-Murray half bridge inverter, Three phase inverter.	8	CO4
5	**Choppers**	Principle of choppers, Analysis of chopper circuits, Multi quadrant choppers, Commutation of choppers, Switched mode power supplies.	8	CO5

Reference Books:

1.M. H. Rashid, “Power Electronics: Devices, Circuits and applications”, Pearson, 4th edition, 2014.

2. J. M. Jacob, “Power Electronics: Principles and applications”, Thomson Press (India) Ltd; 1st edition, 2006.

3. Vedam Subramanium, “Power Electronics: Devices, Converters, Application”, New Age Int. (P) Ltd., 2nd edition, 2012.

4. Ned Mohan, “Power Electronics: Converters, Applications and Design”, Wiley, 3rd edition, 2002.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2	1	3	3	2	2	2	1	1	2	3	2	3			
CO2	3	3	2	1	3	3	2	2	2	1	1	2	3	2	2			
CO3	3	3	2	1	3	3	2	2	2	1	1	2	2	2	2			
CO4	3	3	2	1	3	3	2	2	2	1	1	2	2	3	2			
CO5	3	3	2	1	3	3	2	2	2	1	1	2	3	3	2			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE305**	**Title of the Course**	**DIGITAL CIRCUITS AND SYSTEMS**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**5th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To understand number representation and conversion between different representation in digital electronic circuits. • Became familiar with the digital signal, positive and negative logic, Boolean algebra, logic gates, logical variables, the truth table, number systems, codes, and their conversion from one to others. • To analyze logic processes and implement logical operations using combinational logic circuits. • To understand competence in Combinational Logic Problem formulation. • To understand concepts of sequential circuits and to analyze sequential systems in terms of state machines. • To understand competence in analysis of synchronous and asynchronous sequential circuits. • To understand characteristics of memory and their classification. • To understand concept of Programmable Devices, PLA, PAL, PLD and FPGA and implement digital system. • To impart how to design Digital Circuits.						

Course Outcomes	
CO1	Convert different type of codes and number systems which are used in digital communication and computer systems. Develop a digital logic and apply it to solve real life problems.
CO2	Employ the codes and number systems converting circuits and Compare different types of logic families which are the basic unit of different types of logic gates in the domain of economy, performance and efficiency.
CO3	Analyze, design and implement combinational and sequential logic circuits.
CO4	Analyze different types of digital electronic circuit using various mapping and logical tools and know the techniques to prepare the most simplified circuit using various mapping and mathematical methods.
CO5	Design different types of with and without memory element digital electronic circuits for particular operation, within the realm of economic, performance, efficiency, user friendly and environmental constraints. Classify different semiconductor memories. Assess the nomenclature and technology in the area of memory devices and apply the memory devices in different types of digital circuits for real world application.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Number system, codes and Minimization Techniques**	Decimal, Binary, Hexadecimal, Octal Number systems and their Conversions, Arithmetic operations, subtraction using 1's and 2's compliment, Binary coded decimal, Excess-3 Codes, Gray Codes. Different types of Logic Gates and their implementation, Standard representation of logic functions- SOP and POS forms, simplification of switching functions- K Map..	8	CO1
2	**Logic Families**	Introduction to different logic families. RTL, DTL,TTL, MOS. TTL inverter – circuit description and operation, CMOS inverter – circuit description and operation, design of gates using TTL and CMOS circuits, Electrical characteristics of logic gates	8	CO2
3	**Combinational logic systems, Modules and their applications**	Basic logic operation and logic gates, Decoder, Encoder, Multiplexer, De-multiplexer, Parity circuits and comparators, Arithmetic modules- Half Adder, Full Adder, Half Subtractor, Full Subtractor, Carry Look Ahead Adder, Serial Adder, BCD adder	8	CO3
4	**Sequential logic systems, Modules and their applications**	Sequential Circuits- Latches and Flip-flops, Transition, Excitation table, Excitation maps and equations, Counters, Shift registers, 555 timers, Multivibrator.	8	CO4
5	**Memory and Programmable logic devices**	Read only memory, read/write memory- SRAM and DRAM. PLAs, PALs and their application, Sequential PLDs and their application, Introduction to Field Programming Gate Array.	8	CO5

Reference Books:

1. R.P. Jain, "Modern Digital Electronics", TMH, 4th Edition, 2010.
2. Morris Mano, "Digital Design", PHI, 3rd Edition, 2014.
3. R. J. Tocci, "Digital Systems", PHI, 4th Edition, 2016.
4. Malvino and Leach, "Digital principles and applications", TMH, 8th Edition, 2014.
5. J. M. Yarbrough, "Digital Logic-Application and Design", PWS Publishing, 5th Edition, 2006
6. B. S. Nai, " Digital Electronics and Logic Design", PHI, 7th Edition, 2012

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	2	2	2		1	2	1		1		1	2	2				
CO2	2	3		2	2	1	3			1	1	1	2	3	2			
CO3	3	3	3	2	2						1	1	3	3	3			
CO4	2	3	3	2		2	2			2	3		2	2	3			
CO5	1	2	2	2	2	2		3			1		2	2	2			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE307**	**Title of the Course**	**POWER SYSTEM I**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**5th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To get knowledge of Power System Components and Transmission Lines • To get knowledge of inductance and capacitance of Over-Head Transmission Lines • To attain knowledge of Corona and Overhead line Insulators • To study about Mechanical Design of transmission line and Insulated cables • To have the knowledge of Electrical Design of Transmission Line and Neutral grounding						

Course Outcomes	
CO1	Understand the Power System Components and Transmission Lines
CO2	Analyse the inductance and capacitance of Over-Head Transmission Lines
CO3	Understand the phenomenon of Corona and Overhead line Insulators
CO4	Having knowledge of Mechanical Design of transmission line and Insulated cables
CO5	Design Electrical Transmission Line and Neutral grounding

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Power System Components and Transmission Lines**	Single line Diagram of Power system, Brief description of Power System Elements: Synchronous machine, transformer, transmission line, busbar, circuit breaker and isolator. Different kinds of supply system and their comparison, Choice of transmission voltage. Transmission Line Configurations, Types of conductors, Resistance of line, Skin effect, Kelvin's law, Proximity effect.	8	CO1
2	**Head Transmission Lines**	Calculation of inductance and capacitance of single phase, three phase, single circuit and double circuit transmission lines; Representation and performance of short, medium and long transmission lines; Ferranti effect; Surge impedance loading.	8	CO2
3	**Corona and Overhead line Insulators**	Phenomenon of corona, Corona formation, Calculation of potential gradient, Corona loss, Factors affecting corona, Methods of reducing corona and interference, Electrostatic and electromagnetic interference with communication lines. Types of insulators and their applications, Potential distribution over a string of insulators, Methods of equalizing the potential, String efficiency.	8	CO3
4	**Mechanical Design of transmission line and Insulated cables**	Centenary curve, Calculation of sag & tension, Effects of wind and ice loading, Sag template. Type of cables and their construction, Dielectric stress, Grading of cables, Insulation resistance, Capacitance of single phase and three phase cables, Dielectric loss, Heating of cables.	8	CO4
5	**Electrical Design of Transmission Line and Neutral grounding**	Design consideration of Extra High Voltage (EHV) transmission lines, Choice of voltage, Number of circuits, Conductor configuration, Insulation design and selection of ground wires. Necessity of neutral grounding, Various methods of neutral grounding, Earthing transformer,Grounding practices.	8	CO5

Reference Books:

1. W. D. Stevenson, "Element of Power System Analysis", McGraw Hill, 4th revised edition,1982.
2. C. L. Wadhwa, "Electrical Power Systems", New age international Ltd , 6th Edition, 2010.
3. L.P. Singh, "Advance Power System Analysis & Dynamics", New Academic Science, 6th edition, 2012.
4. Ashfaq Hussain, "'Power System", CBS Publishers and Distributors, 5th Edition, 2010.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	2	1	1								1	2	1	2			
CO2	3	3		1								1	2	3	2			
CO3	3	3	1	2								1	2	3	2			
CO4	3	2	3				3		3	2	2	1	2	3	2			
CO5	3	1	3	2	2	2			3	2	2	2	2	3	2			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE323**	**Title of the Course**	**PROCESS INSTRUMENTATION**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**5th**	3	1	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Knowledge of different process ant its characteristics. • Understanding of different control loops used in process. • Study and analysis of feedback control system and its applications. • Applications and design of multi-loop control system. • Concepts and design of multivariable control systems.						

