DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

LIST OF COURSES OFFERED FOR MINOR PROGRAM (R23)

Course Code	Course Title	Contact hours/week			Credits
		L	T	P	
23EEM1	Linear Control System	3	0	0	3
23EEM2	Fundamentals of Power Electronics	3	0	0	3
23EEM3	Elements of Electrical Power Systems	3	0	0	3
23EEM4	Renewable energy systems	3	0	0	3
23EEM5	Basics of Electric Drives and Applications	3	0	0	3
23EEM6	Fundamentals of Electrical Measurements and Instrumentation	3	0	0	3
23EEM7	Linear Control System Lab	0	0	3	1.5
23EEM8	Fundamentals of Power Electronics Lab	0	0	3	1.5

L	T	P	Cr.
3	0	0	3

B.Tech. (Minor)

23EEM1-Linear Control System

Pre Requisite: None

Course Educational Objective: The objective of this course is to introduce to the students the principles and applications of control systems in everyday life. It deals with the basic concepts of block diagram reduction, time domain analysis solutions to time invariant systems the different aspects of stability analysis of systems in frequency domain and time domain.

Course Outcomes: At the end of the course, the students will be able to:

CO1. Develop mathematical model of linear time invariant systems. **(Apply-L3)**
CO2. Understand various controllers and compensators **(Understand-L2)**
CO3. Analyze linear time invariant systems in Time domain **(Apply-L3)**
CO4. Analyze time invariant systems in Frequency domain **(Apply-L3)**
CO5. Apply state space analysis concepts for deriving state models and understand the concept of controllability and observability **(Apply-L3)**

UNIT – I: INTRODUCTION-MATHEMATICAL MODELLING OF CONTROL SYSTEM

Concepts of Control Systems- Classification of control systems, Open Loop and closed loop control systems - Different examples of control systems.

Mathematical models – Mechanical Translational and Rotational systems, Electrical systems, Block diagram representation of systems -Block diagram algebra, Signal flow graph - Reduction using Mason's gain formula.

UNIT – II: TIME RESPONSE ANALYSIS-I

Standard test signals, Time response of second order systems, Time domain specifications, Steady state errors and error constants.

UNIT – III: TIME RESPONSE ANALYSIS-II

The concept of stability – R-H stability criterion, The root locus concept - construction of root loci, Introduction to PI, PD and PID controllers

UNIT – IV: FREQUENCY RESPONSE ANALYSIS

Introduction, Frequency domain specifications, Bode diagrams, Stability Analysis from Bode Plots, Nyquist Plot - Nyquist stability criterion, Introduction to Lag, Lead, Lag-Lead compensators

UNIT – V: STATE SPACE ANALYSIS OF CONTINUOUS SYSTEMS

Concepts of state, state variables and state model, Canonical state space models-Controllable, Observable and Diagonal canonical forms, solving the Time invariant state Equations- State Transition Matrix and it's Properties – Concepts of Controllability and Observability.

TEXT BOOKS:

1. B. C. Kuo , "Automatic Control Systems" , John wiley and sons ,9th edition, 2014
2. I. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International (P) Limited, 6th edition , 2017

REFERENCE:

1. Katsuhiko Ogata , "Modern Control Engineering", Prentice Hall of India Pvt. Ltd., 3rd edition,1998.
2. Norman S. Nise, "Control Systems Engineering" , John Wiley, New Delhi, 6th edition, 2012
3. Richard C Dorf and Robert H Bishop, "Modern control systems" , Prentice Hall Pearson education, Inc.) New Delhi, 12th edition, 2003.

L	T	P	Cr.
3	0	0	3

B.Tech. (Minor) **23EEM2-Fundamentals of Power Electronics**

Prerequisite: Applied Physics, Basic Electric and Electronics Engineering

Course Educational Objective: This course deals with the basic theory of power semiconductor devices and their characteristics. It also deals with operating principles of rectifiers, AC voltage controllers, DC to DC converters and inverters.

