National Institute of Technology Raipur												
Course of Study and Scheme of Examination							B. Tech. 5th Semester				Branch: Electrical	
S. No.	Subject Code	Subject Name	Periods per Week			TA	Examination Scheme				Total Marks	Credits
							MSE/MTR		ESE/ESVE			
			L	T	P		Theory	Prac.	Theory	Prac.		
1	EL105101EL	Control System Engineering	3	1	0	20	30		50		100	4
2	EL105102EL	Electrical Machines-II	3	1	0	20	30		50		100	4
3	EL105103EL	Power System Analysis	3	1	0	20	30		50		100	4
4		Program Elective	3	0	0	20	30		50		100	3
5		Open Elective	3	0	0	20	30		50		100	3
6	EL105401EL	Control System Engineering Labortory	0	0	2	40		20		40	100	1
7	EL105402EL	Electrical Machines-II Labortory	0	0	2	40		20		40	100	1
8	EL105701EL	Summer Internship I	-	-	-	40		20		40	100	1

Program Electives		
Subject Code	Name of Subject	
EL105201EL	Advanced Power Electronics	
EL105202EL	Digital Electronics & Embedded Systems	
EL105203EL	Introduction to AI and ML	
EL105204EL	Biomedical Instrumentation	
EL105205EL	Electrical Engineering Materials	
Open Electives		
Subject Code	Name of Subject	
EL105301EL	Energy Conversion System	
EL105302EL	Instrumentation & Control	
EL105303EL	Digital System Design	
EL105304EL	Advanced Semiconductor Devices	
EL105305EL	Design and Integration of Optical Sensors in Mechatronic Systems	

Control System Engineering

[5th Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Electrical Engineering	3-1-0, (4)	Program Core	EL105101EL

[Pre-requisites: Mathematics- I (MA101001MA), Basic Electrical Engineering (EL101022EL)]

Course Objectives

Making the students

- Acquire the knowledge of modeling and analyzing dynamic systems in time and frequency domain
- Understand the requirement of feedback in improving system response.

UNIT I: General Control Systems

Introduction, open and closed-loop control, Transfer function, Mathematical modelling of various physical systems, e.g., electrical, mechanical, hydraulic, pneumatic, thermal, etc., feedback and feed-forward control systems.
(a) Block diagrams and reduction techniques.
(b) Signal flow-graph analysis.

Unit II: Time Domain Analysis & Design:

Steady-state and transient analysis of first and second order systems, steady-state errors, error constants, performance specifications in time domain, Types of feedback control system, Proportional Integral and derivative control, PID controller, Design specifications and considerations of second-order systems, Performance indices

Unit III: Stability and frequency Domain Analysis

Stability: concept, necessary conditions, Routh-Hurwitz stability criterion, relative stability analysis.
(a) Polar plots, Bode plots, Experimental determination of transfer function, Design considerations.
(b) Stability in frequency domain: Hurwtiz stability criterion and Relative stability assessment, Gain Margin and Phase Margin, Systems with transportation lag, Closed-loop frequency response, Nichol's chart, Sensitivity analysis in frequency domain.

Unit IV: Design using Root Locus

Definition, magnitude and angle criteria, properties of root locus, construction rules for root locus plot of negative feedback systems, determining the gain from root locus plot, effect of addition of poles and zeros of G(s)H(s).

Unit V: Control System Design

Controller design in time and frequency domain
(a) Compensation using root locus: Cascade lag, cascade lead, cascade lag-lead network.
(b) Compensation using Bode plots: Lag, lead and lag-lead networks.

Required Text: Text books

(1) Benjamin. C. Kuo, "Automatic Control Systems", Prentice Hall of India, 7th Edition, 1995.
(2) Ogata. K, "Modern Control Engineering", Prentice Hall of India, 5th Edition, 2010
(3) J.Nagrath and M.Gopal," Control System Engineering", New Age International Publishers, 5th Edition, 2007

Course Outcomes (CO)

1. Analyze continuous systems mathematically through the use of Laplace functions and state equations.
2. Apply fundamental principles of closed loop system and appreciate the use of feedback to improve system performance.
3. Interpret any physical system in both transfer functions and state equations form.
4. Design controllers to improve the performance of continuous controlled system in both time and frequency domains.
5. Infer knowledge to succeed in any competitive examination as well as develop the lifelong learning process.

Mapping and Correlation of COs with POs

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

Electrical Machines – II

[5thSemester, 3rd Year]

Course Description

Offered by Department	Credits	Status	Code
Electrical Engineering	3-1-0, (4)	Program Core	EL105102EL

[Pre-requisites: Basic Electrical Engineering EL10I022EL, Electrical Machine –I EL104102EL]

Course outcome:

On successful completion of the course the students will be able to:

l. Understand the operating concept, and analyze the performance of synchronous machine.

2. Understand the operating concept, speed control methods and analyze the performance of Induction machine

3. Understand the practical application and advantages of induction motor in industries.

4. Describe the structure of AC Drive systems and their role in various applications

Course Content

Unit 1 Synchronous Machines - I

Theory of non-Salient pole synchronous machines, Equivalent circuit and phasor diagrams of synchronous machines, Saturation effects, Armature reaction, Open circuit, Short circuit and Zero power factor lag tests on synchronous machines, Synchronous reactance, SCR, Voltage regulation of alternators by Synchronous impedance, MMF and Zero power factor method, Steady state power angle characteristics, Excitation systems of alternators.