Course Outcomes	
CO1	Know about different process ant its characteristics.
CO2	Understand different control loops used in process
CO3	Use feedback control system.
CO4	Design of multi-loop control system.
CO5	Design of multivariable control systems.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Process characteristics**	Incentives for process control; Process Variables types and selection criteria; Process degree of freedom; The period of Oscillation and Damping; Characteristics of physical System: Resistance, Capacitance and Combination of both; Elements of Process Dynamics; Types of processes: Dead time, single and multi-capacity, self-regulating and non self-regulating, interacting and non interacting, linear / non-linear; Selection of control action.	8	CO1
2	**Analysis of Control Loop**	Steady state gain; Process gain; Valve gain; Process time constant; Variable time Constant; Transmitter gain; Linearizing an equal percentage valve; Variable pressure drop; Analysis of Flow Control, Pressure Control, Liquid level Control, Temperature control; Single Line Process Controller: features, faceplate, functions; Multi Line Process Controller: features, faceplate, functions; Comparison of Single Line Process Controller and Multi Line Process Controller. Scaling: Types of scaling, Examples of scaling.	8	CO2
3	**Feedback Control**	Basic principles, Elements of the feedback Loop, Block Diagram, Control Performance Measures for Common Input Changes, Selection of Variables for Control Approach to Process Control. Factors in Controller Tuning; Determining Tuning Constants for Good Control Performance; Correlations for tuning Constants; Fine Tuning of the controller tuning Constants; The performance of feedback Systems; Practical Application of Feedback Control: Equipment Specification, Input Processing, Output Processing.	8	CO3
4	**Multi-Loop System**	Cascade control; Feed forward control; Feedback-feed forward control; Ratio control; Selective Control; Split range control: Basic principles, Design Criteria, Performance, Controller Algorithm and Tuning, Implementation issues, Examples and any special features of the individual loop and industrial applications	8	CO4
5	**Multivariable Control**	Concept of Multivariable Control, Interactions and its effects; Modeling and transfer functions; Influence of interaction on the possibility of feedback control; Important effects on multivariable system behavior; Relative Gain Array; Effect of interaction on stability and multi-loop control system; Multi-loop control performance through loop paring; Tuning; Enhancement through decoupling; Single loop enhancements.	8	CO5

Reference Books:

1. Donald P. Eckman, "Automatic Process Control", Wiley India Edition, Wiley India Pvt. Ltd, 2009
2. F. G. Shinskey, "Process control Systems", McGraw Hill, 4th Edition, 1996.
3. P. W. Murrill, "Fundamentals of Process Control Theory", International Society of Automation, 3rd Edition, 2012.
4. G. D. Considine, "Process Instrumentation and control Handbook", McGraw Hill, 5th Edition, 1993

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	1	1	1	1	3	1				1	3	3	3	1	3		
CO2	3	2	2	1	3	2	1				1	2	2	2	1	3		
CO3	3	2	2	1	3	3	3				1	3	1	1	2	2		
CO4	3	2	3	2	3	3	3				1	3	2	1	2	3		
CO5	3	3	3	3	3	3	2				1	3	3	3	3	3		

2- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session:							
Course Code	**EE 302**	**Title of the Course**	**Control system Lab**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	V	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**					
Course Objectives	• To learn of Transfer function and mathematical modeling of mechanical system. • To analyze the first order and second order system. • To evaluate the stability of the system using different frequency domain analysis tools • To design the compensator						

Course Outcomes	
CO1	To learn of Transfer function and mathematical modeling of mechanical system.
CO2	To analyse the first order and second order system.
CO3	To evaluate the stability of the system using different frequency domain analysis tools
CO4	To design the compensator and analyse the controller performance

Exp. No.	Title of the Unit	Content of Experiment	Contact Hrs.	Mapped CO
1	Input/ Output Relationship	To study the performance characteristics of a DC motor speed control system. 1) Open loop 2) Close loop	2	1
2	Time Domain Analysis	To study the steady state behavior of type 0 system.	2	2
3	Introduction to Compensator design	To study the phase lag network.	2	4
4	Controller performance analysis	To study the performance of various types of controller used to control the temperature of an oven. • ON /OFF control • Proportional control.	2	4
5	Time Domain Analysis	To study the Transient response of a series RLC circuit.	2	2
6	Input/ Output Relationship	To study and plot speed vs voltage characteristic of the dc servo motor.	2	1
7	Controller performance analysis	To simulate a DC motor (Armature control) system and draw the characteristic of the angular velocity using MATLAB/ SIMULINK	2	4
8	Frequency domain analysis	To check the sensitivity of the system using MATLAB at different gain for a given transfer function	2	3

Reference Books:

B. C. Kuo, “Automatic Control system”, Wiley, 9th Edition, 2014.

I. J. Nagrath & M. Gopal, “Control system Engineering”, New Age International, 4th Edition, 2015.

K. Ogata, “Modern Control Engg.”, PHI, 4th Edition, 2002.

S. K. Bhattacharya, “Control system Engg.”, Pearson Education, 2nd Edition, 2008.

e-Learning Source:

https://nptel.ac.in/courses/107106081

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	1	2	3							2	2	2		3	3	3
CO2	2	3	1	2	3							2	2			3	3	3
CO3	3	1	3	2	3							2	2			3	3	1
CO4	3	1	1	1	3							2	2			3	3	1

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE 304**	**Title of the Course**	**Power Electronics lab**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	5th	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**					
Course Objectives	• To understand and experiment of power electronics devices.. • To understand and experiment of SCR's. • To understand and experiment of solar cell. • To understand and experiment of the SMPS and chopper.						

Course Outcomes	
CO1	Adopt, perform, analyze and implement and to study the various components of power electronics devices.
CO2	Adopt, perform, analyze and implement and to study the RC and UJT trigger circuit of SCR..
CO3	Adopt, perform, analyze and implement and to study the working and characteristics of solar cell and basic components and circuit diagram of electronic fan regulator /light dimmer..
CO4	Adopt, perform, analyze and implement the to study the SMPS and plot the V-I characteristic and single phase bridge inverter.