Course Outcomes: At the end of the course, the student will be able to:

CO1: Understand the operation of various power semiconductor devices. **(Understand-L2)**

CO2: Analyze the performance of rectifiers with and without filters. **(Apply-L3)**

CO3: Understand the operation of ac voltage controller with different loads. **(Understand-L2)**

CO4: Analyze the performance of various dc-dc converter topologies **(Apply-L3)**

CO5: Analyze the performance of inverters with different modulation techniques. **(Apply-L3)**

UNIT – I: POWER SEMI-CONDUCTOR DEVICES

Basic symbol, operation and characteristics of different power semiconductor devices - BJT, MOSFET, IGBT, SCR, GTO, DIAC and TRIAC.

UNIT – II: RECTIFIERS AND FILTERS

Half wave rectifier, Full wave rectifier, Bridge rectifier, Ripple factor Harmonic components in a rectifier circuit, Inductor filter, Capacitor filter, L- section filter, π- section filter, Multiple L section and Multiple π section filter, and comparison of various filter circuits in terms of ripple factors, basics of regulators. single-phase Controlled rectifier with R and RL loads.

UNIT – III: AC VOLTAGE CONTROLLERS

AC voltage controllers–single phase ac voltage controller with R and RL loads for both half wave and full wave– continuous and discontinuous modes

UNIT – IV: DC TO DC CONVERTERS

Principle of operation-Control Strategies, Step-up and step-down chopper–Chopper classification-class A, B, C, D, E

UNIT – V: INVERTERS

Single phase inverter–Voltage Source Inverter (VSI)-Current source inverters (CSI) - Comparison between VSI and CSI- Single Pulse Width Modulation, Multiple Pulse Width Modulation, Sinusoidal Pulse Width Modulation.

TEXT BOOKS:

1. Md.H.Rashid “Power Electronics:Circuits, Devices and Applications”, Pearson Education fourth Edition, first Indian Reprint- 2014.

2. Dr.P.S. Bhimbra, “Power Electronics”, Khanna Publishers, 5th Edition, 2012.

REFERENCE:

1. Ned Mohan, T.M. Undeland and William P.Robbins, “Power Electronic ConvertersApplications”, John Wiley & Sons, 3rd Edition, , 2009

2. M D Singh, K B Khanchandani “Power Electronics”, Tata MC Graw Hill publishers,2nd edition 2008.

B.Tech. (Minor)	23EEM3-Elements of Electrical Power System	L	T	P	Cr.
		3	0	0	3

Prerequisite: Applied Physics, Basic Electric and Electronics Engineering

Course Educational Objective: This course deals with generation, transmission, and utilization of electric power and allied accessories like generators, motors and transformers.

Course Outcomes: At the end of the course, the student will be able to:

CO1: Understand the basic concepts of electrical power engineering. **(Understand-L2)**

CO2: Develop a comprehensive working knowledge of the synchronous machines and transformer. **(Understand-L2)**

CO3: Identify various technologies available for electric power transmission and distribution. **(Understand-L2)**

CO4: Identify various utilization methods of electrical energy. **(Understand-L2)**

UNIT-1: INTRODUCTION

A brief history of electric power systems, the structure of the power system, concepts of power in alternating current systems-single line diagram of power Systems, Electromagnetism and Electromechanical Energy Conversion, sources of energy, comparison of energies, growth of power systems in India

UNIT -II: SYNCHRONOUS MACHINE& ELECTRIC POWER GENERATION

The Synchronous Machine: Preliminaries-synchronous machine fields-a simple equivalent circuit-steady-state characteristics-problems. Qualitative treatment of various power generation schemes-thermal, solar.

UNIT -III: ELECTRIC POWER TRANSMISSION

Transformer: introduction-operation-transformer connections. Electric transmission line parameters-line inductance-line capacitance-transmission line models-T&pi model, simple problems.

UNIT-IV: DISTRIBUTION OF ELECTRIC POWER

Introduction- Classification of distribution systems, characteristics of distribution systems, Elementary concepts of AC and DC power Distribution systems, voltage regulation and substation location.