Unit 2 Synchronous Machines - II

Theory of salient pole synchronous machines ,Two Reaction theory, Phasor diagram, Power angle characteristics, Determination of X_d and X_q, Phasor diagrams, Starting of synchronous machines, damper winding, Hunting.Synchronous motor: Construction, General load/phasor diagram, Torque and Power in salient and non salient pole motors, V-curves, Capability curve, Synchronous condenser. Parallel operation of synchronous machines, Load sharing, Operation of synchronous machines with infinite bus bars, Synchronizing torque, Active and Reactive power flows.

Unit 3 Induction Motor

Theory and operating principle of three phase Induction Machine, Equivalent circuit, Phasor diagram, Torque-Speed (slip) relationship, Testing of induction motors, Circle diagram,Starting and speed control of induction motor, cogging and crawling, double cage induction motors, Applications.

Unit 4 Electric Drives

Induction motor drives, Inverter fed induction motor drive, VSI and CSI fed induction drives, Cyclo-converter fed drives, Static Kramer &Scherbius drives.

Course Materials

Required Text: Text books

1. D.P. Nagrath, I.J. Kothari,"Electric Machines", McGraw Hill Education, Fifth edition, 2017.
2. A.E. Fitzgerald, Charles Kingsley Jr., Stephen D. Umans, "Electric Machinery", McGraw Hill Education, 6th edition, 2017.
3. Gopal K. Dubey, "Fundamentals of Electrical Drives", Narosa, Second Edition, 2010.

Optional Materials: Reference Books

1. A.E. Clayton, N.N. Hancock, "The Performance and Design Of Direct Current Machines", CBS Publications, 2004.
2. M.G. Say, "The Performance And Design Of Alternating Current Machines", C.B.S. Publishers, 2002.
3. Vedam Subrahmanyam,"Electrical Drives: Concepts and Applications", McGraw Hill Education (lndia Private Ltd.), 2011.

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	1					1	1	3
CO2	3	3	3	3	1					1	1	3
CO3	3	3	3	3	3	1	1	1	1	1	1	3
CO4	3	3	3	3	3	1	1	1	1	1	1	3

Power System Analysis

[5th Semester, Third Year]

Course Description			
Offered by Department	Credits	Status	Code
Electrical Engineering	3-1-0, (4)	Program Core	EL105103EL

[Pre-requisites: Electrical Power System (EL103105EL)]

Course Objectives

To model various power system components and carry out load flow, short circuit, and stability studies.

Course Content

Unit 1 Symmetrical Three-Phase Short Circuit

Calculation of interrupting capacity of circuit breakers, Current limiting reactors, Symmetrical components, Synthesis of unbalanced phasors from symmetrical components, Representation of phase variables voltage, Current and Power in terms of symmetrical components, Sequence impedances of power system elements, Sequence networks of power system elements, Phase shift in star-delta transformer banks, Formulation of bus impedance matrix.

Unit 2 Unsymmetrical Short Circuits

Single line-to-ground, Line-to-line, Double-line-to-ground faults on unloaded alternators, Unsymmetrical faults on power systems, Fault through impedance, Open conductor faults.

Unit 3 Power System Stability

The stability problem, Steady-state stability, Transient stability, Swing equation, Equal area criterion of stability, Application of equal area criterion, Step-by-step solution of the Swing equation, Factors affecting transient stability.

Unit 4 Load Flow Studies

Formulation of bus admittance matrix, Formulation of load-flow equations and their solution techniques, Digital computer techniques, Reactive power optimization.

Unit 5 Automatic Generation & Voltage control

Introduction, Single area and two area load frequency control and Economic dispatch control, Optimal (two area) Load frequency control, Automatic voltage control, Tie-line bias control.

Course Materials

Required Text: Textbooks

1. I. J. Nagrath, D. P. Kothari, "Modern Power System Analysis", McGraw Hill Education, 4th edition, 2011.
2. Hadi Saadat, "Power System Analysis", McGraw Hill Education India Pvt. Ltd., 2002.

Optional Materials: Reference Books

1. Ashfaq Husain, "Electrical Power Systems", CBS Publication, 5th edition, 2018.
2. Olle I. Elgerd, "Electric Energy Systems Theory: An Introduction", McGraw Hill Education, 2nd edition, 2017.
3. Arthur R. Bergen, Viay Vittal, "Power Systems Analysis", Pearson Education, 2nd edition, 2002.
4. J. Grainger and William D. Stevenson Jr., "Power System Analysis", John McGraw Hill Education, 2017.

COURSE OUTCOME:

Course Outcomes (COs) on completion of the course students will be able to:

1. Analyze and apply the concepts of symmetrical components
2. Identify and solve symmetrical & unsymmetrical faults
3. Utilize the knowledge of power system stability to evaluate the operation under steady state & transient state condition.
4. Predict the load demand using load flow analysis
5. Develop the capability to estimate economical load distribution

Mapping of COs and POs

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

Advanced Power Electronics

[5th Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Electrical Engineering	3-0-0, (3)	Program Elective	EL105201EL

[Pre-requisites: Power Electronics (EL104103EL)]

Course Objectives

To understand the configuration, working and applications of converters and inverters.

Course Content

Unit I Overview

Overview of Power Electronics, Review of Phase Controlled Converters: Single and three-phase controlled converters, power factor improvement techniques, PWM rectifiers: equal area PWM, sine PWM, Single Phase and Three phase boost rectifier circuits.