Exp. No.	**Title of the Unit**	**Content of Experiment**	**Contact Hrs.**	**Mapped CO**
1		To study the various components of power electronics devices.	2	1
2		To study the characteristics ofSCR and plot the V-I graph.	2	1
3		To study the RC trigger circuit of SCR.	2	2
4		To study the UJT trigger circuit of SCR.	2	2
5		To study the phase control circuit of SCR.	2	2
6		To study the working and characteristics of sollar cell.	2	3
7		To study the basic components and circuit diagram of electanic fan regulator /light dimmer.	2	3
8		To study the SMPS and plot the V-I characteristic.	2	4
9		To study the single phase bridge inverter with resistive -capcitive load.	2	4
10		To study the fully controlled bridge rectifier with resistive load.	2	4
11		To study the SCR based step-down chopper with resistive load.	2	4

Reference Books:

1. M. H. Rashid, "Power Electronics: Devices, Circuits and applications", Pearson, 4th edition, 2014.
2. J. M. Jacob, "Power Electronics: Principles and applications", Thomson Press (India) Ltd; 1st edition, 2006.
3. Vedam Subramanium, "Power Electronics: Devices, Converters, Application", New Age Int. (P) Ltd., 2nd edition, 2012.
4. Ned Mohan, "Power Electronics: Converters, Applications and Design", Wiley, 3rd edition, 2002.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	3							2	2	2		3
CO2	3	3	1	2	3							2	2			3
CO3	3	1	1		3							2	2			3
CO4	3	1	1		3							2	2			3

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE306**	**Title of the Course**	**Digital Circuits & Systems Lab**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	5^{th}	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**	EE305				
Course Objectives	• To acquire the basic knowledge of digital logic levels and application of knowledge to understand digital electronics circuits. • To know the concepts of Combinational circuits. • To understand the concepts of flip-flops, registers and counters						

Course Outcomes	
CO1	Identify relevant information to supplement to the Digital Circuits & Systems (EE305) course.
CO2	Define different types of logic gates, identify their ICs, verify their truth table. Derive adder, subtractor, encoder, decoder, and counters using logic gates.
CO3	Illustrate realization of Boolean expression in SOP form and design it using logic gates.
CO4	Design and implement combinational logic circuits.
CO5	Design and implement sequential logic circuits.

Exp. No.	**Topic of Experiment**	**Content of Experiment**	**Contact Hrs.**	**Mapped CO**
1	Realization of gate	Realize OR, NOR, XOR, XNOR gates using NAND gate and verify its truth table.	2	1,2
2	Comparator	Design and study of 1-bit Magnitude Comparator.	2	1,2,4
3	Code converter	Design and test a CODE converter from decimal number to binary number. Use diode and LED's. Measure voltage drops across the diodes, LED's and resistor R. Find the current flowing through LED.	2	1,2,4
4	Adder Subtractor	Assemble the half Adder circuit using X-OR and AND gates. Verify the truth table for Half Adder. Using two Half Adder and an OR gate, assemble Full Adder circuit, verify truth table. Express sum and carry with all the minterms in minimization possible.	2	1,2,3,4
5		Study and verify 4-bit adder / subtractor circuit using IC7483 and IC7486.	2	1,2
6	Encoder/ Decoder	Use a BCD to 7 segment decoder 0-9 digits. Study the 7 segment LED display. Is it common anode or common cathode type? What is a suitable value or R for bright display of digit? Design a BCD to 7 segment decoder using NAND gates. Use K-Maps and don't care terms to implement the design with minimum number of gates.	2	1,2,3,4
7	XOR gate IC-module (7486)	Verify the truth table and record voltage levels. Design a 3-input X-OR gate using 2-input X-OR gate. Obtain its truth table. $F_1 = A \oplus B \oplus C$ Design a 3-input X-NOR gate using 7486 &7402. Obtain its truth table. $F_2 = A \odot B \odot C$ Find expressions of F1 and F2 as Sum of product (SOP) and compare F_1 and F_2.	2	1,2,4
8	Flip Flops	Design and test J-K Master-Slave F/F IC 74LS76. Make special observation of edge triggering present and clear. Make and test D-F/F and T-F/F and verify its truth table.	2	1,5
9	Counter	Design MOD-10 Counter using Master – Slave F/F (7476) and logic gates (7400 & 7408). Verify truth table.	2	1,3,5
10	Register	Design of Shift Registers.	2	1,5

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3		3	3	2				2	1	3	2	1	
CO2	2	2	1		2		1					1	3	1	1	
CO3	2	2	2	2		1				1	1	1	1	2	1	
CO4	3	2	2	3				2	1	2		2	2	3	1	
CO5	2	3	3	2				1	2	2		2	2	3	1	

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session:							
Course Code	**EE324**	**Title of the Course**	**Process Instrumentation Lab**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	5^{th}	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**					
Course Objectives	• To understand and experiment with the IC Temperature Sensor (LM335). • To understand the characteristics of Platinum RTD • To understand the characteristics of K Type Thermocouple. • To understand the characteristics of NTC Thermistor. • To understand the working principle of Strain gauge.						

Course Outcomes	
CO1	Adopt, perform, analyze the use of IC Temperature Sensor (LM335).
CO2	Adopt, perform, analyze the use of Platinum RTD.
CO3	Adopt, perform, analyze the use of K type Thermocouple
CO4	Adopt, perform, analyze the use of NTC Thermister
CO5	Adopt, perform, analyze the use of Strain Gauge

Exp. No.	**Title of the Unit**	**Content of Experiment**	**Contact Hrs.**	**Mapped CO**
1		To study the characteristics of IC Temperature Sensor (LM335).	2	1
2		To study the characteristics of platinum RTD	2	2
3		To study the characteristics of K Type Thermocouple.	2	3
4		To study the characteristics of NTC Thermistor.	2	4
5		To study the Temperature controlled Alarm System using 1NTC.	2	4
6		To study the Temperature controlled Alarm System using 2NTC.	2	4
7		To study the characteristics of NTC Bridge circuit.	2	4
8		To understand the working principle of Strain gauge.	2	5

Reference Books:

1. Donald P. Eckman, “Automatic Process Control”, Wiley India Edition, Wiley India Pvt. Ltd, 2009
2. F. G. Shinskey, “Process control Systems”, McGraw Hill, 4^{th} Edition, 1996.
3. P. W. Murrill, “Fundamentals of Process Control Theory”, International Society of Automation, 3^{rd} Edition, 2012.
4. G. D. Considine, “Process Instrumentation and control Handbook”, McGraw Hill, 5^{th} Edition, 1993

e-Learning Source:

	Course Articulation Matrix: (Mapping of Cos with Pos and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	1	2	3							2	2	2		3	3	3
CO2	3	3	1	2	3							2	2			3	3	3
CO3	3	1	1		3							2	2			3	3	1
CO4	3	2	2		3							2	2			3	3	1
CO5	3											3	3			3		2

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE311**	**Title of the Course**	**POWER SYSTEM II**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**6th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Representing elements of a power system including generators, transmission lines, and transformers. • Understand the functioning of a synchronous machine and represent it with simple models. • Perform Fault analysis for a balanced three-phase power system . • Analyze multi-node power systems using an admittance matrix or impedance matrix representation of the power system factor the admittance matrix to obtain a solution of the network voltages. • Understand the formulation of the power flow problem, and have the ability to cast any given system in this framework. • Solve power flow problems by the application of Newton method & Gauss seidel. • Perform Steady-state analysis for a balanced three-phase power system,Reflection and Transmission of travelling waves under different line loadings • Protection of equipments and line against travelling waves						

Course Outcomes	
CO1	Representation of Elements in Electric Power System in Per-Unit system and Analysis of Symmetrical faults.
CO2	Analysis of Unsymmetrical faults.
CO3	Understanding the formulation of the power flow problem and to cast any given system in this framework
CO4	Understanding the concept of steady state and transient stability.
CO5	Need of Protection of equipments and line against travelling waves.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Representation of Power System Components**	Synchronous machines, Transformers, Transmission lines, Single line diagram, Impedance and reactance diagram, Per unit System, Transient in R-L series circuit. Symmetrical fault analysis: Calculation of 3-phase short circuit current and reactance of synchronous machine, internal voltage of loaded machines under transient conditions	8	CO1
2	**Symmetrical components**	Symmetrical Components of unbalanced phasors, power in terms of symmetrical components, sequence impedances and sequence networks. Unsymmetrical faults: Analysis of single line to ground fault, line-to-line fault and Double Line to ground fault on an unloaded generators and power system network with and without fault impedance. Formation of Zbus using singular transformation and algorithm	8	CO2
3	**Load Flows**	Introduction, bus classifications, nodal admittance matrix, development of load flow equations, load flow solution using Gauss Siedel and Newton-Raphson method, approximation to N-R method, line flow equations and fast decoupled method.	8	CO3
4	**Power System Stability**	Stability, Stability limit, Steady state stability study, derivation of Swing equation, transient stability studies by equal area criterion and step-by-step method, Factors affecting steady state & transient stability and methods of improvement.	8	CO4
5	**Traveling Waves**	Wave equation for uniform transmission lines, velocity of propagation, surge impedance, reflection and transmission of traveling waves under different line loadings, Protection of equipments and line against traveling waves.	8	CO5

Reference Books:

1.W.D. Stevenson, Jr. " Elements of Power System Analysis", Mc Graw Hill 4th edition

2. C.L. Wadhwa, "Electrical Power System", New Age International, 2009

3. Chakraborthy, Soni,Gupta & Bhatnagar, "Power System Engineering", Dhanpat Rai & Co. ,2008

4. T.K Nagsarkar & M.S. Sukhija, "Power System Analysis" Oxford University Press, 2007.

5. Hadi Sadat; "Power System Analysis", Tata McGraw Hill. 2nd Edition, 2002.

6.D.Das, " Electrical Power Systems" New Age International, 2006.

