IPS Academy

INSTITUTE OF ENGINEERING & SCIENCE

(A UGC Autonomous Institute affiliated to RGPV)

Electrical and Electronics Engineering Department

Minor degree certification course in Power Electronics

S. No.	Course Code	Sem	Course Title	Hrs./ week			Credits
				L	T	P	
1		V	Electrical Circuit Analysis	3	0	2	4
2		VI	Electrical Machine	3	0	2	4
3		VII	Power Electronics	3	0	0	3
4		VIII	Electrical Drives	3	0	2	4
Total credits				12	0	6	15

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Electrical and Electronics Engineering Department

	Electrical Circuit Analysis	**3L: 0T : 2P (5 hrs.)**	**4 Credits**

Course Objective:-

Objective of this course is to introduce the students the analysis of Electric circuits using different types of theorem, the steady state and transient behavior, concept of different techniques such as Laplace transform, Fourier series/ transform and two port network.

Pre Requisite:-

Should have basic knowledge of Ordinary differential equations,Matrix,Laplace and Fourier Series & transform.

Module 1 (11 hrs.)

Review of circuit elements R,L,C and voltage & current sources controlled & uncontrolled sources KCL and KVL analysis, Nodal & mesh analysis, Network Theorems for AC & DC circuits- Thevenins & Norton's, Superpositions, Reciprocity, Compensation, Substitution, Maximum power transfer, and Millman's theorem, Tellegen's theorem, problems with dependent & independent sources.

Module 2(08 hrs.)

Transient analysis:- Transients in RL, RC&RLC Circuits, initial conditions, time constants. Steady state analysis. Analysis of magnetically coupled circuits: Dot convention, coupling co- efficient, tuned circuits, Series & parallel resonance. Network topology, concept of Network graph, Tree, Tree branch & link, Incidence matrix, cut set and tie set matrices, dual networks.

Module 3 (07 hrs.)

Frequency domain analysis – Review of Laplace transform, solution of Integro-differential equations, transform of waveform synthesized with step ramp, Gate and sinusoidal functions, Initial & final value theorem, Network Theorems in transform domain.

Module 4 (07 hrs.)

Concept of signal spectra, Fourier series co-efficient of a periodic waveform, symmetries as related to Fourier coefficients, Trigonometric & Exponential form of Fourier series.

Module 5 (07 hrs.)

Network function & Two port networks – concept of complex frequency, Network & Transfer functions for one port & two ports, poles and zeros, Necessary condition for driving point & transfer function. Two port parameters – Z, Y, ABCD, Hybrid parameters, their inverse &image parameters, relationship between parameters, Interconnection of two ports networks, terminated two port networks.

Experiment List

1. To Verify Thevenin Theorem.
2. To Verify Superposition Theorem.
3. To Verify Reciprocity Theorem.
4. To Verify Maximum Power Transfer Theorem.
5. To Verify Millman's Theorem.
6. To Find Frequency Response of RLC Series Circuit.
7. To Find Frequency Response of RLC parallel Circuit.
8. To Determine Open Circuit parameters of a Two Port Network and to Determine Short Circuit parameters of a Two Port Network.
9. To Determine A,B, C, D parameters of a Two Port Network
10. To Determine h parameters of a Two Port Network

Course Outcomes: Students will be able to

CO1: i. understand circuit elements R,L & C and various sources.
ii. apply various network theorems (Superposition, Thevenin's & Norton's Theorem etc). for the analysis of electrical networks

CO2: i. write equilibrium equations for the transients and steady state analysis of a network.
ii. understand resonance in circuits.

CO3: apply Laplace transforms for the solution for network with periodic /aperiodic excitation

CO4: apply Fourier series analysis for study of harmonics in voltage / current in a network.

CO5: compute z,y, ABCD etc., parameters of a two port network and their applications.