Unit II Power Converters

Basic concepts of Switching-Mode Regulators, Comparison of Regulators, Multi-output Boost Converter, Diode Rectifier-Fed Boost Converter, Averaging Models of Converters, State–Space Analysis of Regulators, Design Considerations for Input Filter and Converters, Drive IC for Converters.

Unit III Power Inverters

Single phase and Three phase inverters, Voltage Source Inverter: 120^0 and 180^0 conduction modes, PWM techniques of voltage fed converters: Selective Harmonic Elimination (SHE), sine modulation, Third harmonic injection, Hysteresis Current Control, Sigma-Delta Modulation, Space Vector Pulse Width Modulation: under-modulation and over-modulation and their implementation Current Source inverters and their role in high power drives: Auto-sequential Current Fed inverter, Pulse Width Modulation of CSI.

Unit IV Cyclo-converters

Single phase and three phase Cyclo - converters. Reduction in Output Harmonics. Three phase matrix converters and their control, basic input filter, protection of matrix converter. Zero voltage and zero current switching, resonant switch converters, and comparison with hard switching.

Unit V Multilevel Inverters

Multilevel Inverters, Diode Clamped MLI, Flying Capacitor MLI, Cascaded H-Bridge topology: operation with equal and unequal DC voltages, Carrier modulation schemes of multilevel inverter, Applications of Power Electronic.

Course Materials

Required Text: Textbooks

1. Rashid M. H., "Power Electronics Circuits, Devices and Applications", Prentice Hall India, Third Edition, New Delhi, 2014.
2. Mohan, Undeland and Robins, "Power Electronics – Concepts, applications and Design, John Wiley and Sons, Third Edition, Singapore, 2007
3. B.W. Williams 'Power Electronics: Devices, Drivers, Applications and Passive Components, Tata McGraw Hill.

Optional Materials: Reference Books

1. L. Umanand, Power Electronics, Essentials and Applications, Wiley India Pvt. Ltd.
2. Philip T Krein, "Elements of Power Electronics", Oxford Press
3. B.K. Bose: Modern Power Electronics and AC Drives, Prentice Hall India Learning Private Limited, 2005.
4. Robert Erickson and Dragon Maksivimovic, Fundamentals of Power Electronics

Course Outcome:

Course Outcomes (COs) on completion of the course students will be able to:

1. Analyze rectifier circuits and their PWM schemes
2. Analyze power converter circuit and their design
3. Analyze power inverter circuit and their design
4. Analyze power cyclo-converter circuit.
5. Analyze multi-level inverter circuit.

Mapping of course outcomes with program outcomes

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

Digital Electronics & Embedded Systems

[5th Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Electrical Engineering	3-0-0, (3)	Program Elective	EL105202EL

[Pre-requisites: NIL]

Course Objectives

1. To acquire the basic knowledge of various logic families, digital logic circuit design, minimization techniques for logic circuit design implementation.
2. To understand the concept of combinational circuit and its applications in PLD, PLA,FPGA in engineering Application
3. To understand the concept of sequential circuit and its applications.
4. To developed the knowledge of embedded system, processors, and interfacing with theperipherals.

Course Content

Unit IBasics of digital circuits & Combinational circuits

Basic logic gates& logic families (TTL, MOS), Boolean Algebra, Boolean Minimization methods, Implementation of basic combination circuits and its application, Programmable logic devices

Unit II Sequential circuits

Sequential circuits: Introduction to Flip- Flops, Basics of Registers and counters and its Applications

Unit III Embedded Systems

Introduction to embedded systems, characteristics& Quality attributes, classification of Embedded processors, processor technology, Design process& matrices in Embedded system, IC technology, memory.

Unit IV Peripherals and interfacing

Peripherals and Interfacing: Adding Peripherals& interfacing, IO ports, Serial Peripheral& interfacing, communication interface basics, serial bus communication, Interfacing External ADC and DAC.

Course Materials

Required Text: Textbooks

1. R.P.Jain, “Modern Digital Electronics”, McGraw Hill Education
2. P. Leach, A. P. Malvino & Gautam Saha “Digital principle and Application”, McGraw Hill Education
3. Introduction to Embedded Systems, Shibu K V, Tata McGraw Hill Publishing, New Delhi 2017
4. Vahid, Frank and Givargis, Tony, "Embedded System Design - A Unified hardware/SoftwareIntroduction", John Wiley & Sons, (Asia) Pvt Ltd., Replika Press Pvt.

Optional Materials: Reference Books

1. S. Salivahanan, S. Arivazhagan, “Digital circuits and design”, OXFORD University press
2. Anand Kumar, “Fundamental of Digital circuits”, PHI publisher
3. Raj Kamal, “Embedded Systems: Architecture, Programming and Design”, Third Edition, McGraw Hill Education (India)
4. Neil H. E. Weste and K. Eshragian,” Principles of CMOS VLSI Design: A System Perspective,” 2nd edition, Pearson Education (Asia) Pvt. Ltd.

Course Outcomes:

CO1: To apply the basic knowledge of various logic families, and logic gates to build logic circuit and its applications in the design of complex digital circuit using combinational circuit.

CO2: To build knowledge of sequential logic circuits for processing and transmission of data for Engineering applications.