UNIT -V: UTILIZATION OF ELECTRICAL ENERGY

Introduction to Illumination- Basic Terms- Laws of illumination-sources of light-illumination methods- discharge lamps- Mercury Vapour lamps. Electric Heating: Methods of Electrical Heating-Resistance heating- Dielectric heating- Advantages of electrical heating. Electric Welding Types – Electrical resistance welding- Arc Welding.

TEXT BOOKS

1. J.B.Gupta, “A course in Power Systems” ,S.Chand Publications,11 th Edition.2013.

2. V.K.Mehta, “Principles of Power Systems” ,S.Chand Publications,10 th Rev.Edn,2006

3. Wadhwa, C L, “Generation Distribution and Utilization of Electrical Energy” (multi colour edition), 4 th Edition, 2017.

REFERENCES

1. Mohamed E. El-Hawary, “Introduction to Electrical Power Systems”,John Wiley & Sons, Inc., Hoboken, New Jersey, 2008.

2. D.P.Kothari & I.J.Nagrath, “Power System Engineering”, Third Edition, Mc Graw-Hill ,3 rd Education, 2019

B.Tech. (Minor)	23EEM4-Renewable Energy System	L	T	P	Cr.
		3	0	0	3

Pre-requisites: Applied Physics, Applied Chemistry

Course Educational Objective: This course enables the student to understand and analyze various renewable energy technologies.

Course Outcomes: At the end of the course student will able to:

CO1: Understand the principles of renewable energy**. (Understand-L2)**

CO2: Analyze the basic physics of solar and wind power generation. **(Understand-L2)**

CO3: Appreciate the ecological context of bio-energy. **(Understand-L2)**

CO4: Evaluate the performance of fuel cells under different operating conditions for a given

application. **(Understand-L2)**

UNIT–I: PRINCIPLES OF RENEWABLE ENERGY

Introduction, energy and sustainable development, fundamentals, scientific principles of renewable energy, technical implications.

UNIT–II: THE SOLAR RESOURCE

Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability. Solar Photovoltaic Technologies- Amorphous, mono-crystalline, polycrystalline; Solar Thermal Power Generation: Technologies-elementary analysis.

UNIT–III: PHYSICS OF WIND POWER

History of wind power, Wind physics, Betz limit ratio, stall and pitch control, Wind Generator Topologies: Review of modern wind turbine technologies, Fixed and Variable speed wind turbine, Induction Generators, Doubly-Fed Induction Generators and their characteristics.

UNIT-IV: INTRODUCTION TO BIOMASS

Photosynthesis: a key process for life on Earth - Trophic level photosynthesis - Relation of photosynthesis to other plant processes - Photosynthesis at the cellular and molecular level, Biomass production for energy - Wood resource - Crop yield and improvement –Plant physiology and biomass - Bioengineered photosynthesis - Artificial photosynthesis. Social and environmental aspects: Bio-energy in relation to agriculture and forestry

UNIT-V: INTRODUCTION TO FUEL CELLS

History, Working principle of fuel cells, Fuel cell thermodynamics, fuel cell electrochemistry - Nernst equation, Electrochemical kinetics, Butler-Voltmeter equation, performance evaluation of fuel cells, Types of Fuel Cells: AFC, PAFC, SOFC, MCFC, DMFC, relative merits and demerits. Future trends in fuel cells.

TEXT BOOKS:

1. G. M. Masters, "Renewable and Efficient Electric Power Systems", John Wiley and Sons, 2004.

2. John Twidell, Tony Weir "Renewable Energy Resources", Routledge publishers, third edition 2015.

REFERENCE:

1. S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill, 2008.

B.Tech. (Minor) **23EEM5-Basics of Electric Drives and Applications**

L	T	P	Cr.
3	0	0	3

Electrical Machines, Control Systems and Fundamentals of Power Electronics.

Course Educational Objectives: This course enables the student to learn the fundamentals of electric drive and different electric braking methods. It also covers the controlling of dc motors, induction motors and synchronous motors using various converters.