Text/ Reference books:

1. M.E. Van Valkenburg, Network Analysis, Pearson
2. U.A. Patel, Circuit And Networks, Mahajan Publishing House.
3. J David Irwin, Robert M Nelms, Engineering Circuit Analysis, WileyIndia,2015
4. Abhijit Chakrabarty Circuit Theory, Dhanpat Rai & sons

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Electrical and Electronics Engineering Department

	Electrical Machine	3L: 0T:2P (5 hrs.)	4 Credits

Course Objective:

To teach students basic principle of operation, construction and application of static and rotating electrical machines.

Pre Requisite:

Fundamentals of electrical engineering.

Module 1 (08 hrs.)
Transformer-I: Working principle, e.m.f. equation, construction, phasor diagrams, equivalent circuit, voltage regulation, losses, separation of hysteresis and eddy current losses, efficiency, tests: open circuit and short circuit, load, Sumpner's test, Condition for maximum efficiency and regulation, Power and distribution transformer, all day efficiency. Autotransformer: working, advantages.

Module 2 (08 hrs.)
Three Phase Induction Motor- I: Working principle, construction, comparison of slip ring and squirrel cage motors, steady state analysis, phasor diagram and equivalent circuit, power flow diagram, torque-speed and power-speed characteristics, Losses and efficiency, Starting of squirrel cage and slip ring motors,

Module 3 (09 hrs.)
Three phase Induction Motor- II: Double cage &Deep bar Indication Motor, impact of unbalanced supply speed control, braking, Induction Generator. Single Phase Motors: Single Phase Induction motor; double revolving field theory, equivalent circuit and its determination, performance calculation, starting methods and types of single phase Induction motors: their working principle and applications, comparison with three phases Induction Motor.

Module 4 (09 hrs.)
D.C. Machine: Basic construction of DC machines; types of DC machines and method of excitation; Emf equation; armature reaction; Commutation process; Basic performance of DC generators and their performance

characteristics; Basic operation of DC motors; Torque equation; Operating characteristics of DC motors, Starting of DC motors- 2point, 3 point and 4 point starters; speed control of DC motors; losses and efficiency of DC machines;

Module 5 (06 hrs.)
Brush Less DC Motor construction and principle, speed control, basic concept of torque, outer and inner rotor, magnetic circuit concept, electrical analogy, winding pattern series and parallel, Thermal consideration

List of Experiments

Experiments can cover any of the above topics, following is a suggestive list:

1. Perform turn ratio and polarity test on 1-phasetransformer
2. Perform load test on a 1-phase transformer and plot its load characteristic
3. Perform OC and SC tests on a 1-phase transformer and determine its equivalent circuit. Also find its efficiency and regulation at different load and power factor.
4. Perform load test on a 3- phase IM and plot its performance characteristics.
5. Study various types of starters used for 3- IMs.
6. Perform No-load and block rotor test on a 1- phase IM and determine its equivalent circuit.
7. Perform stepper motor for 90 degree in forward and 90 degree in reverse in 20 sec using PLC.
8. To plot magnetisation characteristic of a separately excited DC generator
9. 2. To perform load test on DC generators.
10. 3. To perform load test on DC series and shunt motor

Course Outcomes: Students will be able to

CO1: Explain the working principle, construction, operation and testing of Single Phase Transformer

CO2: Explain the working principle, construction, operation and testing of Three Phase Induction Motor.

CO3: Explain the working principle, construction, operation and testing of Single Phase Induction Motor.

CO4: Explain working principle, Construction and characteristics of DC Machine

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CO5: Appraise knowledge about the fundamental principles and classification of special machines.

Text/ Reference books

1. Electrical Machines by Nagrath and Kothari, McGraw-Hill
2. Electrical Machines by P.S. Bimbhra, Khanna Publishers

3. Special Electrical Machine by E.G. Janardanan, PHI Learning
4. Brushless Permanent Magnet & Reluctance Motor Drives – T.J.E. Miller
5. V.Del Toro, “Electrical Machines & Power Systems”, 1985, Prentice-Hall, Inc., Englewood Cliffs.