CO3: To impart the knowledge of embedded system and its processors for various applications

CO4: To apply knowledge of embedded system and its interfacing with the peripherals for advanced Engineering applications.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	3	3	3	2	2	1	1	1	2	1	2	3
CO 2	3	3	3	3	2	1	1	1	3	1	3	3
CO 3	3	3	3	2	3	1	1	1	3	1	2	3
CO 4	3	2	3	3	3	2	1	1	3	1	3	3

Introduction to AI & ML

[5th Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Electrical Engineering	3-0-0, (3)	Program Elective	EL105203EL

[Pre-requisites: NIL]

Course Objectives:

1. To intrduce the fundamentals of Artificial Intelligence and its applications.
2. To learn the basics of machine learning and its associated terminalogies.
3. To learn the length of artificial neral networks from its basics to variants of CNN.

Course Content

Unit-1 Fundamentals of Artificial Intelligence (AI)

Concepts of intelligence, knowledge and learning, Problem formulation, State space search, Heuristic search, Knowledge representation, Constraint satisfaction, Uncertainty in AI, Brief introduction to Fuzzy logic and Genetic Algorithms, Popular Applications of AI.

Unit-2 Introduction to Machine Learning

Basic definitions, Hypothesis space and inductive bias, Candidate elimination algorithms, Statistical learning, Evaluation, Cross-validation, Supervised learning, Unsupervised learning, Reinforcement learning, Regression, Classification, Clustering ,Association, Over fitting, Bias-Variance trade off, Regularization, Optimization, Activation functions.

Unit-3Machine Learning Algorithms

Linear Regression, Logistic Regression, K-Nearest Neighbour, Decision Trees, Support Vector Machine, NaïveBayes, Random forest, Gradient boosting, Clustering Techniques: K-Mean, Fuzzy C means and Hierarchical Clustering.

Unit-4 Neural Network and CNN

Introduction to Neural Networks, Biological Neuron model and extension to artificial Neuron models, McCulloch-Pitts model, Perceptron, Multi-layer perceptron, Feed forward network Back-propagation, introduction to deep neural network, Convolution Neural Network (CNN), layers in CNN, CNN models for Image recognition (Alexnet, VGG, Resnet, Inception Net etc.),

Course Materials Required Text: Text books

1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 3rd edition, Pearson Education,2015
2. Bishop, C. M. Neural Networks for Pattern Recognition Oxford University Press. 1995.
3. S. N. Sivanandam and S. N. Deepa, Principles of Soft Computing, Wiley India Pvt Ltd, 2011.
4. Tom M. Mitchell,Machine Learning, McGraw Hill Science Publication.

Optional Materials: Reference Books

1. Elaine Rich and Kelvin Knight, Artificial Intelligence, 3rd edition, Tata McGraw Hill, 2017.
2. Dan.W. Patterson, Introduction to AI and Expert Systems – PHI, 2007.
3. Bishop C., Pattern Reorganization and Machine Learning, Berlin Springer Verlag.
4. E. Alpaydin, Introduction to Machine Learning, Prentice Hall of India, 2006.

Course Outcomes

On successful completion of the course students will be able to:

1. Explain concepts and applications of Artificial Intelligence.
2. Illustrate fundamentals and types of machine learning.
3. Elucidate different supervised and unsupervised machine learning algorithms.
4. Analyze and explain working of artificial neural network .
5. Explain the concepts and working of Convolution Neural Network (CNN) and its well-knownarchitectures.

Mapping of COs and POs

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

Biomedical Instrumentation

[5th Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Electrical	3-0-0 (3)	PE	EL105204EL

[Pre-requisites: NIL]

Course Objectives

- Learning about usage of technology in healthcare.
- Study of various biomedical signals.
- Understanding the working of measurements for biomedical signals

Course Content

UNIT-I: INTRODUCTION

Physiological systems of human body: Neuronal, muscular, cardiovascular and respiratory systems, Source of bioelectric potential resting and action potential, propagation of action potential. Basics of Biomedical Instrumentation: Biometrics, basic design specifications of biomedical instrumentation system in terms of range, linearity, hysteresis, frequency response, accuracy, signal to noise ratio, stability insolation simplicity.

UNIT-II: BIOELECTRIC SIGNAL

Bioelectric signals, Microelectrodes, skin surface electrode, needle electrode, electrodes and lead systems for EEG, ECG, EMG. Transducer for biomedical applications, factors governing the selection of transducer, pressure, temperature, flow, biomedical ultrasonic transducer.

UNIT-III: MEASURING INSTRUMENTS

Blood pressure, blood flow, cardiac output, cardiac rate and heart sound measurements, electrocardiograph, phonocardiograph, plethysmograph, echoctrocardiograph, respiratory system measurements, instrumentation for clinical laboratory, measurement of electrical activity in neuromuscular system and brain.

UNIT-IV: MEDICAL IMAGING

Medical imaging: X-ray imaging, Computer tomography (CT), Magnetic Resonance imaging, Ultrasound imaging.

UNIT-V: PATIENT MONITORING SYSTEMS

Patient care and monitoring systems, safety measures. Computer applications, biotelemetry, prosthetics and orthotics, assisting and therapeutic devices, Laser applications in medicine.

Course material

1. Joseph J. Carr and John M. Brown, *"Introduction to Biomedical Equipment Technology"*, 4th ed., Singapore: Pearson Education, Inc., (2001). (ISBN 81-7808- 327-2)

2. Cromwell L., Weibell F. J. and Pfeiffer E. A., *"Biomedical Instrumentation and Measurements"*, 2nd ed. Singapore: Pearson Education, Inc., (2003). (ISBN 812970028X)

Course Outcomes:

After the completion of the course the student will be able to:

1. The insight of instrumentation applications in medical field and this covers brief description about the human physiology and bioelectrical potentials.
2. The various bioelectric signals used for the bioelectrical potentials measurement.
3. The overview of other medical instruments and healthcare monitoring systems.
4. The various imaging systems.
5. Various monitoring systems and patient care.

