IPS Academy

INSTITUTE OF ENGINEERING & SCIENCE

(A UGC Autonomous Institute affiliated to RGPV)

Electrical and Electronics Engineering Department

Minor degree certification course in Renewable Energy

S. No.	Course Code	Sem	Course Title	Hrs./ week			Credits
				L	T	P	
1		V	Electrical Circuit Analysis	3	0	2	4
2		VI	Power System	3	0	2	4
3		VII	Power Electronics	3	0	2	4
4		VIII	Solar & Wind Energy Systems	3	0	0	3
Total credits				12	0	6	**15**

	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

	Power System	3L:0T:2P (5 hrs.)	4 credits

Course Objective: The course deals with exploring the knowledge of Power generation, transmission and distribution. Also to expose the students to the different electrical & mechanical aspects of the power network.

Pre Requisite: Student should be aware about inductance, capacitance, KCL-KVL and fundamentals of Electrical Machines.

Module 1 (08hrs.)

An overview of Electrical Energy Generation General background, structure and components of power network. Power generation – Introduction to conventional, non-conventional & distributed generation, Effect of transmission voltage on power system economy. Selection of size of feeder. Power Plant Economics - Load curves, base load, peak load, load factor, demand factor, diversity factor, capacity factor, utilization factor, cost of electricity, capital cost, fuel and operation cost.

Module 2 (10hrs.)

Transmission Line Components & Under Ground Cabling

Inductance resistance and capacitance of transmission line, & its calculation, Composite conductor, bundle conductor, Skin and proximity effect,. Underground Cable Comparison of cables and overhead transmission lines, Classification of cables, construction of cable, capacitance of single and multi-core cable, economic core diameter.

Module 3 (08hrs.)

Transmission systems & performance of transmission line

Various systems of transmission, effect of system voltage, comparison of conductor materials required for various overhead systems. Short, Medium line and their representation, Nominal T, Nominal JI, Equivalent T and equivalent JI, network models, ABCD constants for symmetrical & asymmetrical network, Mathematical solution to estimate regulation & efficiency of all types of lines.

Module 4 (08hrs.)

Insulator & Mechanical design

Mechanical Design Types of conductors used in overhead transmission line, Types of line supports and towers, Distribution of conductors over transmission towers, Spacing between conductors, Length of span and sag- tension calculation for transmission line, Wind & ice loading, support of line at two different levels, string chart, Insulator Materials used for transmission line insulations, Types of insulator for overhead transmission line failure of insulator, Voltage distribution of suspension insulator, String efficiency, Shielding and grading

Module 5 (08hrs.)

Distribution system and protection

Ac single phase, 3 phase, 3wire & 4 wire distribution, Types of distribution system.

Faults in power systems, single line diagram and equivalent impedance diagram

Relays General considerations, sensing of faults, construction of electro-magnetic attraction and induction type's relays, Buchholz and negative sequence relay, concept of reset, pick up, inverse time and definite time characteristics. Types of circuit breakers.

List of Experiments

1. To study the Thermal Power Station.
2. To study the Hydro Power Station.
3. To study the Nuclear Power Station.
4. To study & draw Towers used in Transmission lines.
5. To study & draw the different types of insulator.
6. To study & design Electrical Power Transmission line.
7. Determination of Transmission Parameters of a transmission line
8. Study of Ferranti Effect.

Course Outcomes: Students will be able to

CO1: Understand the electrical energy generation power plant economics.
CO2: Analyze the transmission line components & under Ground Cabling.
CO3: Analyze the transmission systems & performance of transmission line,
CO4: Understand insulator & mechanical design of conductors used in overhead transmission line
CO5: To impart the knowledge of distribution and protection system.

Text/ Reference books

1. William Stevenson, Elements of Power System Analysis, McGraw Hill.
2. C.L. Wadhwa, Electrical Power System Analysis, New Age International.
3. D.P. Kothari, I.J. Nagrath, Modern Power System Analysis TMH, III Ed. Reprint 2008.
4. John Grainger and William Stevenson, Power system Analysis, McGraw Hill.
5. Ashfaq Husain, Electrical Power Systems, Vikas Publishing House.
6. Rao Sunil S, Switchgear and protection.

	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 & Electronics 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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	Renewable Power Generation	L: T: P 3:0:0(3 hrs.)	3 Credits

Course Objective: The students are expected to identify the new methodologies / technologies for effective utilization of renewable energy sources

Pre Requisite: Should have basic knowledge of Electrical Power System, Basic Electrical Engineering.

Module-I(06Hrs)

World Energy Use – Reserves of Energy Resources – Environmental Aspects of Energy Utilisation – Renewable Energy Scenario in Tamil nadu, India and around the World – Potentials – Achievements / Applications – Economics of renewable energy systems.

Module-II(08Hrs)

Solar Radiation – Measurements of Solar Radiation – Flat Plate and Concentrating Collectors– Solar direct Thermal Applications – Solar thermal Power Generation – Fundamentals of Solar Photo Voltaic Conversion – Solar Cells – Solar PV Power Generation – Solar PV Applications.

Module-III(06Hrs)

Wind Data and Energy Estimation – Types of Wind Energy Systems – Performance – Site Selection – Details of Wind Turbine Generator – Safety and Environmental Aspects

Module-IV(06Hrs)

Biomass direct combustion – Biomass gasifiers – Biogas plants – Digesters – Ethanol production – Bio diesel – Cogeneration – Biomass Applications

Module-V(06Hrs)

Tidal energy – Wave Energy – Open and Closed OTEC Cycles – Small Hydro-Geothermal Energy – Hydrogen and Storage – Fuel Cell Systems – Hybrid Systems.

Course Outcomes: Students will be able to

CO1: Understanding about the Economics and Energy Resources for renewable Power Generation.
CO2: Apply solar energy in thermal and electrical power generation considering energy crisis, environmental and social benefits.
CO3: Importance of wind based energy generation along with its design and analysis
CO4: Demonstration of the components of Biomass power plant and their applications.
CO5: Understanding the operation of electrical energy generation using tidal, geothermal, hydel plants and interconnection with grid.

REFERENCE BOOKS

1. Rai. G.D., "Non Conventional Energy Sources", Khanna Publishers, New Delhi, 2011.
2. Twidell,J.W.&Weir,A.,"RenewableEnergySources",EFNSponLtd.,UK,2006.
3. Gupta, B.R., Generation of Electrical Energy, S. Chand(1998).
4. Solar Energy, G. N. Tiwari, Narosa PublishingHouse