7. P.S.R. Murthy " Power System Analysis" B.S. Publications,2007.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2								2	2	3	3	2			
CO2	3	3	2	2	2								3	3	2			
CO3	3	3	1	2	2							2	3	3	2			
CO4	3	2	3	2	3					2	2		3	2	1			
CO5	3	3	3			2	1				2	2	3	2	1			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE313**	**Title of the Course**	**Microprocessor and Peripheral Devices**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**6th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Knowledge of I/O devices and memories • To get knowledge of architecture of 8085 and 8086 • To attain knowledge of different instruction set of 8085 and 8086 • To study about different types of Programmable Peripheral Interface • To have the knowledge of analog to digital and digital to analog converter chips						

Course Outcomes	
CO1	Understand the basics of microprocessor
CO2	Understand the architecture of 8085 and 8086
CO3	Knowledge of instruction set of 8085 and 8086
CO4	Knowledge of programmable peripheral interface
CO5	Knowledge of analog to digital and digital to analog converter

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction of Microcomputer System**	Introduction of Microcomputer System: General definition of minicomputer, microprocessors,CPU, I/O devices, clock, memory, bus architecture, tri-state logic, address bus, data bus and control bus. Semiconductor Memories: Development of semiconductor memory, internal structure and decoding,memory read and writes timing diagrams, ROM, RAM.	8	CO1
2	**Architecture of Microprocessors**	Architecture of Microprocessors: Introduction of Intel 8085 and 8086 microprocessor, Pindescription and their internal architecture. Introduction of Intel 80386. Operation and Control of Microprocessor: Timing and control unit, memory read/write machinecycles, I/O read/write machine cycles, interrupt acknowledge machine cycle.	8	CO2
3	**Instruction Set**	Instruction Set: Addressing modes- Data transfer, arithmetic, logical, branch, stack andmachine control groups of instruction set, unspecified flags and instructions. Assembly Language Programming, Assembler directives, Subroutines..	8	CO3
4	**Interfacing**	Interfacing: Interfacing of memory chips, Interfacing of I/O devices, I/O addressing-I/Omapped and memory mapped I/O schemes, 8257(DMA Controller), 8259(Interrupt priority Control), 8253/8254 Programmable timer/counter with modes of operation. Interrupts: Interrupt structure of 8085 microprocessor.	8	CO4
5	**Programmable Peripheral Interface**	Programmable Peripheral Interface: Intel 8255, pin configuration, internal structure of a portbit, modes of operation, bit SET/RESET feature, ADC and DAC chips and their interfacing. Programmable Interval Timer: Intel 8253, pin configuration, internal block diagram of counter andmodes of operation, counter read methods.	8	CO5

Reference Books:

1.B.Ram, "Fundamentals of Microprocessor and Microcomputer", Dhanpat Rai Publication, 4th Edition.2008

2. M.Rafiquzzaman, "Microprocessors and Applications", John Wiley & Sons ,2008

3. Hall D.V.,"Microprocessor and Interfacing-Programming and Hardware", 2nd Ed., Tata McGraw-Hill Publishing Company Limited, reprinted 2008

4. Gaonkar R.S.,"Microprocessor Architecture,Programming and Applications", 6th Ed., Penram International, 2013.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3			1	1	1	1					3	3	3	2			
CO2	3	2	2	2	2	1						3	3	3	2			
CO3	3	2	2	2	2	1						3	3	2	2			
CO4	3	2	2	2	2	1	1					3	2	2	2			
CO5	3	1	1	1	1	1	1					3	3	2	2			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE325**	**Title of the Course**	**CONVENTIONAL & CAD OF ELECTRICAL MACHINES**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**6th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To develop knowledge on principles of design of static and rotating machines. • To understand the fundamental concepts of design process, designing of main dimensions & cooling systems of transformers and rotating machine. • To provide advanced knowledge and understanding about the construction and design of the electrical machines. • To provide the basis and the methodologies to correct a design of the electrical machines (transformers, rotating (AC machines and DC machines). • To understand the design optimization of the electrical machine for industrial, automotive and aerospace applications.						

Course Outcomes	
CO1	Student understands the basic concept of design, limitations faced in the designing process, and classification & importance of Insulating materials.
CO2	Student is able to understand the design concepts of transformers and know about how to design the core, yoke & windings.
CO3	Upon completing the course, student is able to understand the factors affecting the size of rotating machines and design of core & armature in DC machines along with selection of frame size.
CO4	Student is able to understand the rotor design of Induction motor and field system design of Synchronous machines & DC machines along with problem solving techniques related to design.
CO5	Student understands the importance of Computer aided design and different approaches based on their applications along with the concept of optimization.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Basic Considerations**	Basic concept of design, Limitation in design, Standardization, Modern trends in design and manufacturing techniques, Classification of insulating materials. Calculation of total magnetomotive force (m.m.f) and magnetizing current.	8	CO1
2	**Transformer Design**	Output equation; Design of core, yoke and windings; Overall dimensions; Computation of no load current to voltage regulation; Efficiency and cooling system designs	8	CO2
3	**Design of rotating machines I**	Output equations of rotating machines, Specific electric and magnetic loadings, Factors affecting size of rotating machines, Separation of main dimensions, Selection of frame size, core and armature design of dc machines.	8	CO3
4	**Design of rotating machines II**	Core and armature design of 3-phase ac machines, Rotor design of three phase induction motors, Design of field system of Direct Current (DC) machine and synchronous machines, Estimation of performance from design data.	8	CO4
5	**Computer Aided Design**	Philosophy of computer aided design, advantages and limitations; Computer aided design approaches analysis; Synthesis and hybrid methods; Concept of optimization and its general procedure; Flow charts and 'c' based computer programs for the design of transformer, DC machine, three phase induction and synchronous machines.	8	CO5

Reference Books:

1. A. K. Sawhney, **"**A Course in Electrical Machine Design**",** Dhanpat Rai & Sons, 6th Edition, 2006.
2. K.G. Upadhyay, "Conventional and Computer Aided Design of Electrical Machines",Galgotia Publications, 1st edition, 2004
3. M.G. Say, "The Performance and Design of AC Machines", Pitman & Sons, 2nd Edition 1952
4. A.E. Clayton and N.N. Hancock, "The Performance and Design of D.C. Machines", Pitman &Sons.
5. S.K. Sen, "Principle of Electrical Machine Design with Computer Programming", Oxford and IBM Publications

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2									3	3	3	2			
CO2	3	3	2	2	2						2		3	3	2			
CO3	3	3	1	2	2						2	2						
CO4	3	2	3	2	3					2	2							
CO5	2	2	2			2	2											