Mapping of COs and POs

COs / POs	PO1	PQ2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	3	1		3		2		1	3	3
CO2	3	1	3	1		3		2		1	3	3
CO3	3	1	3	1		3		2		1	3	3
CO4	2	1	3	1		3		2		1	3	2
CO5	3	1	3	1		3		2		1	3	2

Electrical Engineering Materials

[5th Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Electrical	3-0-0, (3)	Program Elective	EL105205EL

[Pre-requisites: NIL]

Course Objectives

1. To learn in depth about electrical and magnetic properties of materials.
2. To study properties of conductor, semiconductor and dieectric materials. dielectric and semiconductor materials.
3. To introduce the optical properties of solids.

Course Content

Unit 1 Conducting materials

Review of energy bands, description of materials, drift velocity, collision time, mean free path, mobility, conductivity, relaxation time, factors affecting conductivity of materials, types of thermal conductivity, Wiedmann-Franz law, super conductivity, effect of magnetic field, properties and application of high conducting materials, properties and applications high resistive material.

Unit 2 Semiconductors

Review of Silicon and Germanium as semiconducting materials, Continuity Equation, P-N junction, Hall effect, mobility, Drift & Diffusion, Diffusion & Transition capacitances of P-N junction.

Unit 3 Dielectric materials

Behavior of dielectric materials in static electric field, Dipole moments, Polarization, Dielectric constant, Polarizability, Susceptibility, mechanisms of polarization, behavior in alternating field, dielectric loss, loss tangent, types of dielectric & insulating materials, electrostriction, Piezo - electricity, Properties and Applications of gaseous(H_2, N_2 ,SF_6 etc), liquid (transformer oil, capacitor oil, paints etc) and solid (fibrous, paper board, wood, plastic, mica, ceramic material, rubber etc.) insulators.

Unit 4 Magnetic materials

Permeability, Magnetic susceptibility, magnetic moment, Magnetization, Dipole moment, types of magnetic materials, Magnetostriction, eddy current & hysteresis losses, applications of silicon steel, soft and hard magnetic material.

Unit 5 Optical properties of solids

Photo emission, photo emission materials, electro luminescence junction diode, photo emitters, photo transistor, photo resistors, injunction lasers, solar cell, optical properties of semiconductor, application of photo sensitive materials (CRT, Tube light, photo panels).

Course Materials

Required Text: Textbooks

1. Electrical Engineering Materials: A.J. Dekker, PHI.
2. Millman & Halkias , “Millman's Electronic Devices & Circuits”, McGraw Hill Education; 4th edition, 2015.

Optional Materials: Reference Books

1. S.P Seth, “A Course In Electrical Engineering Materials”, Dhanpat Rai, 3rd edition, 2011.
2. Ben G Streetman & Sanjay K Banerjee, “Solid State Electronic Devices”, Pearson, Seventh Edition,2015.
3. Boylestad & Nashelsky, “Electronic Devices & Circuit Theory”, Pearson, Eleventh Edition, 2015.
4. Jaspreet Singh, “Semiconductor devices: Basic Principles”, John Wiley, First Edition, 2000.

Course Outcomes:

After the completion of the course the student will be able to:

1. Understand the types, properties and applications of various materials.

2. Select a particular type of material for an engineering design.

3. Analysis the behavior of various electrical engineering materials through the laws and theories.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1		2		1		1		3	2
CO2	3	1			1	1	2		1		3	2
CO3	2	1					1		1		3	2

Energy Conversion Systems

[5th Semester, Third Year]

Course Description Offered by Department	Credits	Status	Code
Electrical Engineering [Pre-requisites: NIL]	3-0-0, (3)	EPR	EL105301EL

Course Objectives

1. To understand the principles of solar PV systems and design solar PV systems.
2. To analyze the performance of wind and hydro energy conversion systems.
3. To explore the new and hybrid energy conversion systems.
4. To design, simulate and analyze various energy conversion systems

Course Content

Unit-1 Photo voltaic power generation

Introduction, spectral distribution of energy in solar radiation, solar cell configurations, voltage developed by solar cell, photo and load current, practical solar cell performance.

Unit-2 Wind Energy Conversion System

Power from wind, classification of wind power plant, types of wind turbines, operating characteristics, wind energy generation system, recent advancements.

Unit-3 Hydro Electric power Generation

Hydropower history, Hydrology, hydrographs, flow duration curve, mass curve, types of dam, principle of working of a hydroelectric plant, types of turbine and their characteristics, characteristics of generators, Pumped storage hydropower.

Unit-4 New energy conversion systems

Fuel cell: principle, advantages, disadvantages and applications. Biomass and bio-energy: biomass conversion, combustion of biomass, advantages and disadvantages, applications.
Hybrid Energy Systems: Design, simulation and Analysis

Course Materials Required Text: Text books

1. Energy Conversion Systems, Begamudre R.D, New Age
2. Solar PV and Wind Energy Conversion Systems, Sumathi, S., Kumar, AshokL., Surekha, P., Springer

Optional Materials: Reference Books

1. Renewable energy conversion systems, Muhammad Kamran Muhammad Fazal, Elsevier
2. Power Conversion of Renewable Energy Systems, Ewald F. Fuchs and Mohammad A.S. Masoum, Springer

Course Outcomes:

On successful completion of the course the students will be able to:

1. Understand and illustrate the principle of working of solar PV system and its operation.
2. Interpret the concepts of Energy cycle of the earth & renewable energy sources.
3. Analyze the operation of Fuel Cell, Biomass, Biogas etc. and Develop Hybrid energy systems
4. Understand, Analyze and Design Solar PV, Wind energy systems and Hydro power plants.