Course Outcomes: At the end of the course, student will able to:

CO1: Understand the fundamentals of electric drive. **(Understand-L2)**

CO2: Analyze the operation of 1-phase converter fed dc motor drive **(Understand-L2)**

CO3: Analyze the operation of dc-dc converter fed dc motor drive **(Understand-L2)**

CO4: Understand the speed control of 3—phase induction motor by using various methods **(Understand-L2)**

CO5: Understand the operation of synchronous motor drives. **(Understand-L2)**

UNIT – 1: Fundamentals of Electric Drives

Electric drive and its components– Fundamental torque equation – Load torque components – Classification of load torques –Load equalization– Four quadrant operation of drive (hoist control).

UNIT – 2: Controlled Converter Fed DC Motor Drives

1-phase half and fully-controlled converter fed separately and self-excited DC motor drive – Output voltage and current waveforms and their expressions – Speed-torque characteristics.

UNIT – 3: DC–DC Converters Fed DC Motor Drives

Single quadrant – Two quadrant and four quadrant DC-DC converter fed separately excited and self-excited DC motors – Continuous current operation -Output voltage and current waveforms – Speed–torque characteristics.

UNIT – 4: Control of 3-phase Induction motor Drives

Stator voltage control using 3-phase AC voltage regulators – Waveforms –Speed torque characteristics– Variable Voltage Variable Frequency control. Static rotor resistance control– Static Scherbius drive – Static Kramer drive – Performance and speed torque characteristics.

UNIT – 5:Control of Synchronous Motor Drives

Separate control of synchronous motor – self-control of synchronous motor employing load commutated thyristor inverter - closed loop control of synchronous motor drive (qualitative treatment only).

Text Books:

1. Fundamentals of Electric Drives, G. K. Dubey, Narosa Publications, 2002.
2. Power Semiconductor Drives, S.B.Dewan,G.R.Slemon, A.Straughen, WileyIndia, 2009.

Reference Books:

1. Electric Motors and Drives Fundamentals- Types and Apllications - by Austin Hughes and Bill Drury - Newnes.4th edition - 2013.
2. Thyristor Control of Electric drives – Vedam Subramanyam Tata McGraw Hill Publications-1987.
3. Power Electronic Circuits- Devices and applications by M.H.Rashid - PHI - 3rd edition -2009.
4. Power Electronics handbook by Muhammad H.Rashid- Elsevier - 2nd edition - 2010.

Online Learning Resources:

1. https://archive.nptel.ac.in/courses/108/104/108104140
2. https://nptel.ac.in/courses/108104011

B.Tech. (Minor)	23EEM6-Fundamentals of Electrical Measurements and Instrumentation	L	T	P	Cr.
		3	0	0	3

Pre-requisite: Basics of Electrical and Electronics Engineering.

Course Educational Objectives: This course enables the student to learn the working principles of various analog measuring instruments, power, energy and parameter measurements, transducers and digital meters and their functionalities.

Course Outcomes: At the end of the course student will able to:

CO1: Identify the appropriate instrument for the measurement of AC and DC voltage and current. **(Understand-L2)**

CO2: Analyse the operation of wattmeters and energy meters. **(Understand-L2)**

CO3: Differentiate between the operations of AC and DC bridges. **(Understand-L2)**

CO4: Understand the working principles of various transducers. **(Understand-L2)**

CO5: Understand the working principles of digital meters. **(Understand-L2)**

UNIT – I: Fundamentals of Analog Measurement

Analog Ammeter and Voltmeter: Classification of instruments – Deflecting, controlling, and damping torques. Types of Instruments: PMMC and Moving Iron type – Construction, working principle, advantages, and disadvantages. Applications and simple numerical problems.

UNIT – II: Measurement of Power and Energy

Analog Wattmeter: Electrodynamometer type wattmeters – Low Power Factor (LPF) and Unity Power Factor (UPF) designs, advantages, and disadvantages. Energy Meters: Induction type Energy Meter – Construction and working principle Simple numerical problems.

UNIT – III: Measurement of Electrical Parameters

DC Bridges: Measurement of resistance – Low (Kelvin's double bridge), medium (Wheatstone bridge), and high resistance (Loss of charge method).

AC Bridges: Measurement of inductance (Maxwell's Bridge) and capacitance (Schering Bridge), Numerical problems.