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE333**	**Title of the Course**	**ADVANCED CONTROL SYSTEMS**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**6th**	**3**	**1**	**0**	**4**
Pre-Requisite	Control System EE301/EE301	**Co-requisite**	None				
Course Objectives	• To learn the concept of state space analysis of continuous system. • To get the knowledge of state equations, controllability and observability • To design the state observer and controller using pole-placement approach • To gain information on non-linear control system • To evaluate the stability of the system using Lyapunov's stability analysis						

Course Outcomes	
CO1	Students will be able to understand different state model of a system, and have the knowledge to find its solution.
CO2	Students will be industry ready by analysis of controllability and observability of the dissimilar system.
CO3	Students will be industry ready by designing the State observer and controller using pole- placement approach
CO4	Students will be able to understand nonlinear system models, and analyse its stability.
CO5	Students will be able to analyse system's stability using Lyapunov stability analysis.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**State Space Analysis of Continuous System**	Introduction, Concept of state, Sate variable description, State space representation, state variable representation of continuous system, Conversion of state variable models to transfer function and vice-versa.	8	CO1
2	**State Equations, Controllability and Observability**	Characteristic equation, state transition matrix, Solution of state equations, Concept of controllability and Observability, Controllable, observable and diagonal canonical form.	8	CO2
3	**Pole-Placement Design and State observer**	Concept of pole-placement, Stability improvement by state Feedback, State regulator design, design of state observers and controller.	8	CO3
4	**Non-linear Control System**	Types and characteristics of non-linearity, phenomena related to non-linear systems. Phase plane analysis, types of phase portraits, singular points, construction of phase portraits, system analysis by phase-plane method, describing function and its application to system analysis.	8	CO4
5	**Lyapunov's Stability analysis**	Concept of Lyapunov's stability, Stability of equilibrium state, asymptotic stability, Lyapunov's stability theorems for continuous systems, methods of generating Lyapunov's function for continuous system, Stability analysis of non-linear system.	8	CO5

Reference Books:

1.M.Gopal, "Digital Control and State variable Methods", Tata Mc Graw Hill, 4th Edition, 2015

2.Ajit K.Madal, "Introduction to Control Engineering: Modelling, Analysis and Design" New Age International, 5th Edition, 2013.

3.K. Ogata, "Modern Control Engg.", PHI, 4th Edition, 2002.

4.S. K. Bhattacharya, "Control system Engg.", Pearson Education, 2nd Edition, 2008.

5.B.N. Sarkar "Advanced control system" PHI Learning Pvt. Ltd., 2013.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	2		1										2	2			
CO2	3	2													3			
CO3	3	2		2								1	2	2				
CO4	1	2		3								1			2			
CO5	2	2	3		2							1		2				

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2023-24							
Course Code	**EE335**	**Title of the Course**	**INDUSTRIAL AUTOMATION**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**6th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To improve quality, and reduce human involvement and possibility of human error. • To raise the level of safety for personnel • To reduce the work piece damage caused by manual handling						

Course Outcomes	
CO1	Understand and analyze the concept, design, technique, advancement and application of Automatic Control, Proportional- Integral-derivative (PID) Control and their Tuning, Feed-forward and Ratio Control, Time Delay Systems and Inverse Response Systems
CO2	Understand and analyze the concept, design, technique, advancement and application of Different types of controllers, Single loop and Multi loop controllers, Sequential and Programmable controllers, Architecture, Functional blocks, Programming of PLC: Relay logic and Ladder logic, Communication Networks for PLC, PLC based control of processes- Computer control of liquid level system, heat exchanger; Smart sensors.
CO3	Understand and analyze the concept, design, technique, advancement and application of Functional requirements and Components. General features, Functions and Applications, Benefits. Configurations of SCADA, Remote Terminal Unit Connections. Human Machine interface.
CO4	Understand and analyze the concept, design, technique, advancement and application of Different architectures, Local control unit, Operator Interface, Engineering interface, Study of any one DCS available in market, Factors to be considered in selecting DCS
CO5	Understand and analyze the concept, design, technique, advancement and application of robot, Asimov's Laws of robotics, construction and configuration, Pick and Place robot, Industry 4.0

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Industrial Automation Systems	Introduction, Architecture, Introduction to Automatic Control, Proportional- Integral-derivative (PID) Control and their Tuning, Feed-forward and Ratio Control, Time Delay Systems and Inverse Response Systems.	8	CO1
2	Controllers	Different types of controllers, Single loop and Multi loop controllers, Sequential and Programmable controllers, Architecture, Functional blocks, Programming of PLC: Relay logic and Ladder logic, Communication Networks for PLC, PLC based control of processes- Computer control of liquid level system, heat exchanger; Smart sensors	8	CO2
3	Supervisory Control and Data Acquisition (SCADA)	Introduction, Functional requirements and Components. General features, Functions and Applications, Benefits. Configurations of SCADA, Remote Terminal Unit Connections. Human Machine interface.	8	CO3
4	Distributed Control System (DCS):	Evolution, Different architectures, Local control unit, Operator Interface, Engineering interface, Study of any one DCS available in market, Factors to be considered in selecting DCS	8	CO4
5	Industrial Automation using Robots	Robotics: Introduction, Definition of a robot, Asimov's Laws of robotics, Robot terminology, Basic construction and configuration, Pick and Place robot, Introduction to Industry 4.0	8	CO5

Reference Books:

1. Seborg, D.E., Edgar, T.F. and Mellichamp, TF Edgar, FJ Doyle III, "Process dynamics and control", Wiley, 3rd edition 2010
2. Smith, C.A. and Corripio, A.B. "Principles and practice of automatic process control", Wiley, 3rd edition, 1997
3. Johnson, C.D. "Process control instrumentation technology," Prentice-Hall, 8th edition, 2008
4. 4. Kalsi, H.S., "Electronic Instrumentation", McGraw Hill, 3rd edition, 2010
5. Anjana, R., "Industrial Automation", Technical Publications, 1st Edition, 2022

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	1	2	3							2	3	2	3			
CO2	3	3	1	2	3							2	3	2	3			
CO3	3	1	1	2	3							2	3	2	3			
CO4	3	1	1	2	3							2	3	2	3			
CO5	3	1	1	2	3							2	3	2	3			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE343**	**Title of the Course**	**RENEAWABLE ENERGY TECHNOLOGY**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**6th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To Give the basic knowledge of Nonconventional energy Resources sources. • To make aware the students about alternate resources of energy. • To provide the knowledge of decentralized energy supply to agriculture, industry, commercial and House-hold sector.						

Course Outcomes	
CO1	Given an energy systems and quantifying energy students shall be able to represent this in comparison to various conventional Fossil fuels, identify type of system, apply vector algebra, and formulate the Remedies & alternatives for fossil fuels.
CO2	Given a Modelling of Solar Energy with sources, student shall be able to analyse theory of solar cells, solar radiation, solar characteristics and limitations.
CO3	For a Wind Energy Systems, student shall be able to generate its analytical response and resource assessment, analyse and evaluate the characteristics by Power Conversion Technologies.
CO4	For a given Hydro power, students shall be able to identify its characteristics and for Generation and Distribution, select suitable design of application of Mini and Micro-hydel Power with various combination for System
CO5	Given a Nuclear Energy system, student shall be able to define its fuel enrichment, different types of nuclear reactors, nuclear waste disposal, solve/ analyse, and modify Integrated Energy systems