Mapping of course outcomes with program outcomes

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

Instrumentation & Control

[5th Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Electrical Engineering	3-0-0 (3)	Open Elective	EL105302EL

[Pre-requisites: Basic Electrical Engineering (EL101022EL)]

Course Objectives

1. To understand the instruments and their working principles for measurement of displacement, temperature, pressure, level, flow and speed.
2. To introduce data acquisition of industrial parameters and their control.
3. To understand the modelling of continuous time systems.
4. To understand the concept of stability in control system.

Course Content

Unit-1 Introduction to Transducers

Introduction, Types of Transducers, Selection of transducers, Basic concept of pressure measurement, flow measurement, level measurement, displacement measurement, temperature measurement using transducers, Encoder type digital transducers.

Unit-2 Data Acquisition Systems

Data Acquisition Systems, Signal conditioning and telemetry, Use of signal conditioners, scanners, signal converters, recorders, display devices, A/D & D/A circuits in digital data acquisition, Analog and Digital Recording system and their usage, basic concepts of smart sensors and application.

Unit-3 Introduction to system analysis and control system: Introduction, open and closed-loop control, Transfer function, Mathematical modelling of various physical systems, e.g., electrical, mechanical, hydraulic, pneumatic, thermal, etc., feedback and feed-forward control systems. Steady-state and transient analysis of first and second order systems, frequency response

Unit-4 Stability Analysis and Controller Design: Stability: concept, necessary conditions, Routh-Hurwitz stability criterion, relative stability analysis, Types of feedback control system, Proportional Integral and derivative control, PID controller, Design specifications and considerations of second-order systems, Performance indices

Course Materials

Required Text: Textbooks

1. D. S. Kumar, Measurement Systems: Applications & Design, McGraw Hill Publications.
2. S. K. Singh, Industrial Instrumentation & Control, Tata McGraw Hill Publication.
3. A. K. Sawhney, Electrical and Electronics Measurement and Instrumentation, Dhanpat Rai & Sons' publications.
4. Benjamin.C.Kuo, "Automatic Control Systems", Prentice Hall of India, 7th Edition, 1995.

Optional Materials: Reference Books

1. E.O. Doebelin, Measurement Systems Application and Design, Tata McGraw Hill Publication.
2. D Patranabis, Principles of Industrial Instrumentation, 3rd edition, Mc Graw Hill Publication.
3. R. K. Jain, Mechanical & Industrial Measurements, Khanna Publications.
4. Ogata. K, "Modern Control Engineering", Prentice Hall of India, 5th Edition, 2010
5. J.Nagrath and M.Gopal," Control System Engineering", New Age International Publishers, 5th Edition, 2007

Course Outcomes

On completion of the course students will be able to:

1. Choose a proper transducer based on their characteristics for measurement of different parameters.
2. Apply knowledge of data acquisition to perform PC based measurements.
3. Analyze and model continuous systems in time and frequency domain.

4. Apply fundamental principles of closed loop system and appreciate the use of feedback to improve System performance.

Mapping and Correlation of COs with POs

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

Digital System Design

[5th Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Electrical Engineering	3-0-0, (3)	Program Elective	EL105303EL

[Pre-requisites: NIL]

Course Objectives

- Learning about the concepts of digital systems
- Study about the VHDL and Verilog programming techniques for digital system
- Apply VHDL and Verilog programming for practical application.

Course Content

Unit 1 Digital and Analog Quantities
Number Representations, Fixed- and Floating-Point Representations, Arithmetic Operations on Binary Numbers in VHDL systems, Data Types in Verilog and VHDL
.

Unit 2 Logic Gates
Verilog and VHDL Fundamentals, VHDL and Verilog programming for Inverter, AND Gate, OR Gate, NAND Gate, NOR Gate, The Exclusive-OR and Exclusive-NOR Gates, NAND Gate

Unit 3 Combinational Logic Analysis
VHDL and Verilog programming for Basic Combinational Logic Circuits, VHDL and Verilog programming for Adders, Comparators, decoder, encoder, multiplexer, demultiplexer.

Unit 4 Practical applications of VHDL and Verilog programming
Home Alarm System;Digital Safe System;Car Park Occupied Slot Counting System, Programming using EDA.

Course Materials Required

Text: Textbooks

1. John M. Yarbrough, Digital Logic Applications and Design, Cengage Learning 2011.
2. M. Morris Mano and Charles Kime, Logic and computer design Fundamentals, Pearson Learning 4thEdition, 2014.
3. Charles H Roth, Jr. and Larry L. Kinney, Fundamentals of logic design, Cengage Learning 7th Edition,2015.
4. A. Anand Kumar, Fundamentals of Digital Circuits, PHI, 4th Edition, 2016.

Optional Materials: Reference Books

1. Donald D. Givone, Digital Principles and Design, McGraw Hill Education 1st Edition, 2017.
2. K. A. Navas, Electronics Lab Manual, Volume II, PHI, 6th Edition, 2018.
3. Volnei A. Pedroni, Circuit Design and Simulation with VHDL, PHI 2nd Edition.