UNIT – IV: Transducers and Sensors

Classification of Transducers: Basics and applications. Resistive: Strain Gauge. Inductive: Linear Variable Differential Transformer (LVDT). Capacitive: Piezoelectric – Applications

UNIT – V: Introduction to Digital Measurement

Digital Instruments: Digital Voltmeters (Successive approximation type),Digital Frequency Meters and Multimeters, Digital Tachometers and Energy Meters, – Overview and applications.

Text Books:

1. Electrical & Electronic Measurement & Instruments by A.K.Sawhney, DhanpatRai & Co. Publications – 19th revised edition - 2011.
2. Electronic Instrumentation by H.S.Kalsi - THM.

Reference Books:

1. Electrical Measurements and measuring Instruments by E.W. Golding and F.C.Widdis - 5 th Edition - Wheeler Publishing.
2. Modern Electronic Instrumentation and Measurement Techniques by A.D. Helfrick and W.D. Cooper - PHI - 5th Edition - 2002.
3. Electrical and Electronic Measurements and instrumentation by R.K.Rajput - S.Chand -

3rdedition.

Online Learning Resources:

1. https://archive.nptel.ac.in/courses/108/105/108105153

B.Tech. (Minor)	23EEM7-Linear Control System Lab	L	T	P	Cr.
		0	0	3	1.5

Course Educational Objective: This laboratory course enables the student to implement the mathematical techniques used in linear control systems to solve real world problems through experimentation and simulation tools.

Course Outcomes: At the end of the course, the student will be able to:

CO1. Simulate the physical control system for stability studies **(Apply-L3)**

CO2. Demonstrate feedback controllers **(Understand-L2)**

CO3. Develop logic gates using PLC **(Apply-L3)**

CO4: Analyze the stability, controllability and observability using simulation tools **(Apply-L3)**

LIST OF EXPERIMENTS

1. Modeling of Physical Systems (Mechanical and Electrical systems).

2. Block Diagram Reduction of Linear Systems

3. Time response analysis of Linear Systems for impulse and step inputs

4. Frequency response analysis of Linear Systems

5. Stability and relative stability analysis of Linear Systems Using (Root Locus, Bode and Nyquist plot).

6. Time Response analysis of Second Order System.

7. Study the effect of PD, PI, PID controllers on second order systems.

8. Magnitude and phase plot of Lag and lead compensators.

9. Determination of transfer function and effect of feedback on DC servo motor.

10. Study of logic gates using PLC

Additional Experiments

11. Design of Lag and Lead Compensators for a given system

12. Study the effect of P, PD, PI, PID controllers on Temperature control system

using PLC.

L	T	P	Cr.
0	0	3	1.5

B.Tech. (Minor) **23EEM8-Fundamentals of Power Electronics Lab**

Prerequisite: Applied Physics, Basic Electric and Electronics Engineering

Course Educational Objective: This course enables the student to provide practical exposure to converter circuits, hardware modules and Software tools to simulate various power electronic converter.

Course Outcomes: At the end of the course, the student will be able to:

CO1: Examine the characteristics of Power electronic devices **(Understand-L2)**

CO2: Analyze the performance of different power electronic converters using trainer kits. **(Apply-L3)**

CO3: Evaluate the performance of different power converters using simulation tools **(Apply-L3)**

List of Experiments

1. Characteristics of SCR, BJT, MOSFET and IGBT
2. Performance of 1-phase Full bridge rectifier with R and RL loads
3. Performance of Single-phase ac voltage controller with R and RL loads
4. Performance of Single-phase inverter with R and RL loads
5. Performance of Step-down dc chopper with R and RL loads
6. Performance of Step-up dc chopper with R and RL loads
7. Performance of 1-phase half wave rectifier with and without filter using simulation tools
8. Performance of 1-phase full wave mid-point type rectifier with R and RL loads using simulation tools
9. Performance of 1-phase half wave ac voltage controller with R and RL loads using simulation tools
10. Performance of Step-up dc chopper with R and RL loads with R and RL loads using simulation tools