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction**	Introduction to energy systems and resources; Energy: sustainability & the environment, Quantifying energy & energy arithmetic, Electricity - a primer, Fossil fuels - past, present & future, Remedies & alternatives for fossil fuels, Energy efficiency and conservation, Introduction to renewable energy, availability, classification, relative merits and demerits.	8	CO1
2	**Source of Energy**	Sun as Source of Energy, Availability of Solar Energy, Nature of Solar Energy, Solar Energy & Environment. Various Methods of using solar energy –Photo thermal, Photovoltaic, Present & Future Scope of Solar energy. Theory of solar cells, solar radiation, solar characteristics, limitations, solar thermal power plants, Solar Photovoltaic systems.	8	CO2
3	**Basics & Power Analysis**	Basics & Power Analysis, Wind resource assessment, Power Conversion Technologies and applications, Wind Power estimation techniques, Principles of Aerodynamics of wind turbine blade, classification of rotors, wind characteristics, Performance and limitations, various aspects of wind turbine design.	8	CO3
4	**Hydro power**	Hydro power: Potential, Hydropower Generation and Distribution, Mini and Micro hydel Power (MHP) Generation: Classification of hydel plants, Concept of micro hydel, merits, MHP plants: Components, design and layout, Turbines, efficiency, Status in India.	8	CO4
5	**Nuclear Energy**	Potential of Nuclear Energy, Nuclear Energy Technologies – Fuel enrichment, Different Types of Nuclear Reactors, Nuclear Waste Disposal and Nuclear Fusion. Hybrid energy systems - Integrated Energy systems, Diesel-PV, wind-diesel power, wind conventional grid, wind-Photovoltaic system.	8	CO5

Reference Books:

1.B.H Khan, "Non-Conventional Energy Resources" Tata Mc Graw-Hill Pvt. Ltd., 2nd Edition,2009.

2.G.D.Rai, "Non-Conventional Energy Resources" Khanna Publishers, 4th Edition, 2000.

3.Freris, L.L. "Wind and Solar Power Systems" Prentice Hall, London, 1999

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2										2	2	2			
CO2	3	3	2	2	2								2	2	2			
CO3	3	3	1									2	3	2	2			
CO4	3	3	3	2	3					2	2		2	3	2			
CO5	3	3	3			2	1						2	2	2			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE345**	**Title of the Course**	**POWER ELECTRONICS BASED CONVERTERS DESIGN**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**6th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• Knowledge and concept of non-isolated DC-DC converters. • Analysis & Design of Isolated Converters. • Knowledge and concept of AC Regulators. • Analysis & Design of Self Driven Inverters. • Designing of Soft switching Converters						

Course Outcomes	
CO1	Know about the concept of non-isolated DC-DC converters.
CO2	Analyze & Design Isolated Converters.
CO3	Know about concept of AC Regulators.
CO4	Analyze & Design Self Driven Inverters.
CO5	Design Soft switching Converters.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Unit I**	Limitations of Linear power supplies; Switched Mode Power Conversion; Analysis & Design of Non-isolated DC-DC Converters: Buck, Boost, Buck-boost operations in CCM and DCM.	8	CO1
2	**Unit II**	Analysis & Design of Isolated Converters: Forward, Push-Pull, Half Bridge, Full Bridge, Flyback, Cuk, SEPIC, High-Boost Topologies.	8	CO2
3	**Unit III**	Review of AC Regulators and Cyclo-converters; Voltage control and Harmonic minimization in inverters, square wave operation; Multilevel Inverter.	8	CO3
4	**Unit IV**	Analysis & Design of Self Driven Inverters, Driven Inverter, Quasi-Square Wave Inverter;PWM, PWM with Harmonic Elimination; Matrix Converter.	8	CO4
5	**Unit V**	Soft switching Converters - Switching loss, hard switching, soft switching; Resonant Converter, basic principles of ZVS, ZCS, and ZVZCS.	8	CO5

Reference Books:

1. Ned Mohan, Tore M, Undelnad, William P, Robbins (3rd Edition), "Power Electronics:Converters, Applications and Design," Wiley 2002.
2. L. Umanand, Power Electronics - Essentials and Applications; Wiley India Pvt. Ltd
3. P.C Sen.,' Modern Power Electronics ', Wheeler publishing Co, First Edition, New Delhi,1998.
4. M H Rashid, Power Electronics - Circuits, Devices and Applications; PHI, New Delhi.
5. Philip T Krein: Elements of Power Electronics; published by Oxford University Press.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	1	1	1	1	3	1					3		2	2			
CO2	3	2	3	1	3	3	1					3	2	3	2			
CO3	3	1	1	1	1	3	1					3		3	2			
CO4	3	2	3	1	3	3	1					3	2	3				
CO5	3	2	3	3	3	3	2					2	2	2	2			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE347**	**Title of the Course**	**Modeling and Dynamic Analysis of Electrical Machines**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**6th**	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To develop knowledge of the concept of magnets • To understand the advance concepts of DC machine • To provide advance knowledge of reference frame theory • To understand the advance concepts of Induction machine • To understand advance concepts of Synchronous machine						

Course Outcomes	
CO1	Student understands the basic concept of magnets and electromechanical conversion
CO2	Student is able to understand the characteristics of DC machines
CO3	Student is able to understand the concept of reference frame theory
CO4	Student is able to understand the reference frame concept in induction machines
CO5	Student understands the importance of performance of synchronous machine under different conditions

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Basics of Magnetic Circuits**	Flux, mmf, reluctance - self, leakage, magnetizing and mutual inductances; Analysis of magnetic circuits with airgap; Analysis of singly excited electromechanical system with linear magnetics; Basic Fundamentals of electromechanical energy conversion.	8	CO1
2	**Analysis of DC Machines**	Voltage & Torque Equations; Dynamic Characteristics of Permanent Magnet & Shunt DC Motors; Time-Domain Block Diagrams & State Equations; Solution of Dynamic Characteristics by Laplace Transformation.	8	CO2
3	**Reference Frame Theory**	Introduction; Equations of Transformation; Commonly Used Reference Frame – Rotor, Stator, Synchronous & Arbitrary; Transformation between reference frames..	8	CO3
4	**Analysis of Induction Machines**	Voltage & Torque Equations; Commonly used reference frames; Analysis of Steady-State operation; Free Acceleration Characteristics; Dynamics Performance under load change.	8	CO4
5	**Analysis of the Synchronous Machines**	Voltage & Torque Equations ; Analysis of steady state operation and Dynamic performance; Response under short circuit conditions, sub transient, transient and steady state conditions.	8	CO5

Reference Books:

1. Paul C. Krause, “Analysis of Electrical Machinery & Drive System”, Wiley India, 2nd Edition 2010
2. R.Krishnan, “Electric Motor Drives, Modeling, Analysis, & Control”, Prentice Hall, 2nd Edition 2002
3. P.S. Bimbhra, “Generalised Theory of Electrical Machines”, Khanna Publishers
4. B.K.Bose, “Modern Power Electronics & AC Drives”, Prentice Hall, 2015
5. O'Simmons and Kelly, "Introduction to Generalized Machine Theory", 1968
6. Bernard Adkins, “The General theory of electrical Machines”, Chapman & hall ltd
7. I.P. Kopylov, “Mathematical Models of Electric Machines”, Mir Publisher

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	2									3	3	3	2			
CO2	3	3	2	2	2						2		3	3	2			
CO3	3	3	1	2	2						2	2						
CO4	3	2	3	2	3					2	2							
CO5	2	2	2			2	2											

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE351**	**Title of the Course**	**SENSOR AND INSTRUMENTATION**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**6th**	**2**	**1**	**0**	**3**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• different types of sensors and transducers used in Industries • DSP,ADC,DAC,S/H circuit. • Analyse the instuments on the basis of accuracy,precision and resolution						

Course Outcomes	
CO1	Knowledge of different types of sensors and transducers used in Industries
CO2	Knowledge of DSP,ADC,DAC,S/H circuit. Measurement of flux and hysteresis of magnetic specimen
CO3	Analyse the instuments on the basis of accuracy,precision and resolution
CO4	Knowledge of different telemetry systems