On completion of this course, the students will be able to:

1. Understand about the concept of digital number system.
2. Verilog and VHDL programming for basic logic Gates.
3. Verilog and VHDL programming for combinational circuits
4. Verilog and VHDL programming for practical example.

Mapping of COs and POS

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	Po12
CO1	1	1	3	3	1	-	-	-	-	-	2	1
CO2	2	2	3	2	1	-	-	-	-	-	3	1
CO3	3	3	3	3	2	-	-	-	-	-	3	1
CO4	3	2	3	3	2	-	-	-	-	-	3	1

Advanced Semiconductor Devices

[5th Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Electrical	3-0-0, (3)	OE	EL105304EL

[Pre-requisites: NIL]

Course Objectives

1. To make students aware of the knowledge of different semiconductor switches
2. To impart the understanding operations of power semiconductor switches
3. To enhance the ability of switch selection

Course Content

Unit 1 Introduction

Power switching devices overview – Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability – (SOA); Device selection strategy – On-state and switching losses – EMI due to switching, Emerging Power Devices: Basics of GTO, MCT, FCT, RCT and IGCT. Smart power devices, Intelligent Power Modules. Silicon Carbide Devices.

Unit 2 Power diodes

Structure, operating principle, switching characteristics, types, forward and reverse characteristics, Safe Operating Area (SOA), Basic Structure and I-V Characteristics, Breakdown Voltages and Control, On State Losses, Switching Characteristics . Turn on Transient, Turn off Transient, Reverse Recovery Transient, Schottky Diodes, Snubber Requirements for Diodes and Diode Snubber's.

Unit 3 Power Transistors

Construction, static characteristics, physics of operation, switching characteristics; Negative temperature co-efficient and secondary breakdown – Power Darlington- Safe operating regions. dynamic models of BJT, Basic Structure and I-V Characteristics . Breakdown Voltages and Control .Second Breakdown and its Control- FBSOA and RBSOA Curves - On State Losses . Switching Characteristics . Resistive Switching Specifications . Clamped Inductive Switching Specifications .

Unit 4 Power Thyristors

Physics of operation, Two transistor analogy – concept of latching; Gate and switching characteristics; converter grade and inverter grade and other types; series and parallel operation– comparison of BJT and Thyristor – steady state and dynamic models of Thyristor.

Unit 5 Power MOSFETs and IGBTs

Principle of voltage controlled devices, construction, types, static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs. New power semiconductor devices . Thermal design of power electronic equipment .Mode ling of power semiconductors (principles) . Simulation tools.

Course Materials

Required Text: Text books

1. Ned Mohan, Tore M. Undeland, “Power Electronics – Converters, Applications and Design”, John Wiley & Sons, 2008.
2. Rashid M.H., "Power Electronics: Circuits, Devices and Applications ", Pearson Education, June 2014.
3. G. Massabrio, P. Antognetti,” Semiconductor Device Modeling with Spice”, McGraw-Hill Education.,2010.

Optional Materials: Reference Books

1. Robert Perret, “Power Electronics Semiconductor Devices”, John Wiley & Sons,2010.
2. Joseph Vithayathil, “Power Electronics Principles and Applications”, McGraw-Hill Education, 2017.
3. B. J. Baliga, “Fundamentals of Power Semiconductor Devices”, Springer, Second Edition 2019.
4. V. Benda, J. Gowar, D. A. Grant, “ Power Semiconductor Devices. Theory and Applications”, John Wiley & Sons.

Course Outcomes: After the completion of the course the student will be able to

1. Recall knowledge of various applications of semiconductor switches by understanding their static and dynamic characteristics and various protections.
2. Experiment with the significance of advanced switches on device stress and EMI.
3. Categorise the performance characteristics of semiconductor switches for different applications.
4. Design different applications of converters with the help of advanced semiconductor devices.

Mapping of COs and POs

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

Design and Integration of Optical Sensors in Mechatronic Systems

Course Description
Offered by Department Credits: 3-0-0(3) Status: Open Elective Code:EL105305EL
Electrical Engineering

Course Objectives:

1. To provide the students a broad understanding of the fundamentals of lasers: their unique properties, their operations, and their applications.
2. To equip the students with how a coherent light is generated and amplified.
3. To provide the students an understanding of different lasers' design and their applications.
4. To provide the students with a fundamental understanding of optical sensor systems' operation and principal components.
5. To provide the students with the basic knowledge of the Opto-mechatronics design process and real-time applications.

Course content

UNIT-I

(A) Science of light – evolution, ray/wave optics; Laser fundamentals Introduction; Importance: why laser? unique properties of lasers; Brief history of laser development; Laser basics

(B) Concept of stimulated emission; Population inversion; Amplification of stimulated emission; Laser instrumentation fundamentals: Cavity, resonator and pumping processes; Gain medium; Coherent radiation, standing waves, and modes; The kinetics of laser emission; Rate equations; Threshold conditions;

UNIT-II

(A) Pulsed and continuous-wave laser emission; Various pulsing techniques: cavity dumping, Q-switching and mode-locking, Transitions, lifetimes and linewidths: Three-level laser, Four-level laser, emission linewidth; Properties of laser light: monochromaticity, spatial and temporal coherence, intensity, beam-width.

(B) Laser sources; different types of lasers; Laser instrumentation details; Introduction to Semiconductor lasers; Semiconductor junction characteristics; Semiconductor light sources; Semiconductor light detectors.