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	Power Electronics	**3L: 0T: 2P (5 hrs.)**	**4 Credits**

Course Objective: The objectives are to study
1. To understand and acquire knowledge about various power semiconductor devices.
2. To prepare the students to analyze and design different power converter circuits.

Pre Requisite

Knowledge of Basic Electrical Engineering, Network Analysis & Engineering Mathematics.

Module 1: **(10 Hrs)**
Power Semiconductor Devices - Advantages and application of power electronic devices, Study of switching devices, Power Diode, SCR, TRIAC, GTO, BJT, MOSFET, IGBT, Static characteristics: SCR, MOSFET and IGBT, Triggering and commutation circuit for SCR, SCR rating & protection of SCR, Design of snubber circuit, heating, cooling & mounting of SCR, series and parallel operation of SCR, String efficiency

Module 2: (10 Hrs)
AC-DC Converters - Operation and analysis of single phase (Half wave & Full Wave) and multiphase (Three Phase) uncontrolled and controlled rectifier circuit with resistive, resistive & inductive load (continuous & non continuous conduction, FW small & very large inductive loads) and RLE Loads, Effect of freewheeling diode and source inductance on performance rectifier circuits, Comparison of mid-point & Bridge rectifier circuits, Harmonic analysis.

Module 3: (7 Hrs)
DC-AC Converters - Introduction & Classification of inverter, Operating principle, Voltage source & current source inverter, Single phase and three phase bridge inverter, PWM techniques, Multiple PWM, Sinusoidal PWM, modified sinusoidal PWM, Mc- murray & MC murray bed ford inverters, Harmonics analysis and elimination techniques.

Module 4: (7 Hrs)
DC-DC Converters - Introduction of chopper, Basic chopper classification, Step-down and step-up chopper, Steady state analysis of chopper circuits, types of choppers-A, B, C, D and E, Switched mode regulators- Buck, Boost, Buck- Boost regulator, Resonant Converters, Applications-Battery operated vehicles.

Module 5: (6 Hrs)

AC-AC Converters - Single phase and Three phase AC voltage controllers, Control strategy, Power Factor Control, Multistage sequence control, Cyclo converter-Operation, control problems, various power circuits, single phase and three phase cyclo converters, Applications

List of Experiments

1. Plot the VI Characteristics of SCR (Silicon Control Rectifier)
2. Study of Different Commutation Techniques of SCR
3. Study of SCR Triggering circuits
4. Performance evaluation of single phase uncontrolled converter
5. Performance evaluation of single phase controlled converter
6. To plot waveforms for output voltage and current of 3φ SCR Half Controlled Converter
7. To plot waveforms for output voltage and current of 3φ SCR Full Controlled Converter
8. Performance evaluation of Step up Chopper
9. Performance evaluation Study of Series Inverter using SCR's
10. Phase control of TRIAC using DIAC and RC circuit in light dimming circuit.

Course Outcomes: Students will be able to

CO1: Acquire knowledge about fundamental concepts and switches used in power electronics
CO2: Analyze various AC-DC converter (Rectifier) circuits and understand their applications
CO3: Illustrate working principles of various DC-AC converter (Inverters) circuits
CO4: Illustrate working principles of various DC-DC converter (Choppers) circuits
CO5: Illustrate working principles of various AC-AC converter (Cyclo-Converter) circuits

Text Books:

1. Dr. P. S. Bimbhra, "Power Electronics", Khanna Publishers, 3rd Edition, 2003.
2. M D. Singh, K B. Khanchandani, "Power Electronics", Tata McGraw Hill Publishing company limited, 2nd Edition, 2006.
3. M H Rashid, "Handbook of Power Electronics", Pearson Education India, 2008.

Reference Books:

1. C. M. Pauddar, "Semiconductor Power Electronics (Devices and Circuits)", 1st Edition, Jain Brothers New Delhi, 1999.
2. Joseph Vithayathil, "Power Electronics, Principles and Applications", McGraw Hill Series, 6th Reprint, 2013.
3. Ned Mohan Tore. M. Undel and, William. P. Robbins, 'Power Electronics: Converters, Applications and Design', John Wiley and sons, 3rd edition, 2003.
4. Sen, P.C., "Power Electronics", Tata McGraw Hill Publishing Company limited, 1nd Edition, 2001.