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Sensors & Transducer**	Definition, Classification & Characterization, Displacement Sensors: Potentiometric, LVDT & Optical Encoder; Accelerometers: Mass & Piezoelectric; Strain Gauges: Wire & Semiconductor; Pressure Sensor: LVDT based Diaphragm & Piezoelectric, Temperature Sensor: Thermocouple, RTD, & Liquid in Glass; Flow Sensor: Ultrasonic, Electromagnetic, Laser & Thermal; Level Sensor: Ultrasonic & Capacitive; Proximity Sensor, Concept of Smart Sensors.	8	CO1
2	**Digital Processing of Analog Signal**	Analog Multiplexer Circuit, S/H Circuit, ADC, DAC, Convolution, Digital Filtering. Magnetic Measurement: Ballistic Galvanometer, flux meter, determination of hysteresis loop, Measurement of iron losses.	8	CO2
3	**Instrumentation System**	Flow, Pressure, and Temperature Measurement; Measurement Errors: Gross errors and systematic errors, Absolute and relative errors, Accuracy, Precision, Resolution and Significant figures.	8	CO3
4	**Data Transmission and Telemetry**	Telemetry System and its Classification, Voltage, Current and Position Telemetry Systems, Frequency Modulation Telemetry.	8	CO4

Reference Books:

1. Arun K. Ghosh "Introduction to measurements and Instrumentation, PHI, 4th Edition 2012.
2. David A. Bell "Electronic Instrumentation & measurement" 3rd Edition 2013, Oxford University Press.
3. DVS Murthy "Transducers and Instrumentation, PHI 2nd Edition 2013
4. D Patranabis "Sensors and Transducers" PHI 2nd Edition 2013.
5. Ranjan CS (et.al) "Instrumentation and Device Systems" PHI.
6. A.K.Sawhney and Puneet Sawhney," A Course in Electrical and Electronics Measurement and Instrumentation," Dhanpat Rai & Co.Pvt Ltd.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1					3	1				3	2		2	3	1			
CO2	1		2		3								3	2	1			
CO3		3	2		1								3	2	1			
CO4						1			2	3			3	3	1			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	**EE353**	**Title of the Course**	**POWER STATION PRACTICE**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**6th**	**2**	**1**	**0**	**3**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To get the knowledge of electric energy demand and growth in India • To get the detailed knowledge of Thermal Power Plant. • To get the detailed knowledge of Hydro Power Plant. • To get the knowledge of Nuclear, Gas and Diesel Power Plant. • To have the knowledge of Power Plant Economics and Tariffs • To have the knowledge of Economic Operation of Power Systems						

Course Outcomes	
CO1	Understand the Electric energy demand and growth, Thermal Power Plant and Hydro Electric Power Plant
CO2	Understand the Nuclear Power Plant, Gas Turbine Plant and Diesel Power Plants
CO3	Having knowledge of Power Plant Economics and Tariffs
CO4	Having knowledge of Economic Operation of Power Systems

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Thermal Power Plant and Hydro Power Plant**	Introduction: Electric energy demand and growth in India, electric energy sources. Thermal Power Plant: Site selection, general layout and operation of plant, detailed description and use of different parts. Hydro Electric Power Plant: Classification, location and site selection, detailed description of various components, general layout and operation of Plants; brief description of impulse, reaction, Kaplan and Francis turbines; advantages & disadvantages; hydro-potential in India.	8	CO1
2	**Nuclear, Gas and Diesel Power Plant**	Nuclear Power Plant: Location, site selection, general layout and operation of plant. Brief description of different types of reactors, Moderator material, fissile materials, control of nuclear reactors, disposal of nuclear waste material, shielding. Gas Turbine Plant: Operational principle of gas turbine plant & its efficiency, fuels, open and closed-cycle plants, regeneration, inter-cooling and reheating, role and applications. Diesel Power Plants: Diesel power plant layout, components & their functions, its performance, role and applications.	8	CO2
3	**Power Plant Economics and Tariffs**	Load curve, load duration curve, different factors related to plants and consumers, Cost of electrical energy, depreciation, generation cost, effect of Load factor on unit cost. Fixed and operating cost of different plants, Objectives and forms of Tariff, Causes and effects of low power factor, advantages of power factor improvement, different methods for power factor improvements.	8	CO3
4	**Economic Operation of Power Systems**	Characteristics of steam and hydro power plants, Constraints in operation, Economic load scheduling of thermal power plants, Neglecting and considering transmission Losses, Penalty factor, loss coefficients, Incremental transmission loss, Hydrothermal Scheduling.	8	CO4

Reference Books:

1. B.R. Gupta, "Generation of Electrical Energy", S. Chand Publication, 7th Edition ,2017
2. Soni, Gupta & Bhatnagar, "A text book on Power System Engineering", Dhanpat Rai & Co.
3. W. D. Stevenson, "Elements of Power System Analysis", McGraw Hill,4th Edition, 1982.
4. S. L. Uppal, "Electrical Power", Khanna Publishers, 15th Edition,2009

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	2	1	1								1	2	1	2			
CO2	3	3		1								1	2	3	2			
CO3	3	3	1	2								1	2	3	2			
CO4	3	2	3				3		3	2	2	1	2	3	2			
CO5	3	1	3	2	2	2			3	2	2	2	2	3	2			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session:							
Course Code	**EE 334**	**Title of the Course**	**Advanced Control system Lab**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	VI	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**					
Course Objectives	• To learn of Transfer function and mathematical modeling of mechanical system. • To analyze the first order and second order system. • To evaluate the stability of the system using different frequency domain analysis tools • To design the compensator						

Course Outcomes	
CO1	Represent a system (in the form of transfer function) in MATLAB considering it's zeros, poles and gain.
CO2	Analyse the plots of time and frequency responses of SISO and MIMO systems.
CO3	Analyse the response of RLC circuit. Assess gain and phase margin to examine the effect of stability margins on closed loop response characteristics of a control system.
CO4	Frequency domain analysis for the given system

Exp. No.	Title of the Unit	Content of Experiment	Contact Hrs.	Mapped CO
1	Time domain analysis	Study of first order and second order system responses-measurement of system parameters in MATLAB	2	1
2	Stability Analysis	Check the stability of a system. Report whether the system is stable, unstable, or marginally stable.	2	3
3	Time domain analysis	Plotting unit step response of given transfer function and find peak overshoot, peak time.	2	2
4	State space	Finding state space representation of given closed loop system.	2	2
5	Stability Analysis	Plotting Bode plot of given transfer function and finding gain and phase margin.	2	4
6	Stability Analysis	Plotting Nyquist plot for given transfer function and to discuss closed loop stability, gain and phase margin	2	4
7	Stability Analysis	Plotting root locus of given transfer function and finding S, Wd, Wn at given root.	2	4
8	Stability Analysis	Plotting locus of given transfer function, locating closed loop poles for different value of k.	2	3

Reference Books:

M.Gopal, "Digital Control and State variable Methods", Tata Mc Graw Hill, 4th Edition, 2015

Ajit K.Madal, "Introduction to Control Engineering: Modelling, Analysis and Design" New Age International, 5th Edition, 2013.

K. Ogata, "Modern Control Engg.", PHI, 4th Edition, 2002.

S. K. Bhattacharya, "Control system Engg.", Pearson Education, 2nd Edition, 2008.

e-Learning Source:

https://nptel.ac.in/courses/108103007

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	2	3							2	2	2		3	3	3
CO2	3	3	3	2	3							2	2			3	3	3
CO3	3	1	1		3							2	2			3	3	1
CO4	3	3	2	3	3							2	2			3	3	1

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session:							
Course Code	**EE 336**	**Title of the Course**	**Industrial Automation Lab**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	VI	**0**	**0**	**2**	**1**
Pre-Requisite		**Co-requisite**					
Course Objectives	• To provide the student with basic skills useful in identifying the concepts of automation using hydraulics, pneumatics, industrial sensors, PLC and distributed control strategies. • Student will be able to understand & develop the ladder program for DOL starter and its application as a timer. • Student will be able to understand the hardware & software used in PLC and Implementation of logic gates. • Student will be able to understand the Performance of Timers & Counters.						