UNIT-III

Historical Background of Opto-Mechatronic Technology; Understanding Opto-Mechatronic Systems: Definition and Basic Concept; Introduction to Optical Sensors: Building Blocks of an optical sensor system; Basic Roles of Optical Elements: Types of Opto-Mechatronic Systems; Fundamental Functions of Opto-Mechatronic Systems; Elements of Opto-Mechatronic Technology; Synergistic Effects of Opto-Mechatronic Systems.

UNIT-IV

Traditional vs. Opto-Mechatronic Designs; Opto-Mechatronic Design Process; Identification of Need and Design Specifications: Concept Generation, Detail Development and Evaluation. Optical transducers and controllers used in opto-mechatronic systems

UNIT-V

Case Studies: Environemental Gas Monitoring; Distributed Optical-Fiber Sensing, Biological-Based Optical Sensors and Transducers; Optical transducers in Material Processing; Welding process with optical information feedback

Course Materials

Text Books/Reference Books:

1. E. Hecht and A. R. Ganesan, "Optics", Pearson Education., 5th Edition, 2019.
2. N.Subrahmaniyam, Brij Lal and M.N. Avadhanulu, "A Text Book of Optics", S Chand and Company Ltd., 25th Rev. Edition., 2012 .
3. B. E. A. Saleh and M. C. Teich, “Fundamentals of photonics”, New York: Wiley., 3rd Edition 2019.
4. H. Cho, "Opto-Mechatronics Systems Handbook- Techniques and Applications", CRC Press LLC, 2003.

Course Outcomes (COs)

On completion of this course, the students will be able to:

1. Identify the essential components of a laser system for generating lasing action.
2. Categorize various laser sources based on the properties of the system.
3. Analyze the operation of various components associated with an opto-mechatronic system.
4. Analyze the optical transducers and controllers used in opto-mechatronic systems
5. Design optical transducers related to real-time applications.

Mapping of COs and POs

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

Control System Engineering Laboratory

[5th Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Electrical Engineering	0-0-2 (1)	Lab	EL105401EL

[Pre-requisites: Mathematics-I (MA101001MA), Basic Electrical Engineering (EL101022EL)]

Course Objectives

Making the students

- Acquire the skills for analyzing dynamic systems in time and frequency domain
- Appreciate the importance of feedback in improving system response.

List of Experiments

1. To study time response of linear system simulator.
2. Study of the transient and frequency response of second order network.
3. Study of the operation of Synchro Transmitter and Synchro Receiver.
4. To study the digital control of a system using 8-bit microprocessor. Examine the effect on response of system for (a) Time delay (b) Variation in the parameter of PID controller.
5. Study of lead-lag network.
6. Study of the characteristics of magnetic amplifier for series connection.
7. To obtain the transfer function of a second order system (RLC Circuit) using frequency response experimental data.
8. To study the characteristics of a AC servomotor and determine its transfer function.
9. Analyze the effect of different controlling actions (P, PI and PID) on the time response of a closed loop position control of DC Servomotor in both analog and digital mode.
10. Controller design and analysis for a multiple input multiple output system.

Required Text: Text books

(1) Benjamin.C.Kuo, "Automatic Control Systems", Prentice Hall of India, 7th Edition, 1995.
(2) Ogata. K, "Modern Control Engineering", Prentice Hall of India, 5th Edition, 2010
(3) J.Nagrath and M.Gopal," Control System Engineering", New Age International Publishers, 5th Edition, 2007

Course Outcomes (CO)

1. Analyse continuous systems experimentally in both time and frequency domains.
2. Apply fundamental principles of closed loop system and appreciate the use of feedback to improve system performance.
3. Interpret the system characteristics from the time and frequency response data.
4. Design controllers to improve the performance of analog and digital systems.
5. Infer knowledge to develop the lifelong learning process.

Mapping and Correlation of COs with POs

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

Electrical Machine-2 Laboratory

[5th Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Electrical Engineering	0-0-2, (1)	Laboratory	EL105402EL

[Pre-requisites: Basic Electrical Engineering EL10I022EL, Electrical Machine –I EL104102EL]

Course Outcomes (COs)

On completion of this course, the students will be able to:

1) Demonstrate and analyze the steps involved in various testingmethods ofthree-phaseinduction motor and three-phase alternator.
2) Familiarization with the steps involved in various testingmethods ofthree-phase alternator.
3) Examine the steps involved in the synchronization of alternators with infinite bus.
4) Examine the working of starters for three-phase induction motor.
5) Demonstrate and analyze the steps involved in the operation of converter-fed AC drives.

List of Experiments

1. To perform open circuit & short circuit test on 3-ø alternator to calculate voltage regulation.
2. To perform ZPF (zero power factor) test on 3-ø alternator to calculate voltage regulation.
3. To perform no load and blocked rotor test on 3-phase induction motor to calculate equivalent circuit parameters using circle diagram.
4. To calculate the slip of three phase slip ring induction motor.
5. To plot V curve and inverted V curve of a 3-ø synchronous motor.
6. To perform single phasing on 3-ø induction motor.
7. To study the synchronization of alternators with infinite bus.
8. To perform load test on 3-ø alternator to calculate voltage regulation and efficiency.
9. To study AC machines with the help of Cut-view model or Dismantled Motor.
10. To Study various starters and provide connection to 3- phase Induction motor.
11. To perform load test on Slip Ring Induction Motor.
12. To perform the speed control of single-phase induction motor using single-phase step down cycloconverter.
13. To perform the speed control and braking of three phase induction motor.

Mapping of course outcomes with program outcomes

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