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	Electrical Drives	**3L: 0T: 2P (5 hrs.)**	**4 Credits**

Course objective: Electrical drives course are give unified treatment of complete electrical drive systems, electrical machines, power converters and control system.

Prerequisite: Knowledge of Power Electronics & Electrical Machine.

Module 1(hrs.)

Basic Concepts of Electric Drives Elements of drive systems, Requirement of electric drives, Rating & Selection of drives, groups and individual drives, Constant power and Constant torque drives. Motor Mechanism dynamics Review of Characteristics of AC & DC motors, load characteristic, load-drive speed torque characteristics, quadrant speed torque characteristics. Mechanical Systems Stability of Electric drives, referred moment of inertia and torque of motor load combination, load equalization.

Module2(hrs.)

DC Drives Starting & Braking of conventional, Phase controlled and chopper controlled drives, Transient & Steady state analysis, Energy recovery systems.

Module 3(hrs.)

Induction Motor Drives Conventional method of Starting braking and speed control, PWM, (VSI) Voltage source Inverter and Current Sources (CSI) fed IM drives, cyclo converter fed drive, Vector control drives. Slip Controlled IM Drives Review of Conventional methods & converter controlled-Crammers & Scherbius drives; rotor impedance control.

Module 4(hrs.)

Synchronous Motors Drives VSI and CSI fed; self-controlled-Brush less & commutator less DC & AC motor drives.

Module 5(hrs.)

Special Drives: Fundamentals of Switched reluctance motors, Stepper Motors, Permanent Magnet Motor Introduction to vector control; Digital control of drives. Case Studies Electric traction, steel & cements plants, textile & paper mills, machine tool drive and CNC, electric cars.

Course Outcomes:-After successful completion of course students will be able to:

CO 1: Describe the structure of Electric Drive systems and their role in various applications

CO 2: Explain the operation of dc motor drives to satisfy four-quadrant operation to meet mechanical load requirements.
And discuss speed and torque characteristics of motor drives

CO 3: Explain industrial aspects of induction motor drives in an energy efficient manner using power electronics. And its speed control through stator and rotor side.

CO 4: Define industrial application & control of Synchronous Motors by Separate & Self control.

CO 5: Describe various types of special drives and its digital control. And discuss various industrial application of electrical drive

List of Experiments (Expandable)

1. Study the starting and running characteristics of converter fed DC traction motor.
2. To study the energy recovery systems and braking of a DC drive.
3. To study the braking Methods of a three-phase induction motor.
4. To study the performance of VSI fed three-phase induction motor using PWM technique.
5. To control the speed of a three phase slip ring Induction motor using rotor impedance control.
6. To study the performance of Vector Controlled three phase Induction motor drive.
7. To Study frequency Controlled Synchronous motor drive.
8. To study the control & performance Characteristics of switched Reluctance motor.
9. To study the performance & control of a Stepper motor.
10. To Study the Performance of a permanent magnet Brushless dc motor drive.

Text/ Reference Books:

1. Pillai S. K. "A first course on Electrical Drives", Second edition, Wiley Eastern.
2. Ned Mohan Electrical Machine Drive WILEY INDIA
3. Dubey G. K., "Power Semiconductor Controlled Drives", PHI,
4. Dubey G. K. , "Fundamentals of Electrical Drives". Narosa Publishing House.
5. Bose B. K., "Power Electronics and AC Drives", PHI Learning.
6. Murphy M. D., and Tumbuli F., "Power Electronic Control of AC Motors", Pergamon
7. Press, Oxford University Press.
8. P.V. Rao, "Power semiconductor Drives", BS Publications
9. S.ShivaNagaraju power semiconductor drive PHI learning