Course Outcomes	
CO1	Student will be able to understand the hardware & software used in PLC and Implementation of logic gates.
CO2	Student will be able to understand & develop the ladder program for DOL starter and its application as a timer.
CO3	Student will be able to understand the hardware & software used in PLC and Implementation of logic gates.
CO4	Student will be able to understand the Performance of Timers & Counters.

Exp. No.	**Title of the Unit**	**Content of Experiment**	**Contact Hrs.**	**Mapped CO**
1	PlC Application	Study and use of Examine if closed (XIC) and Examine if open (XIO) bit instruction.	2	1
2	PlC Application	Study and Use of NOR Gate.	2	3
3	Latching	Study and use of Latch (L) and Unlatch (U) bit instruction.	2	2
4	Timer on and Timer Off	Study and use of ON Delay Timer (TON) and OFF Delay Timer (TOF) bit instruction.	2	2
5	Math instruction	Study and use of Compute Math (Addition) instruction.	2	3
6	Bit instruction	Study and use of Bit shift left (BSL) bit instruction.	2	4
7	Counter	Study and use of UP Counter (CTU) and of Down Counter (CTD) bit instruction.	2	4
	PlC Application	Study and use of Jump & Label Instruction.		1
8	Relay instruction	Study and use of MCR (Master Control Relay) instruction.	2	3

Reference Books:

Antony Espossito, “Fluid power with Applications ", Pearson, Sixth Edition., 2003

W. Bolton, “Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering” - PrenticeHall - 2013 – 5th Edition.

Singh, Shio Kumar. Industrial Instrumentation & Control, Tata McGraw-Hill Education, 2010.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	2	1	1	1	2							2	2	2		3	3	3
CO2	2	3	2	1	1	1						2	2			3	3	3
CO3	3	2	3	2	2	1	1					2	2			3	3	1
CO4	2	3	2	1	1	2						2	2			3	3	1

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session:							
Course Code	EE342	**Title of the Course**	**Soft Computing Lab**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	6th	**0**	**0**	**2**	**1**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	• To trace the historical developments of artificial intelligence leading to artificial neural networks (ANN). • Demonstrate an understanding of the fundamental properties of linear systems • Uses of transform analysis and convolution, to analyze and predict the behavior of linear time invariant systems • Understanding how to create fuzzy data sets; Understanding how fuzzy data sets can lead to better controller and control system. • To generate high-quality solutions to optimization and search problems by relying on biologically inspired operators such as mutation, crossover and selection.						

Course Outcomes	
CO1	To understand about artificial neuron and their architecture.
CO2	To understand the learning methods of artificial neurons and their memories.
CO3	To understand the difference between crisp sets and fuzzy sets.
CO4	To understand about fuzzy logics, mathematical tools.
CO5	To learn the optimization technique using genetic algorithm.

Unit No.	Title of the Unit	Content of Experiment	Contact Hrs.	Mapped CO
1		Realising Activation Function.	2	1
2		Realising XOR Function using McCulloch-Pitts Neuron.	2	1
3		Create a Perception Network (nntool).	2	2
4		To realize OR gate using nntool in MATLAB.	2	2
5		Develop a single input single output fuzzy logic controller using Fuzzy GUI in MATLAB.	2	3
6		Develop a double input single output fuzzy logic controller using Fuzzy GUI in MATLAB.	2	4
7		Develop a fuzzy logic cruise controller using Fuzzy GUI in MATLAB.	2	4
8		To minimize an objective function using the Genetic Algorithm.	2	5

Reference Books:

1. S. Rajashekharan & G.A. Vijay Lakshmi Pai , "Neural Network , Fuzzy logic and Genetic Algorithms: synthesis and applications", Prentice Hall India, 1st edition 2012.

2. Timonthy J.Ros " Fuzzy Logic with engineering applications" Will India, 2nd edition 2007.

3. S.N Sivanandam & S.N Deepa " Introduction to genetic algorithm" Springer 1st edition, 2008.

e-Learning Source:

NPTEL

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**3**	**2**	**2**		**1**			**1**	**1**		**1**	**1**	**1**	**1**	
CO2	**3**	**3**	**2**	**2**				**1**		**1**		**1**	**1**	**1**	**1**	
CO3	**3**	**3**	**2**	**2**		**1**			**1**	**1**		**1**	**1**	**1**	**1**	
CO4	**3**	**3**	**3**	**2**		**1**			**1**	**1**		**1**	**1**	**1**	**1**	
CO5	**3**	**3**	**2**	**2**		**1**		**1**		**1**		**1**	**1**	**1**	**1**	

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	**EE346**	**Title of the Course**	**Converter Lab**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	**6th**	**0**	**0**	**2**	**1**
Pre-Requisite	**EE201**	**Co-requisite**	**NIL**				
Course Objectives	• Know about the the operation of single phase controlled converter using R and RL load. • Analyze single phase AC voltage control using TRIAC and the operation of a modified Mc-Murray Bedford full bridge inverter. • Know about the operation of inverters. • Analyze the operation of class D commutated technique and the operation of resistance triggering circuits of SCR. • Know about the operation of resistance capacitance triggering circuits of SCR and the operation of resistance, resistance capacitance and UJT triggering circuits of SCR.						

Course Outcomes	
CO1	Know about the the operation of single phase controlled converter using R and RL load.
CO2	Analyze single phase AC voltage control using TRIAC and the operation of a modified Mc-Murray Bedford full bridge inverter.
CO3	Know about the operation of inverters.
CO4	Analyze the operation of class D commutated technique and the operation of resistance triggering circuits of SCR.
CO5	Know about the operation of resistance capacitance triggering circuits of SCR and the operation of resistance, resistance capacitance and UJT triggering circuits of SCR.

Exp. No.	**Content of Experiment**	**Contact Hrs.**	**Mapped CO**
1	To study the operation of single phase half controlled converter using R and RL load and to observe the output waveforms.	2	1
2	To study the operation of single phase fully controlled converter using R and RL load and to observe the output waveforms.	2	1
3	To study the 1-phase AC voltage control using TRIAC.	2	2
4	To study the operation of a modified Mc-Murray Bedford full bridge inverter.	2	2
5	To study the operation of parallel inverter.	2	3
6	To study the operation of series inverter and to obtain variable AC from DC input.	2	3
7	To observe the operation of class D commutated technique.	2	4
8	To study the operation of resistance triggering circuits of SCR	2	4
9	To study the operation of resistance capacitance triggering circuits of SCR.	2	5
10	To study the operation of resistance, resistance capacitance and UJT triggering circuits of SCR	2	5

Reference Books:

1. Ned Mohan, Tore M, Undelnad, William P, Robbins (3rd Edition), "Power Electronics:Converters, Applications and Design," Wiley 2002.
2. L. Umanand, Power Electronics - Essentials and Applications; Wiley India Pvt. Ltd
3. P.C Sen.,' Modern Power Electronics ', Wheeler publishing Co, First Edition, New Delhi,1998.
4. M H Rashid, Power Electronics - Circuits, Devices and Applications; PHI, New Delhi.
5. Philip T Krein: Elements of Power Electronics; published by Oxford University Press

e-Learning Source:

PO-PSO	**Course Articulation Matrix: (Mapping of COs with POs and PSOs)**															
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	1	1	3	1	-	-	-	-	3	1	-	-	-
CO2	3	2	3	1	3	3	1	-	-	-	-	3	1	2	-	-
CO3	3	1	1	1	1	3	1	-	-	-	-	3	1	-	3	-
CO4	3	2	3	1	3	3	1	-	-	-	-	3	1	-	3	-
CO5	3	2	3	3	3	3	2	-	-	-	-	2	1	-	2	-

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation