CURRICULUM AND SYLLABUS
(CHOICE BASED CREDIT SYSTEM)
2018

DEPARTMENT OF
ELECTRICAL AND ELECTRONICS ENGINEERING

Kalasalingam Academy of Research and Education

(Deemed to be University)

(Under Section 3 of the UGC Act 1956)

Anand Nagar, Krishnankoil – 626126

Srivilliputhur (Via); Virudhunagar (Dt.), Tamil Nadu, INDIA

(www.kalasalingam.ac.in)

Kalasalingam Academy of Research and Education

VISION

To be a Centre of Excellence of International Repute in Education and Research.

MISSION

To Produce Technically Competent, Socially Committed Technocrats and Administrators through Quality Education and Research.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION

To become a centre of excellence in teaching and research in the field of Electrical and Electronics Engineering.

MISSION

To produce technically competent Electrical and Electronics Engineering graduates who are able to offer viable solutions to meet the energy security of the nation.

To provide opportunities and resources to carry out cutting edge research on energy systems.

M.TechRenewable Energy Technologies (RET)

Program Educational Objectives (PEOs)

PEO1: *Graduates of the programme will be technically competent to address various issues in power sector.*

PEO2: *Graduates of the programme will have thorough knowledge and innovative skills to design and develop products required in power industry.*

PEO3: *Graduates of the programme will possess the technical skills and motivation to learn lifelong to excel in academic and research organization.*

PEO4: *Graduates of the programme will possess in-depth knowledge and motivation to pursue research for the sustainable development of the society.*

Program Outcomes (POs)

PO1: Scholarship of Knowledge: Possess in-depth knowledge in various domains of power system engineering with an ability to analyze the system and to generate new knowledge.
PO2: Critical thinking: Ability to critically investigate the existing power system to conduct research leading to further improvement.
PO3: Problem solving: Ability to find optimal solutionsinpower system engineering problem that meets the public health and environmental issues.
PO4: Research skill: Ability to analyze the complex problems in power system planning, operation and control and to come out with novel solutions using the knowledge acquired.
PO5: Usage of modern tools: Develop appropriatesoftwaretoolsusing modern techniques for the simulation of power systems.
PO6: Collaborative and multidisciplinary work: Possess interdisciplinary knowledge and decision making skills to participate in collaborative and multidisciplinary research work.
PO7: Project management and finance: Ability to apply the knowledge of power system engineering and management techniques to successfully execute projects in power and energy.
PO8: Communication: Ability to communicate confidently and effectively with the engineering professional and with the society on various engineering activities.
PO9: Life-Long learning: Ability to recognize the importance and engage in life-long learning to acquire new knowledge.
PO10: Ethical Practices and social responsibility: Practices Engineering ethics and contributes to the sustainable development of society through innovative practices.
PO11: Independent and Reflective learning: Ability to critically evaluate the outcome of their action and to take corrective measures for further improvement.

Program Specific Outcomes (PSOs)

PSO1:Analysis and solution of complex problems in power system engineering using modern tools
PSO2:Design and developments of power system products/design
PSO3:Understand and demonstrate the importance of sustainable energy development

KALASALINGAM ACADEMY OF RESEARCH AND EDUCATION

M.Tech -Renewable Energy Technologies (RET)

KALASALINGAM DEEMED TO BE UNIVERSITY

(Kalasalingam Academy of Research and Education)

Anand Nagar, Krishnankoil - 626 126

Department of Electrical and Electronics Engineering

M.Tech – RENEWABLE ENERGY TECHNOLOGIES

SCHEME OF INSTRUCTION

Course Code	Course Name	Category	L	T	P	C
MAT18R5001	Applied Mathematics	T	3	0	0	3
EEE18R5201	Renewable Energy Sources	T	3	0	0	3
EEE18R5202	Solar Photovoltaic Systems	TP	4	0	0	4
EEE18R5203	Fuel Cells	T	3	0	0	3
EEE18R5204	Wind Power Generation	T	3	0	0	3
EEE18R52XX	Program Elective - I	T	3	0	0	3
EEE18R5281	Solar and Wind Energy Conservation Laboratory	L	0	0	3	2
EEE18R5220	Seminar					2
EEE18R5205	Energy Management and Audit*	TP	4	0	0	4
EEE18R5206	Waste Management and Energy Generation Technologies	T	3	0	0	3
EEE18R52XX	Program Elective - II	T	3	0	0	3
EEE18R52XX	Program Elective - III	T	3	0	0	3
EEE18R52XX	Program Elective - IV	T	3	0	0	3
--	General Electives/Interdisciplinary Elective-I	T	3	0	0	3
PGM18R5001	Research Methodology	T	1	0	0	1
EEE18R5282	Bio mass and Waste Energy Conversion Laboratory	L	0	0	3	2
EEE18R5219	Industrial Training					2
EEE18R62XX	Program Elective - V	T	3	0	0	3
EEE18R62XX	Program Elective - VI	T	3	0	0	3
--	General Electives/Interdisciplinary Elective-II	T	3	0	0	3
EEE18R6298	Project Work Phase-I				18	6
EEE18R5199	Mini Project					2
EEE18R6099	Project Work Phase-II		0	0	36	10
					Total	**74**

Program Electives						
Course Code	**Course Title**	**Category**	**L**	**T**	**P**	**C**
EEE18R5010	Flexible AC Transmission Systems	T	3	0	0	3
EEE18R5110	Power Electronics for Renewable Energy Systems	T	3	0	0	3
EEE18R5212	Modelling and Analysis of Electrical Machines	T	3	0	0	3
EEE18R5213	Advanced Thermodynamics	T	3	0	0	3
EEE18R6104	Power Switching Devices	T	3	0	0	3
EEE18R5215	Biomass Energy System	T	3	0	0	3
EEE18R5216	Geothermal & Ocean Energy Conversion	T	3	0	0	3
EEE18R5217	Alternate Fuel for Transportation	T	3	0	0	3
EEE18R5218	Hydro Power Generation	T	3	0	0	3
EEE18R6210	EnergyEfficiencyandPerformance of Electrical Equipment	T	3	0	0	3
EEE18R6211	Energy Efficiency and Performance in Thermal Utilities	T	3	0	0	3
EEE18R6212	Advanced Heat Transfer	T	3	0	0	3
EEE18R6214	Energy Efficiency in Electrical Utilities	T	3	0	0	3
EEE18R6001	Distributed Generation and Micro Grid	T	3	0	0	3
EEE18R5004	Smart Grid Technology	T	3	0	0	3
EEE18R6217	Policy and Regulatory Aspects of Renewable Power Generation	t	3	0	0	3
EEE18R6218	Energy Management in Furnace & Heat Exchangers	T	3	0	0	3
EEE18R6219	Industrial & Commercial Aspects of Renewable Energy Sources	T	3	0	0	3
EEE18R6220	Energy Performance of Pumps, Fans and Blowers	T	3	0	0	3

General Electives						
Course Code	**Course Title**	**Category**	**L**	**T**	**P**	**C**
CSE18R5051	Cloud Computing	T	3	0	0	3
CSE18R5052	IoT and Applications	T	3	0	0	3
CSE18R5053	Big Data Analytics	T	3	0	0	3
EEE18R5020	Soft Computing Techniques	T	3	0	0	3
EEE18R5021	Optimization Techniques	T	3	0	0	3
EEE18R6013	Evolutionary Computation Techniques	T	3	0	0	3

Interdisciplinary Electives						
Course Code	**Course Title**	**Category**	**L**	**T**	**P**	**C**
ECE18R5141	Basics of VLSI Design	T	3	0	0	3
ECE18R5142	CMOS IC Design	T	3	0	0	3

ECE18R6041	High Speed Communication Networks	T	3	0	0	3
MEC18R5153	Mechatronics	T	3	0	0	3
MEC18R6151	Industrial Robotics And Expert Systems	T	3	0	0	3
CSE18R5227	Wireless Network Security	T	3	0	0	3
INT18R5018	Cellular Mobile Communication	T	3	0	0	3

Seminar	2
Industrial Training	2
Total	4

Course Code	Course Title	L	T	P	C
EEE18R6298	Project Work Phase - I				6
EEE18R6099	Project Work Phase - II				10
	Total				16

CORE COURSES

EEE18R5201 Renewable Energy Sources	*Credits*			
	L	*T*	*P*	*Total*
	3	**0**	**0**	**3**
Course Category: Core Course – Theory				

COURSE OUTCOMES:

After successful completion of course, the students will be able to,

CO1: Understand the basic concept of solar energy.

CO2: Understand the basic knowledge of wind energy conversion system.

CO3: Gain the knowledge for biomass, Biochemical and its applications.

CO4: Understand the performance of geothermal and wave technology.

CO5: Analyze the performance of hybrid energy systems

CO/PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S										S
CO2	S	S	S	M							
CO3	S				S					S	
CO4	S	S	S	S							
CO5	S	S		S						S	

Unit-I: Solar Energy

Sun as Source of Energy, Availability of Solar Energy, Nature of Solar Energy, Solar Energy & Environment. Various Methods of using solar energy –Photothermal, Photovoltaic, Photosynthesis, Present & Future Scope of Solar energy.

Unit-II: Wind Energy

Wind Energy: Basics & Power Analysis, Wind resource assessment, Power Conversion Technologies and applications, Wind Power estimation techniques, Principles of Aerodynamics of wind turbine blade, Various aspects of wind turbine design, Wind Turbine Generators: Induction, Synchronous machine, constant V & F and variable V & F generations, Reactive power compensation.

Unit-III: Bio-mass

Biomass: Generation and utilization, Properties of biomass, Agriculture Crop & Forestry residues used as fuels. Biochemical and Thermo-chemical Conversion, Combustion, Gasification, Biomass gasifiers and types etc. Applications of Gasifiers to thermal power and Engines, Biomass as a decentralized power generation source for villages Concept of Bio-energy: Photosynthesis process, Bio-fuels, Biomass resources Bio based chemicals and materials

Bio-fuels: Types of Bio-fuels, Production processes and technologies, Bio fuel applications, Ethanol as a fuel for I.C. engines, Relevance with Indian Economy.

Unit-V: Geothermal, Tide and Wave Energy

Availability of Geothermal Energy-size and Distribution, Recovery of Geothermal Energy, Various Types of Systems to use Geothermal Energy, Direct heat applications, Power Generation using Geothermal Heat, Sustainability of Geothermal Source, Status of Geothermal Technology, Economics of Geothermal Energy.

Unit-V Hybrid System

Hybrid energy systems - wind + diesel power, wind + conventional grid, wind + Photovoltaic system etc.

Text Books:

1. John Twidell, Tony Weir, John Twidell, Renewable Energy Resources, innbundet, Engelsk, 2015.
2. **Godfrey Boyle, Renewable Energy: Power for a Sustainable Future, Import, 2012.**
3. Misak, Stanislav, Prokop, Lukas, Operation Characteristics of Renewable Energy Sources, Springer 2017.

	Credits			
EEE18R5202 SOLAR PHOTOVOLTAIC SYSTEMS	***L***	***T***	***P***	***Total***
	3	**0**	**0**	**3**

Course Category: Core Course – Theory

COURSE OUTCOMES:

After successful completion of course, the students will be able to,

CO1: Understand the fundamental concepts of solar cells.

CO2: Analyze the performance of PV module

CO3: Design the PV systems based on the applications

CO4: Understand the operation and performance of PV systems and its components

CO5: Study the applications of PV systems in practical cases.

CO/PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S		S		S					S	
CO2	S	S		S							S
CO3	S		M		L					M	
CO4	S	S									
CO5	S		S	S	S					M	S

UNIT I - SOLAR CELL FUNDAMENTALS

Photovoltaic effect - Principle of direct solar energy conversion into electricity in a solar cell. Semiconductor properties, energy levels, basic equations. Solar cell, p-n junction, structure.

UNIT II - PV MODULE PERFORMANCE

I-V characteristics of a PV module, maximum power point, cell efficiency, fill factor, effect of irradiation and temperature.

UNIT III - MANUFACTURING OF PV CELLS & DESIGN OF PV SYSTEMS

Commercial solar cells - Production process of single crystalline silicon cells, multi crystalline silicon cells, amorphous silicon, cadmium telluride, copper indium gallium diselenide cells. Design of solar PV systems and cost estimation. Case study of design of solar PV lantern, stand alone PV system - Home lighting and other appliances, solar water pumping systems.

UNIT IV - CLASSIFICATION OF PV SYSTEMS AND COMPONENTS

Classification - Central Power Station System, Distributed PV System, Stand alone PV system, Grid Interactive PV System, small system for consumer applications, Hybrid solar PV system, Concentrator solar photovoltaic. System components - PV arrays, inverters, batteries, charge controls, net power meters. PV array installation, operation, costs, reliability.

UNIT V - PV SYSTEM APPLICATIONS

Building-integrated photovoltaic units, grid-interacting central power stations, standalone devices for distributed power supply in remote and rural areas, solar cars, aircraft, space solar power satellites. Socio-economic and environmental merits of photovoltaic systems.

Text Books

1. Chetan Singh Solanki., Solar Photovoltaic: "Fundamentals, Technologies and Application", PHI Learning Pvt., Ltd., 2009.
2. Jha .A.R, "Solar Cell Technology and Applications", CRC Press, 2010.
3. John R. Balfour, Michael L. Shaw, SharlaveJarosek., "Introduction to Photovoltaics", Jones & Bartlett Publishers, Burlington, 2011.

REFERENCE BOOKS

1. Luque .A. L and Andreev .V.M, "Concentrate or Photovoltaic", Springer, 2007.
2. Partain .L.D, Fraas L.M., "Solar Cells and Their Applications", 2nd ed., Wiley, 2010.
3. Sukhatme .S.P, Nayak .J.K, "Solar Energy", Tata McGraw Hill Education Private Limited, New Delhi, 2010.

EEE18R5203 FUEL CELLS	*Credits*			
	L	***T***	***P***	***Total***
	3	**0**	**0**	**3**
Course Category: Core Course – Theory				

COURSE OUTCOMES:

After successful completion of course, the students will be able to,

CO1: Understand the concepts of storage and utilization of hydrogen products

CO2: Gain the basic knowledge of technology for fuel cells

CO3: Analyze the fuel cell modes of operation and its performance

CO4: Apply the knowledge of fuel cells in practical applications

CO5: Understand the international policy and standards of fuel cells

CO/PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S	S		M		L					
CO2	S		M		S						S
CO3	S	S		S						S	
CO4	S	S	M	S	S	M					
CO5	S	S		S						M	

UNIT I - HYDROGEN PRODUCTION STORAGE AND UTILIZATION

Hydrogen production methods. Hydrogen storage - Onboard hydrogen storage - chemical storage - physical storage - in metal and alloy hydrides, carbon nanotubes. Glass capillary arrays - pipeline storage and hydrogen utilization.

UNIT II - FUEL CELL TECHNOLOGY

Fuel cell electrochemistry - Reaction rate - Butler Volmer equation-implications and use of fuel cell polarization curve - Conversion of chemical energy in electricity in a fuel cell.

UNIT III - FUEL CELL AND MODES OF OPERATION

Type of fuel cells, fuel cell working principle – Design - Proton exchange membrane fuel cells - Design issues - High temperature fuel cells - SOFC-MCFC - Comparison of fuel cell - Performance characteristics - Efficiency of leading fuel cell types.

UNIT IV - APPLICATION OF FUEL CELLS IN POWER COGENERATION

Cogeneration - Fuel cell electric vehicles - Fuel cell vehicles - Motor cycles and bicycles-airplanes - Fueling stations - Fuel cell power plant structure - Fuel processor and fuel cell stack.

UNIT V – POLICY AND STANDARDS OF FUEL CELLS

Power conditioner - Advantages and disadvantages. Problems with fuel cells. Research related to fuel cell development in the world and in India. Energy economy - International agreements on codes, standards and regulations – Policy.

TEXT BOOKS

1. Barclay .F.J. "Fuel Cells, Engines and Hydrogen", Wiley, 2009.
2. Viswanathan .B, "Fuel Cell Principles and Applications", Universities Press, India, 2006.
3. Bagotsky .V.S, "Fuel Cells", Wiley, 2009.

REFERENCE BOOKS

1. Larminie .J, Dicks A. "Fuel Cell Systems", 2nd ed., Wiley, 2003.
2. Harper .G.D.J, "Fuel Cell Projects for the Evil Genius", McGraw-Hill, 2008.
3. DetlefStolten, "Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications", 2010.

EEE18R5204 WIND POWER GENERATION	*Credits*			
	L	***T***	***P***	***Total***
	3	**0**	**0**	**3**
Course Category: Core Course – Theory				

COURSE OUTCOMES:

After successful completion of course, the students will be able to,

CO1: Understand the principle of wind energy conversion and aerodynamics and its types

CO2: Analyzethe variable of direct rotor coupled generator

CO3: Understand the working principle of PMSG / DFIG.

CO4: Understand the construction and operation of offshore wind turbine.

CO5: Design the monitoring system and control system for modern wind turbine.

CO/PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S										
CO2			S				S				S
CO3	S		S	S	M	S	S				S
CO4	M	S				S	M				
CO5	S		M	M	S	S	S				M

Unit 1 WIND ENERGY FUNDAMENTALS AND MEASUREMENTS

Wind energy basics - Wind speed and scales - Terrain-Roughness-Wind mechanics - Power content – Class of wind turbine- Atmospheric boundary layers-Turbulence. Instrumentation for wind measurements - Wind data analysis - tabulation. Wind resource estimation - Betz's limit-Turbulence analysis. Wind Turbine Areodynamics And Types:Airfoil terminology - Blade element theory - Blade design - Rotor performance and dynamics- Balancing technique (Rotor &Blade)-Types of loads - Source of loads-Vertical axis type -Horizontal axis - Constant speed Constant frequency - Variable speed variable frequency - Up wind-Down wind - Stall control-Pitch control - Gear coupled generator type - Direct generator drive/PMG/Rotor excited sync generator.

Unit 2 GEAR COUPLED GENERATOR WIND TURBINE COMPONENTS AND THEIR CONSTRUCTION

Electronics sensors /Encode /Resolvers - Wind measurement: anemometer & wind vane - Grid synchronization system - Soft starter - Switchgear [ACB/VCB]-Transformer - Cables and assembly - Compensation panel - Programmable logic control – UPS - Yaw & pitch system: AC drives - Safety chain circuits - Generator rotor resistor controller(Flexi slip) - Differential protection relay for generator

- Battery/Super capacitor charger & Batteries/Super capacitor for pitch system-Transient Suppressor/Lightning arrestors - Oscillation & Vibration sensing.

Unit 3 WIND POWER GENERATOR

PMSG generator - Control rectifier-Capacitor banks - Step up/Boost converter (DC-DC Step Up) - Grid tied inverter - Power management - Grid monitoring unit (Voltage and current) - Transformer - Safety chain circuits-Doubly Fed Induction Generator – Power Control

Unit 4 OFFSHORE WIND ENERGY

Offshore Wind Energy Resources – Basic structure for offshore wind energy – Factors - Comparison of offshore with conventional wind energy - Commercial Offshore Wind Energy Generation - Transport of Wind-Generated Energy

Unit 5 MODERN WIND TURBINE CONTROL & MONITORING SYSTEM

Details of pitch system &Control algorithms-Protections used & Safety consideration in wind turbine-Wind turbine monitoring with error codes - SCADA & Databases: remote monitoring and generation reports - Operation & Maintenance for product lifecycle - Balancing technique (Rotor & Blade) - FACTS control & LVRT & New trends for new grid codes.

TEXT BOOKS

1. Kaldellis J.K, Stand – alone and Hybrid Wind Energy Systems, CRC Press, 2010
2. Mario Garcia –Sanz, Constantine H. Houpis, Wind Energy Systems,CRC Press 2012
3. John D Sorensen and Jens N Sorensen, Wind Energy Systems, Woodhead Publishing Ltd, 2011
4. Sathyajith Mathew: Wind Energy: fundamentals, resource analysis and economics 5. Prepared by WISE: Wind Power in India, 5000MW BY 2015
5. B.H.Khan: Non Conventional Energy Sources,Tata McGraw-Hill Education, 2006.

REFERENCES

1. Godfrey Boyle., Renewable Energy: Power for a Sustainable Future, Second Edition, Oxford University Press, 2004.
2. L. L. Freris, Wind Energy Conversion systems, Prentice Hall, UK, 1990.

EEE18R5205 ENERGY MANAGEMENT AND AUDIT*	*Credits*			
	L	***T***	***P***	***Total***
	4	**0**	**0**	**4**
Course Category: Core Course – Theory				

COURSE OUTCOMES:

After successful completion of course, the students will be able to,

CO1: Understand the need for energy management.

CO2: Analyze the environmental impact for greenhouse gas emissions.

CO3: Understand the devices used for energy monitoring and measurements.

CO4: Understand the standards of energy and analysis the energy management systems

CO5: Gain the knowledge of standards and conduct the auditing.

CO / PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	S		S		S		S			S	
CO2	S		S	M							S
CO3	S	S			M		S	M		M	
CO4	S	S	S	M				M			S
CO5	S	S			L						

Unit I: Energy Management

Introduction: Energy resources -Environment-climate change and sustainability

Practical: Study of Impact on environment in energy management

Unit II: Energy management in organizations

Energy efficiency and energy conservation; Environmental impacts, including greenhouse gas emissions, of Energy; Legal and other requirements applicable to the energy management.

Practical: Case study for energy management in any industry.

Unit-III Energy monitoring, measurement and analysis:

Energy performance indicators; Energy monitoring devices and instruments; Energy monitoring, measurement and analysis.

Practical: Analyze the various performance indicators in any industry

Unit-IV Energy analysis:

Energy review-Development of energy baseline and energy plans- Energy management systems-Management systems approach for energy management in organizations-Energy management systems and requirements of ISO 50001-Development, implementation, maintenance and improvement of energy management systems.

Practical: Submit the report for energy plans for power industry.

Unit-V Auditing and certification of energy management systems:

ISO 19011 and internal and second party auditing of energy management systems; ISO 17021 and third party auditing and management system certification/registration.

Practical: Energy management system auditing case study.

Text Books:

1. Thumann and W.J. Younger: Handbook of energy audits, Fairmont Press, Georgia, USA (2003).
2. Bureau of energy efficiency, New Delhi, India: Guide Book - National certificate examination for energy management and energy audit, 2005 (Book I - General aspect of energy management and energy audit; Book II - Energy efficiency in thermal utilities; Book III - Energy efficiency in electrical utilities; and Book IV - Energy performance assessment for equipment & utility systems).

Reference Books:

1. ISO 19011: 2011- Guidelines for auditing management systems.
2. ISO 17021: 2011 - Conformity assessment — Requirements for bodies providing audit and certification of management systems.
3. ISO 50001: 2011 - Energy management systems — Requirements with guidance for use.

EEE18R5206 WASTE MANAGEMENT AND ENERGY GENERATION TECHNOLOGIES	*Credits*			
	L	***T***	***P***	***Total***
	3	**0**	**0**	**3**
Course Category: Core Course – Theory				

COURSE OUTCOMES:

After successful completion of course, the students will be able to,

CO1: Understand the sources of waste water.

CO2: Understand the procedure for water treatment and Disposal.

CO3: Understand and analyze the applications of : Biochemical Conversion

CO4: Analyze the performance and applications of biomass.

CO5: Apply the knowledge of Thermo chemical Conversion for power generation.

CO / PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	S	M				S					
CO2	S		S				S	S			
CO3	S		S		S						
CO4	S	S	S		S						
CO5	S	M	S			S	M	S			

Unit I

Solid Waste -Definitions: Sources, types, compositions; Properties of Solid Waste; Municipal Solid Waste: Physical, chemical and biological property; Collection, transfer stations; Waste inimization and recycling of municipal waste Landfill method of solid waste disposal; Landfill classification; Types, methods & siting consideration; Layout & preliminary design of landfills: Composition, characteristics, generation; Design of Sanitary Land fill - Movement and control of landfill leachate &gases; Environmental monitoring system for landfill gases.- Gas Recovery – Applications

Unit II

Waste Treatment & Disposal Size Reduction: incineration; Furnace type & design; Types of Incinerators – Fuel Economy - Medical / Pharmaceutical waste / Hazardous waste / Nuclear Waste incineration .; Environmental impacts; Measures of mitigate environmental effects due to incineration;

Unit III

Energy Generation From Waste Types: Biochemical Conversion: Sources of energy generation, Industrial waste, agro residues; Anaerobic Digestion: Biogas production; Determination of BOD, DO, COD, TOC, & Organic loading, Aerobic & Anaerobic treatments – types of digester – factors affecting biodigestion - Activated sludge process. Methods of treatment and recovery from the in industrial waste water – Case Studies in sugar, distillery, dairy, pulp and paper mill, fertilizer, tanning, steel industry, textile, petroleum refining, chemical and power plant.

Unit IV

Rural applications of biomass –Combustion - Chulas - improved Chulas- Biomass – Physical - Chemical composition – properties of biomass – TGA – DSC characterization – Ash Characterization - Preparation of biomass – Size reduction – Briquetting of loose biomass- Briequtting machine

Unit V

Thermo chemical Conversion -Basic aspects of biomass combustion - heat of combustion - different types of grates - Co combustion of biomass – Gasification - Fixed and Fluidized bed gasifier - Gasification technologies for the selected waste like Rice Husk, Coir pith, Bagasse, Poultry litter etc., - Pyrolysis

Text Books

1. Shah, Kanti L., Basics of Solid & Hazardous Waste Management Technology, Prentice Hall, 2000

References:

1. Parker, Colin, & Roberts, Energy from Waste - An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985
2. ManojDatta, Waste Disposal in Engineered Landfills, Narosa Publishing House, 1997
3. Rich, Gerald et.al., Hazardous Waste Management Technology, Podvan Publishers, 1987
4. Bhide AD., Sundaresan BB, Solid Waste Management in Developing Countries, INSDOC, New Delhi,1983.

EEE18R5281 SOLAR AND WIND ENERGY CONSERVATION LABORATORY	*Credits*			
	L	***T***	***P***	***Total***
	0	**0**	**3**	**2**
Course Category: Core Course – Laboratory				

COURSE OUTCOMES:

After successful completion of course, the students will be able,

CO1 : Acquire the knowledge, experimental procedure in Renewable energy sources.

CO2 : Improve the ability of observation and mathematical manipulation of experiments in solar / wind etc.

CO3 : Apply the knowledge of experiment skills of renewable energy sources for solving the electrical problems to the consumers.

CO / PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	S			S	S						
CO2				S	S				S	M	
CO3				S	S	S	M		S	S	M

1. Study of solar collector efficiency.
2. Study of performance of solar hot water system.
3. Determination of heat loss coefficients in flat plate collector.
4. Study of solar hot air collector/ solar dryer.
5. Study of solar still.
6. Performance evaluation of box type and concentrating type solar cooker.
7. Power vs. load characteristics of solar photovoltaic system.
8. Variation of power output with intensity of solar radiation and load.
9. Determination of efficiency of solar photovoltaic water pump.
10. Variation of diesel replacement with load in gasifiers.
11. Wind power and annual energy estimation from wind data.
12. Simulation of modeling of wind turbine generator.
13. Simulation of MPPT in wind energy conversion systems.
14. Simulation of reactive power compensation by variable speed wind energy conversion systems.

EEE18R5282 BIO MASS AND WASTE ENERGY CONVERSION LABORATORY	*Credits*			
	L	***T***	***P***	***Total***
	0	**0**	**3**	**2**
Course Category: Core Course – Laboratory				

COURSE OUTCOMES:

After successful completion of course, the students will be able,

CO1 : Acquire the knowledge, experimental procedure in wastes.

CO2 : Improve the ability of observation and mathematical manipulation of experiments in bio mass / waste for electrical energy.

CO3 : Apply the knowledge of experiment skills of wastes for solving the electrical problems to the consumers.

CO / PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	S			S	S						
CO2				S	S			S	S	M	
CO3				S	S	S	M	S	S	S	M

1. Study of biogas plant.
2. Bio-gas Production from Kitchen waste.
3. Study on thermal performance and efficiency of biomass downdraft gasifier
4. Study for analysis of air and flue gas from biomass energy systems
5. Study of biogas production by anaerobic digestion
6. Characterize the Pyrolysis Behaviour of Selected Biomass Fuels
7. Estimation of Physical and chemical properties of waste materials
8. Study on sources of waste materials
9. Study of Proximate and Ultimate analysis of solid wastes
10. Combustion characteristics of solid wastes
11. Study of Mechanical handling of solid waste
12. Study of Composting of solid wastes

13. Waste heat recovery
14. Study of refuse derived fuel (RDF)
15. Comparison of Aerobic & Anaerobic treatments of liquid wastes.

SUPPORTIVE COURSES

MAT18R5001 APPLIED MATHEMATICS	*Credits*			
	L	***T***	***P***	***Total***
	3	**0**	**0**	**3**
Course Category: Supportive Courses– Theory				

Course Outcome(s):

After completing this course, the student will be able to

CO1 : Evaluate norms, generalized eigen vector, Pseudo Inverse and QR decomposition of a Matrix.

CO2 : Understand the concept of probability, random variables, various probability distributions and its applications.

CO3 : Apply the techniques of Queueing models in real life situations.

CO4 : Understand the various concepts of classical optimization techniques.

CO5 : Apply graphical method, Simplex method and Dual Simplex method to solve Linear Programming Problems and also solving Transportation problems.

Course Topics:

Unit 1 : MATRIX THEORY

Matrix Norms - Jordan Canonical form Generalized Eigen vectors - Pseudo Inverse – QR-decomposition – QR Algorithm.

Unit 2 : PROBABILITY AND RANDOM VARIABLES

Probability – conditional probability - Random variables – Mathematical Expectation – Moments - Moment Generating function - Binomial, Poisson, Geometric, Uniform, Exponential and Normal Distributions – Function of a random variable.

Unit 3 : QUEUING MODELS

Markovian Queues - Single and multi server models – Little's formula - Steady state analysis – Queuing applications.

Unit 4 : CLASSICAL OPTIMIZATION TECHNIQUES

Classification – optimization technique - Unconstrained Optimization – Equality constraints – Inequality constraints – Lagrange Multiplier method – Kuhn-Tucker Condition - Indirect search methods – Gradient of a function – Steepest descent method – Conjugate gradient method – Newton's method.

Unit 5 : LINEAR PROGRAMMING

Standard form of Linear programming problem – formation – graphical method - Simplex method – Dual simplex method – Transportation problem - Applications.

TEXT BOOK:

1. Bronson.R. Matrix operations, Second Edn., Schaum's Outline series, McGraw Hill Education, 2011.
2. Gupta S.C. and Kapoor V.K. Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi, 2014.
3. Taha H A, "Operations Research, An Introduction", 9th Edn., Pearson Education, 2016.

4. SingiresuS.Rao ,Engineering Optimization: Theory and Practice, Fourth Edition, New Age International (P) Ltd, 2009.

REFERENCES :

1. S.D.Sharma, Operations Research, KedarNath Ram Nath& co, 2008.

2. Sheldon M. Ross, Probability and Statistics for Engineers and Scientists, Fifth Edn., Elsevier India, 2014.

PGM18R5001 RESEARCH METHODOLOGY	*Credits*			
	L	***T***	***P***	***Total***
	1	**0**	**0**	**1**
Course Category: Supportive Courses– Theory				

COURSE OUTCOMES:

After successful completion of course, the students will be able to,

CO1 - To understand the basic concepts of research and its methodologies.

CO2 - To select and define appropriate research problems.

CO3 - To solve statistical problems and probability distributions.

CO4 - To process and analysis the methods of data collection.

CO5- To recognize the powerfulness of the soft computing tools and to formulate the optimization problems and write a research report, thesis and proposal.

CO/PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1								S	M	S	S

CO2								M			
CO3											S
CO4									M		
CO5								S	M	S	S

UNIT I Introduction

Definition and objectives of Research – Types of research, Various Steps in Research process, Mathematical tools for analysis, Developing a research question-Choice of a problem Literature review, Surveying, synthesizing, critical analysis, reading materials, reviewing, rethinking, critical evaluation, interpretation, Research Purposes, Ethics in research – APA Ethics code.

UNIT II Quantitative Methods for Problem Solving

Statistical modeling and analysis, time series analysis probability distributions, Fundamentals of statistical analysis and interference, multivariate methods, concepts of correlation and regression, fundamentals of time series, analysis and spectral analysis, error analysis, applications of spectral analysis.

UNIT III Data Analysis

Tabular and graphical description of data: Tables and graphs of frequency data of one variable, Tables and graphs that show the relationship between two variables, relation between frequency distributions and other graphs, preparing data for analysis.

UNIT IV Soft Computing Application

Computer and its role in research, Use of statistical software SPSS, GRETL etc in research. Introduction to evolutionary algorithms- fundamentals of genetic algorithms, simulated annealing, and neural network based optimization, optimization of fuzzy systems.

UNIT V Report Writing

Structure and Components of Research Report, Types of Report, Layout of Research Report, Mechanism of writing a research report, referencing in academic writing

TEXT BOOKS

1. C.R. Kothari, Research Methodology Methods and Techniques, 2/e, VishwaPrakashan, 2006
2. Donald H.McBurney, Research Methods, 5th Edition, Thomson Learning, ISBN:81-315-0047-0,2006

REFERENCE BOOKS

1. Donald R.Cooper, Pamela S.Schindler, Business Research Methods, 8/e, Tata McGraw Hill Co.Ltd. 2006.

2. Fuzzy Logic with Engg Applications, Timothy J.Ross, Wiley Publications, 2nd Ed[d].

3. Simulated Annealing: Theory and Applications (Mathematica and its applications, by P.J.VanLaarhoven&E.H.Aarts[e]

4. Genetic Algorithms in search, optimization and machine learning by David E Goldberg

PROGRAM ELECTIVES

EEE18R5010 FLEXIBLE AC TRANSMISSION SYSTEMS	*Credits*			
	L	***T***	***P***	***Total***
	3	**0**	**0**	**3**
Course Category: Program Electives– Theory				

COURSE OUTCOMES:

After successful completion of course, the students will be able to,

CO1: To understand the basic concepts and the working mechanism of FACTS and its controllers.
CO2: Ability to analyze the characteristics of SVC and its applications for the implementation of steady state operation.
CO3: Ability to apply knowledge in the various modes of operation of TCSC and to enhance system damping in the networks.
CO4: To study the principle of operation and to analyze the performance characteristics for the various shunt and series compensators.
CO5: Ability to design and model the UPFC for the power flow studies.

CO / PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S										

CO2	M	S		S							
CO3											
CO4	S	S	S	M				M			
CO5	S	M	S	S				M			

Unit 1 INTRODUCTION

FACTS - concept and general system considerations- Basic type of FACTS controller- Brief description and definition of FACTS controller-benefits from FACTS technology.

Unit 2 STATIC VAR COMPENSATOR (SVC) AND APPLICATIONS

Voltage control by SVC – advantages of slope in dynamic characteristics – influence of SVC on system voltage – design of SVC voltage regulator – applications- enhancement of transient stability – steady state power transfer – enhancement of power system damping – prevention of voltage instability.

Unit 3 THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC) AND APPLICATIONS

Operation of the TCSC- different modes of operation – modeling of TCSC – variable reactance model – modeling for stability studies- applications – improvement of the system stability limit – enhancement of system damping – voltage collapse prevention.

Unit 4 STATIC SHUNT AND SERIES COMPENSATORS

Static Compensator (STATCOM) – principle of operation – V-I Characteristics application- Static Series Synchronous Compensator (SSSC) – principle of operation –V-I characteristics-Application-enhancement of power system stability limit.

Unit 5 UNIFIED POWER FLOW CONTROLLER

Unified Power Flow Controller (UPFC) – Principle of operation - Modes of Operation –Applications – Modeling of UPFC for Power Flow studies- Independent active and reactive power flow control-Comparison of UPFC with the controlled series compensators and phase shifters.

TEXT BOOKS

1. Mohan Mathur.R., Rajiv. K.Varma, “Thyristor – Based Facts Controllers for Electrical Transmission Systems”, IEEE press and John Wiley & Sons, Inc.

2. John, A.T., "Flexible A.C. Transmission Systems", Institution of Electrical and Electronic Engineers (IEEE), 1999.

REFERENCES

1. NarainG.Hingorani, Laszio. Gyugy.L, "Understanding FACTS Concepts and Technology of Flexible AC Transmission Systems", Standard Publishers –Delhi, 2001.

EEE18R5110 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	*Credits*			
	L	***T***	***P***	***Total***
	3	**0**	**0**	**3**
Course Category: Program Electives– Theory				

COURSE OUTCOME:

After successful completion of course, the students will be able,

CO1 - To study the impacts of renewable energy generation on environment

CO2 - To understand the operation and analysis of the electrical machines used for renewable energy conversion

CO3 - To analyze the converter types and selection of inverter for renewable power generation.

CO4 - To develop Stand alone operation of fixed and variable speed wind energy conversion systems and solar system

CO5 - To simulate the MPPT for hybrid Systems.

CO / PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	L										
CO2					L		M			M	
CO3	M		S			M					
CO4										S	

CO5		S			L			M			

Unit 1 INTRODUCTION

Environmental aspects of electric energy conversion: Impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources ocean, Biomass, Hydrogen energy systems: operating principles and characteristics of: Solar PV, Fuel cells, wind electrical systems-control strategy, operating area.

Unit 2 ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION

Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG.

Unit 3 POWER CONVERTERS

Solar: Block diagram of solar photovoltaic system: line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing.

Wind: three phase AC voltage controllers-AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.

Unit 4 ANALYSIS OF WIND AND PV SYSTEMS

Stand alone operation of fixed and variable speed wind energy conversion systems and solar system-Grid connection Issues -Grid integrated PMSG and SCIG Based WECS- Grid Integrated solar system-Case studies

Unit 5 HYBRID RENEWABLE ENERGY SYSTEMS

Need for Hybrid Systems-Range and type of Hybrid systems-Case studies of Wind-PV- Maximum Power Point Tracking (MPPT)-Case studies

REFERENCES

1. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electricaal Systems”, Oxford University Press, 2009
2. Non-conventional Energy sources B.H.Khan Tata McGraw-hill Publishing Company,New Delhi.

3. Rai,G.D., "Non- conventional resources of energy", Khanna publishers, Fourth edition, 2010.
4. Rao. S. &Parulekar, "Energy Technology", Khanna publishers, Fourth edition, 2005.
5. Godfrey Boyl, "Renewable Energy: Power sustainable future", Oxford University Press, Third edition, 2012.
6. Khan B.H., "Non-Conventional Energy Resources", The McGraw Hills, Second edition, 2009.
7. John W Twidell and Anthony D Weir, "Renewable Energy Resources", Taylor and Francis, 2006.

EEE18R5212 MODELLING AND ANALYSIS OF ELECTRICAL MACHINES	*Credits*			
	L	***T***	***P***	***Total***
	3	**0**	**0**	**3**
Course Category: Program Electives– Theory				

COURSE OUTCOMES:

After successful completion of course, the students will be able,

CO1 - To understand the basic working concept of the rotating machine and to derive the transformation concepts.

CO2 -To understand and derive the basic concepts of reference frame theory for implementing control techniques in the analysis of electrical machines.

CO3 - To draw the equivalent circuit and design the performance characteristics of the induction machine.

CO4 - To explain, analyze and simulate the performance characteristics of the synchronous machine

CO5 – To derive the Machine Interconnection Matrices

CO/PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1											
CO2	S			L		S			L		
CO3							S				L
CO4			M			S			M		
CO5	L						M				

UNIT-I: INTRODUCTION

Introduction to the theory of basic two pole machine applicable to DC machines, 3-ph induction machines and synchronous machine. Kron's primitive Machine. Need of modeling**,** Introduction to modeling of electrical machines, voltage and torque equations.

Concept of Transformation: change of variables & m/c variables and transform variables for arbitrary reference frames.

UNIT-II: REFERENCE FRAME THEORY

Phase transformation– transformation of variables from stationary to arbitrary reference frame-variables observed from several frames of reference.

UNIT-III: POLYPHASE INDUCTION MACHINES

Voltage, torque equations, Equivalent circuit ,Steady state analysis, Dynamic performance during sudden changes in load torque and three phase fault at the machine terminals.

UNIT-IV: POLYPHASE SYNCHRONOUS MACHINE

Voltage and Torque Equations in stator, rotor and air-gap field reference frames . Transformation and Transformed Equations. Parks Transformation Voltage and power equation for salient and non salient alternator, their phasor diagrams, Simplified equations of a synchronous machine with two damper coils.

UNIT-V: DYNAMICAL ANALYSIS OF INTERCONNECTED MACHINES

Machine Interconnection Matrices. Transformation of Voltage and Torque Equations using Interconnection Matrix . Large Signal Transient Analysis using Transformed Equations'. The Alternator /Synchronous Motor / Induction Motor System.

TEXT BOOKS

1. Analysis of Electric Machinery - P.C.Krause
2. The General theory of Electrical Machines - B.Adkins

REFERENCES

1. Paul C.Krause, OlegWasyzczuk, Scott D.Sudhoff"Analysis of Electric Machinery and Drive Systems" IEEE Press, Second Edition, 2002.

2. Krishnan. R., "Electric Motor Drives, Modeling, Analysis and Control", Prentice Hall of India, 2002.
3. Samuel Seely, "Electromechanical Energy Conversion", Tata McGraw Hill Publishing Company, 2000.
4. Fitzgerald A.E., Charles Kingsley, Jr. and Stephen D.Umans, "Electric Machinery", Tata McGraw Hill, 5th Edition, 1992.
5. Bimbhra P.S., "Generalized theory of Electrical Machines", Khanna Publishers, 1995.
6. Ned Mohan, "Advanced Electric Drives, Analysis, Control and Modelling using Simulink", MNPERE, 2001.

EEE18R5213 ADVANCED THERMODYNAMICS	*Credits*			
	L	***T***	***P***	***Total***
	3	**0**	**0**	**3**
Course Category: Program Electives– Theory				

COURSE OUTCOMES:

After successful completion of course, the students will be able to,

CO1: To understand the availability analysis and thermodynamic property relations.

CO2: To calculate real gas behavior and multi-component systems.

CO3: To understand the chemical thermodynamics and equilibrium concept.

CO4: To understand microstates and macrostates of statistical thermodynamics.

CO5: To understand theirreversible thermodynamics.

CO/PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	S	S	M						S		
CO2	S	S	S	M		S					
CO3	S	S	S	S	S	S	S	S			
CO4	S	S			S	M	S			M	
CO5	S	S	S	S		S	S	M			

Unit 1 AVAILABILITY ANALYSIS AND THERMODYNAMIC PROPERTY RELATIONS

Availability, irreversibility and second-law efficiency for a closed system and steady - state control volume - availability analysis of simple cycles - thermodynamic potentials, Maxwell relations, generalized relation for changes in entropy, internal energy and enthalpy, generalized relations for Cp and CvClausiusClaypeyron equation, Joule - Thomson Coefficient, Bridgman tables for thermodynamic relations.

Unit 2 REAL GAS BEHAVIOUR AND MULTI-COMPONENT SYSTEMS

Different equations of state, fugacity, compressibility, principle of corresponding states, use of generalized charts for enthalpy and entropy departure, fugacity coefficient, Lee-Kesler generalized three parameter tables - fundamental property relations for systems of variable composition, partial molar prosperities, real gas mixtures, ideal solution of real gases and liquids, equilibrium in multi phase systems, Gibbs phase rule for non-reactive components.

Unit 3 CHEMICAL THERMODYNAMICS AND EQUILIBRIUM

Thermo chemistry, first law analysis of reacting systems, adiabatic flame temperature, entropy change of reacting systems, second law analysis of reacting systems, criterion for reaction equilibrium composition.

Unit 4 STATISTICAL THERMODYNAMICS

Microstates and macrostates, thermodynamic probability, degeneracy of energy levels, Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein statistics, microscopic interpretation of heat and work, evaluation of entropy, partition function, calculation of the microscopic properties from partition functions.

Unit 5 IRREVERSIBLE THERMODYNAMICS

Conjugate fluxes and forces, entropy production, Onsager's reciprocity relations, thermoelectric phenomena and formulations.

TEXT BOOK

1. McQuarrie D.A, Statistical Mechanics, Viva Books Private Limited, 2003.
2. Kenneth Wark, Jr., Advanced Thermodynamics for Engineers, McGraw-Hill Inc., 1995.

REFERENCES

1. Bejan, A., Advanced Engineering Thermodynamics, John Wiley and Sons, 1998.
2. Holman, J. P., Thermodynamics, Fourth Ediction, McGraw-Hill Inc., 1998.
3. 4. Sonntag, R. E., and Vann Wylen, G, Introduction to Thermodynamics, Classical and Statistical, third Edition, John Wiley and Sons, 1991.
4. DeHoft, R. T. Thermodynamics in Materials Science, McGraw-Hill Inc.,1993.
5. Rao, Y. V. C., Postulational and Statistical thermodynamics, Allied Publisher Limited, New Delhi, 1994.

EEE18R6104 POWER SWITCHING DEVICES	*Credits*			
	L	***T***	***P***	***Total***
	3	**0**	**0**	**3**
Course Category: Program Electives– Theory				

COURSE OUTCOMES:

After successful completion of course, the students will be able,

CO1: Understand the switching characteristics of Power Switching Devices.

CO2: Understand the construction and characteristics of various current controlled devices and analyze the steady state and dynamic model of current controlled devices.

CO3: Understand the construction and characteristics of various voltage controlled devices and analyze the steady state and dynamic model of voltage controlled devices.

CO4: Design the firing and protection circuit for Power semiconductor devices.

CO5: Design the thermal protection for Power semiconductor devices.

CO and PO Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1						L					
CO2	S										M
CO3						S	S				M
CO4	S						S				M
CO5	S	S		M	S		M				M

Unit 1 SWITCHING CHARACTERISTICS

Overview of Power switching devices – Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability – Safe Operating Area (SOA); Device selection strategy – On-state and switching losses – EMI due to switching – Power diodes - Types, forward and reverse characteristics, switching characteristics – rating.

Unit 2 CURRENT CONTROLLED DEVICES

BJTs – Construction, static characteristics, switching characteristics; Negative temperature co-efficient and secondary breakdown; Power Darlington - Thyristors –Physical and electrical principle underlying operating mode, 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 BJT &Thyristor.

Unit 3 VOLTAGE CONTROLLED DEVICES

Power MOSFETs and IGBTs – Principle of voltage controlled devices, construction, types, static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs - GTO, MCT, FCT, RCT and IGCT.

Unit 4 FIRING AND PROTECTING CIRCUITS

Necessity of isolation, pulse transformer, optocoupler – Gate drive circuits: SCR, MOSFET, IGBT and base driving for power BJT - Over voltage, over current and gate protections; Design of snubbers.

Unit 5 THERMAL PROTECTION

Heat transfer – conduction, convection and radiation; Cooling – liquid cooling, vapour –phase cooling; Guidance for hear sink selection – Thermal resistance and impedance -Electrical analogy of thermal components, heat sink types and design – Mounting types.

TEXT BOOKS

1. MD Singh and K.B Khanchandani, "Power Electronics", Tata McGraw Hill, Second Edition, 2009.
2. Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004.

REFERENCES

1. Mohan, Undcland and Robins, "Power Electronics – Converters, applications and Design, John Wiley and Sons, Third Edition, Singapore, 2003.
2. B.W Williams "Power Electronics Circuit Devices and Applications".1987

EEE18R5215 BIOMASS ENERGY SYSTEM	*Credits*			
	L	***T***	***P***	***Total***
	3	**0**	**0**	**3**
Course Category: Program Electives– Theory				

COURSE OUTCOMES:

After successful completion of course, the students will be able to,

CO1: Understand the energy conservation mechanism from biomass and waste characteristics.

CO2: Apply the different biomass conversion techniques for power generation.

CO3: Design biogas plant for bio-chemical conversion.

CO4: Understand the various liquid bio fuels and its production.

CO5: Design biogas plant for the given specification.

CO/PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S	M				S	S				S
CO2	S			S							
CO3	S	S				S	M				
CO4	S	S	M		M	S					M
CO5	S			M	S	S	S				

Unit 1 BIOMASS RESOURCES AND WASTES CHARACTERISTICS

Biomass potential - terrestrial, aquatic and marine. Production and availability of biomass- biopolymers - lignin - cellulose - hemi cellulose contents of biomass. Potentials of solid and liquid wastes - agriculture - industrial - human origin (municipal and kitchen wastes) - quantities and characteristics.

Unit 2 THERMO-CHEMICAL CONVERSION

Thermo-chemical conversion of biomass, biomass processing, briquetting, pelletisation, biomass stoves, biomass carbonization, pyrolysis of biomass, biomass gasification, gasifiers: [updraft (forced draft & Natural draft), downdraft (Open core, throat type &modular)], Gasifier stoves, gasifier thermal applications, gasifier engine applications: dual fuel and 100% gas mode operation, power generation systems: (decentralized, grid interactive).

Unit 3 BIO-CHEMICAL CONVERSION

Aerobic, and anaerobic processes, activated sludge process, plug flow reactors, anaerobic fixed film reactor, UASB reactor, anaerobic fluidized bed reactor, estimation of methane yield, anaerobic digestion system for MSW, Vermi-composting, different designs of biogas plants for animal waste, Biogas engine applications.

Unit 4 LIQUID BIO FUELS

Liquid biofuels, non-edible oilseeds, oil extraction, preprocessing, transesterification, biodiesel, characterization of liquid fuels, production of syngas from biomass, production of methanol from syngas, production of ethanol from ligno-cellulosic biomass, Liquid bio-fuel applications.

Unit 5 BIO GAS PLANT AND ITS APPLICATIONS

Commissioning and management of biogas plant, community plant - Biogas appliances - manurial aspects. Socio-economic aspects - cost- benefit analysis. Composting - pathway - utilisation. Solid state - fermentation - recycling of industrial and municipal wastes - activated sludge system - trickling filters - lagooning - oxidation ponds.

TEXT BOOKS

1. Nijaguna, B.T., Biogas Technology, New Age International publishers (P) Ltd., 2002

2. VVN Kishore, Renewable energy engineering and Technology, Principles and Practices, TERI, 2009

REFERENCES

1. Rezaiyan. J and N. P. Cheremisinoff, "Gasification Technologies, A Primer for Engineers and Scientists", Taylor & Francis, 2005
2. Bioenergy and Biofuel from Biowastes and Biomass edited by Samir Kumar Khana, ASCE Publications, 2010

EEE18R5216 GEOTHERMAL & OCEAN ENERGY CONVERSION	*Credits*			
	L	***T***	***P***	***Total***
	3	**0**	**0**	**3**
Course Category: Program Electives– Theory				

COURSE OUTCOMES:

After successful completion of course, the students will be able to,

CO1: Understand the development of magneto static energy conversion.

CO2: Understand the principles of ocean thermal energy conversion.

CO3: Understand the construction and operation of tidal energy.

CO4: Analyze different types of wave-energy converters.

CO5: Apply the knowledge of geothermal power plant for power generation.

CO / PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S	M				S					
CO2	S		S				S	S			
CO3	S		S		S						
CO4	S	S	S		S						
CO5	S	M	S			S	M	S			

Unit 1 MAGNETO STATIC ENERGY CONVERSION

MHD generation – principle – Faraday and Hall effect generators –choice of generation parameters – magnetic field requirements –conductivity and ionization – MHD design problems and developments – Voltage and power output of MHD generator. Recent developments in MHD power systems.

Unit 2 OTEC POWER PLANTS

Ocean energy resources, ocean energy routes, Principles of ocean thermal energy conversion systems, ocean thermal power plants, Operational problem, Ecological & environmental impacts.

Unit 3 TIDAL ENERGY

Tide generating forces, Analysis and prediction of tides and tidal currents, Structure of the tidal currents, Tidal dynamics and tidal energy generation.

Unit 4 WAVE POWER

Introduction to wave energy, resources and potential, Different types of wave-energy converters.

Unit 5 GEOTHERMAL POWER

Description of how geothermal heat is produced from the earth and its electrical potential, geothermal areas. Topographical challenges, calculating estimated yield, environmental challenges and concerns, etc. Measuring yield, connecting to the grid, storing and distributing power, etc. States and countries that already purchase Geothermal power for public and/or commercial structures.

TEXT BOOKS

1. Geothermal Energy and Technology Status: A Review. Barbier, E.

2.Rai, G.D., Non–conventional Energy Sources, Khanna Publishers, New Delhi, 2003.

3. Dr. B. mazumdar.,A Text Book of Energy Technology - Both Conventional and Renewable Source of Energy, S.B. Nangia, A.P.H. Publishing Corporation.

REFERENCES

1. Enhanced Geothermal Systems Wellfield Construction Workshop," Summary Report, 2007.

2. Mann, K. H. and J. R. N. Lazier, 1991. Dynamics of Marine Ecosystems. Blackwell Scientific Pub.

EEE18R5217 ALTERNATIVE FUEL FOR TRANSPORTATION	*Credits*			
	L	***T***	***P***	***Total***
	3	**0**	**0**	**3**
Course Category: Program Electives– Theory				

COURSE OUTCOMES:

After successful completion of course, the students will be able to,

CO1: Understand the characteristics of hydrocarbon fuels.

CO2: Understand the characteristics of Alternative fuels and its application.

CO3: Analyzethe production methods of biodiesel.

CO4: Understand the different types of fuel cells.

CO5: Understand the potential of power generation from other sources like biogas.

CO / PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S	M		S							
CO2	S	S			S	S					
CO3	S	S	S								
CO4	S	S	S								
CO5	S	S		S	M	S					

Unit 1 HYDROCARBON FUELS

An introduction to hydrocarbon fuels - their availability and effect on Environment. Gasoline and Diesel self ignition characteristics of the fuel, octane number, cetane number.

Unit 2 ALTERNATIVE FUELS

Alternative fuels - Liquid and Gaseous Fuels. Physico-chemical characteristics. Alternative Liquid Fuels. Alcohol fuels - Ethanol & Methanol. Fuel composition, Fuel Induction techniques, fumigation, emission of oxygenates, applications to engines and automotive conversions.

Unit 3 BIO DIESEL

History, Production methods of Bio-diesel: Biodiesel formulation techniques Trans esterification, application in diesel engines. CME (Di-methyl ether), properties Fuel injection consideration. Fuel quality, standards and properties, Availability of Raw materials for bio-diesel, Applications, Bio-diesel potential in India.

Unit 4 FUEL CELL TECHNOLOGY

Basics Fuel cell definition, difference between batteries and fuel cells, fuel cell history, components of fuel cells, principle of working of fuel cell, performance characteristics of fuel cells, efficiency of fuel cell, fuel cell stack, fuel cell power plant: fuel processor, fuel cell power section, power conditioner, Advantages and disadvantages of fuel cell power plant. Types of Fuel Cells.

Unit 5 OTHER FUELS

Biogas, Producer gas and their characteristics, System development for engine application. Electric And Solar Powered Vehicles : Layout of an electric vehicle - Advantage and limitations - Specifications - System component. Electronic control system - High energy and power density batteries - Hybrid vehicle - Solar powered vehicles.

TEXT BOOKS

1. Sunggyu Lee, James G. Speight, SudarshanK.Loyalka, Handbook of Alternative Fuel Technologies, CRC Press,Taylor and Franics Group, 2007.
2. Paul Kruger, Alternative Energy Resources : The Quest for Sustainable Energy (Hardcover), John Wiley & Sons, Inc.2006.

REFERENCE BOOKS

1. Rai, G.D., “Non-conventional energy sources”, Khanna Publishers, 2005.

2. Nagpal, " Power Plant Engineering ", Khanna Publishers, 1991.
3. Bechtold. R.L., "Alternative Fuels Guide Book ", SAE, 1997.

EEE18R5218 HYDRO POWER GENERATION	*Credits*			
	L	***T***	***P***	***Total***
	3	**0**	**0**	**3**
Course Category: Program Electives– Theory				

COURSE OUTCOMES:

After successful completion of course, the students will be able to,

CO1: Understand the development of hydropower plant in India.

CO2: Understand the working of hydroelectric power plant.

CO3: Understand the construction and operation of different components like Dams, spillways, cannels, penstocks etc.

CO4: Analyzethe role of prime mover in hydro power plants.

CO5: Apply the knowledge of plant design in small hydropower system.

CO / PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S	M									
CO2	S	S					S				
CO3	S	S	S			S		S			
CO4	S	S	S	S			M				
CO5	S	M	S	S		S		S			

Unit 1 INTRODUCTION

Introduction, Potential of hydropower in India- its development and future prospect. General hydrology - hydrological cycle, precipitation, run-off and its measurement, hydrography, unit hydrograph, flow duration and mass curve. Site investigations.

Unit 2 CLASSIFICATION OF HYDROELECTRIC POWER PLANTS

Classification of hydroelectric power plants. Pondage and storage. Operating principles of different types of hydel plants like run-off-the-river type. Storage reservoir plant-pumped storage plant. Components –Advantages & Disadvantage of underground power station.

Unit 3 DESIGN, CONSTRUCTION AND OPERATION

Design, construction and operation of different components: Dams, spillways, Canals, penstocks, surge tanks, draft tubes etc; Power – house structure.

Unit 4 PRIME MOVER

Selection of prime mover, speed and pressure regulation, methods of governing, starting and stopping of water turbines, operation of hydro turbines. Machine loading and frequency control, Maintenance of hydropower plants

Unit 5 SMALL HYDROPOWER SYSTEMS

Overview of micro, mini and small hydro systems; Hydrology; Elements of pumps and turbine; Selection and design criteria of pumps and turbines; Site selection and civil works; Speed and voltage regulation; Investment issues load management and tariff collection; Distribution and marketing issues: case studies; Potential of small hydro power in North East India. Wind and hydro based stand-alone hybrid power systems

TEXT BOOKS

1. Elliott,T.C.**, "**Standard Hand Book of Power Plant Engineering", McGraw Hill Book Co, 2001.
2. Wakil, E L., "Power Plant Engineering", McGraw Hill Book Co, 2001.
3. Black and Veatch. , "Power Plant Engineering"**,** CBS Published and Distributors, 2004.
4. Small and Mini Hydropwer system, Jack J Fritz, ISBN 0-07-022470-6, MC Graw Hill

REFERENCE BOOKS

1. Arora and Domkundwar., "A Course in Power Plant Engineering", DanpatRai and Co., 2004.
2. Nag, P. K., "Power Plant Engineering," Tata McGraw Hill publishing Co. Ltd., 1998.
3. Water Power Engineering, MM Dandekar& KN Sharma, Vikas Publishing House.

4. Small Hydropower Initiative and Private Sector Participartion, Alternate Hydro Energy Centre, IIT Roorkee.

EEE18R6210 ENERGY EFFICIENCY AND PERFORMANCE OF ELECTRICAL EQUIPMENT	*Credits*			
	L	***T***	***P***	***Total***
	3	**0**	**0**	**3**
Course Category: Program Electives– Theory				

COURSE OUTCOMES:

After successful completion of course, the students will be able,

CO1: Understand the basic parameters of electrical system.

CO2: Analyzethe performance of electric motors.

CO3: Apply the energy performance assessment of motors and variable speed drives.

CO4: Analyzethe performance of lighting system.

CO5: Apply the knowledge of energy efficient techniques in electrical systems.

CO/PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S						S				
CO2	S	S	M	S		S			S	M	
CO3	S	M		M		M					
CO4	S	S			S						
CO5	M		S	S		S	S	M			

Unit 1 ELECTRICAL SYSTEM

Electricity billing, Electrical load management and maximum demand control, Power factor improvement and its benefit, Selection and location of capacitors, Performance assessment of PF capacitors, Distribution and transformer losses.

Unit 2 ELECTRIC MOTORS

Types, Losses in induction motors, Motor efficiency, Factors affecting motor performance, Rewinding and motor replacement issues, Energy saving opportunities with energy efficient motors.

Unit 3 ENERGY PERFORMANCE ASSESSMENT OF MOTORS AND VARIABLE SPEED DRIVES

Performance Terms and Definitions, Efficiency Testing, Field Tests for Determining Efficiency, Determining Motor Loading, Performance Evaluation of Rewound Motors, Application of Variable Speed Drives (VSD), Factors for Successful Implementation of Variable Speed Drives, Information needed to Evaluate Energy Savings for Variable Speed Application.

Unit 4 LIGHTING SYSTEM

Light source, Choice of lighting, Luminance requirements, and Energy conservation avenues. Energy Performance Assessment of Lighting Systems: Purpose of the Performance Test, Performance Terms and Definitions Preparation (before Measurements), Procedure for Assessment of Lighting Systems, ILER Assessment, Areas for Improvement.

Unit 5 ENERGY EFFICIENT TECHNOLOGIES IN ELECTRICAL SYSTEMS

Maximum demand controllers, Automatic power factor controllers, Energy efficient motors, Soft starters with energy saver, Variable speed drives, Energy efficient transformers, Electronic ballast, Occupancy sensors, Energy efficient lighting controls, Energy saving potential of each technology.

TEXT BOOKS

1. Book III – Energy Efficiency in Electrical Utilities, Second Edition, Bureau of Energy Efficiency, Second Edition, 2005
2. Book IV – Energy Performance Assessment for Equipment and Utility Systems, Second Edition, Bureau of Energy Efficiency, Second Edition 2005.

	Credits			
EEE18R6211 ENERGY EFFICIENCY AND PERFORMANCE IN THERMAL UTILITIES	***L***	***T***	***P***	***Total***
	3	**0**	**0**	**3**

Course Category: Program Electives– Theory

COURSE OUTCOMES:

After successful completion of course, the students will be able,

CO1: Understand the basic of fuels and combustion.

CO2: Analyzethe energy performance assessment of boilers.

CO3: Analyze the steam system.

CO4: Apply the energy performance assessment of cogeneration and turbines.

CO5: Apply the knowledge of energy performance assessment of heat exchangers.

CO/PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S				S		S				
CO2	S	S	M	S		S		S	S	M	
CO3	S	S	S			M	S				
CO4	S	S			S						
CO5	S	S	S	S		S	S	M			

Unit 1 FUELS AND COMBUSTION

Introduction to Fuels, Properties of Fuel oil, Coal and Gas, Storage, handling and preparation of fuels, Principles of Combustion, Combustion of Oil, Coal, and Gas. BOILERS:Types, Combustion in boilers, Performances evaluation, Analysis of losses, Feed water treatment, Blow down, Energy conservation opportunities. FBC BOILERS:Introduction, Mechanism of fluidized bed combustion, Advantages, Types of FBC boilers, Operational features, Retrofitting FBC system to conventional boilers, saving potential.

Unit 2 ENERGY PERFORMANCE ASSESSMENT OF BOILERS

Purpose of the Performance Test, Performance Terms and Definitions, Boiler Terminology, The Direct Method Testing - Measurements Required for Direct Method Testing, Boiler Efficiency by Direct Method: Calculation and Example, Merits and Demerits of Direct Method, The Indirect Method Testing- Measurements Required for Performance Assessment Testing, Test Conditions and Precautions for Indirect Method Testing, Boiler Efficiency by Indirect Method: Calculation Procedure

and Formula, Example: Boiler Efficiency Calculation, Factors Affecting Boiler Performance, Data Collection Format for Boiler Performance Assessment.

Unit 3 STEAM SYSTEM

Properties of steam, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Identifying opportunities for energy savings. Cogeneration: Definition, Need, Application, Advantages, Classification, Saving potentials.

Unit 4 ENERGY PERFORMANCE ASSESSMENT OF COGENERATION AND TURBINES

Purpose of the Performance Test, Performance Terms and Definitions, Field Testing Procedure, Measurements and Data Collection, Calculations for Steam Turbine Cogeneration System, Small Cogeneration Plant.

Unit 5 ENERGY PERFORMANCE ASSESSMENT OF HEAT EXCHANGERS

Purpose of the Performance Test, Performance Terms and Definitions, Methodology of Heat Exchanger Performance Assessment, Instruments for monitoring, Terminology used in Heat Exchangers.

TEXT BOOKS

1. Book II – Energy Efficiency in Thermal Utilities, Second Edition, Bureau of Energy Efficiency, Second Edition 2005
2. Book IV – Energy Performance assessment for Equipment and Utility Systems, Second Edition, Bureau of Energy Efficiency, Second Edition 2005.

EEE18R6212 ADVANCED HEAT TRANSFER	*Credits*			
	L	***T***	***P***	***Total***
	3	**0**	**0**	**3**
Course Category: Program Electives– Theory				

COURSE OUTCOMES:

After successful completion of course, the students will be able to,

CO1: To understand the concept of modes of heat transfer (conduction and radiation)

CO2: To understand the concept of turbulent boundary layer heat transfer and convection heat transfer.

CO3: To analyze the phase change heat transfer and heat exchanger.

CO4: To solve the problems to enable the design and analysis of convection and diffusion problems, calculation of the flow field.

CO5: To analyze the combined heat and mass transfer and engine heat transfer correlation.

CO/PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S	S	M				S				
CO2	S	S	S		S	S	S	S	S		
CO3	S			S							
CO4	S	S			S	M				M	
CO5	S	S	S	S		S	S	M			

Unit 1 CONDUCTION AND RADIATION HEAT TRANSFER

One dimensional energy equations and boundary condition, three-dimensional heat conduction equations, extended surface heat transfer, conduction with moving boundaries, radiation in gases and vapour - gas radiation and radiation heat transfer in enclosures containing absorbing and emitting media – interaction of radiation with conduction and convection.

Unit 2 TURBULENT FORCED CONVECTIVE HEAT TRANSFER

Momentum and energy equations, turbulent boundary layer heat transfer, mixing length concept, turbulence model – K Є model, Analogy between heat and momentum transfer – Reynolds, Colburn, Prandtl turbulent flow in a tube, high speed flows.

Unit 3 PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER

Condensation with shear edge on bank of tubes, boiling – pool and flow boiling, heat exchanger, Є – NTU approach and design procedure, compact heat exchangers.

Unit 4 NUMERICAL METHODS IN HEAT TRANSFER

Finite difference formulation of steady and transient heat conduction problems – Discretization schemes – explicit, Crank Nicholson and fully implicit schemes, control volume formulation, steady one dimensional convection and diffusion problems, calculation of the flow field – SIMPLER algorithm.

Unit 5 MASS TRANSFER AND ENGINE HEAT TRANSFER CORRELATION

Mass transfer, vaporization of droplets, combined heat and mass transfer, heat transfer correlations in various applications like I.C. Engines, compressors and turbines.

TEXT BOOK

1.Incropera, F. P. and DeWitt, D.P., Fundamentals of Heat and Mass Transfer, John Wiley and Sons, 1996.

REFERENCES

1. Schlichting, Gersten, Boundary layer Theory, Springer, 2000.
2. P.K. Nag, Heat Transfer, Tata McGraw-Hill, 2002.
3. Ozisik, M. N., Heat Transfer – Basic Approach, McGraw-Hill Co., 1985.
4. Rohsenow, W. M., Harnett, J. P, and Ganic, E. N., Handbook of Heat Transfer Applications, McGraw-Hill, NY1985.
5. Ghoshdasdidar, P. S., Compiler simulation of flow and Heat Transfer, Tata McGraw-Hill, 1998.

EEE18R6214 ENERGY EFFICIENCY IN ELECTRICAL UTILITIES	*Credits*			
	L	***T***	***P***	***Total***
	3	**0**	**0**	**3**
Course Category: Program Electives– Theory				

COURSE OUTCOMES:

After successful completion of course, the students will be able,

CO1 - To understand the maximum demand, power factor, harmonics and distribution losses in the electrical utilities of power system.

CO2 - To analyze the performance characteristics and speed control of electrical motors to save energy.

CO3 - To determine the efficiency of the energy efficient motor and variable speed drives.

CO4 -To explain the operations, performance and the energy efficiency of the refrigeration and compressed air system and explain the operation and the performance analysis of DG set and cooling towers.

CO5 - To understand the fundamental operations and the energy utilities in fans, blowers, pumps and understand and design the various types of illumination systems.

CO / PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S					S					
CO2											
CO3			L				M				
CO4	M			M		L				M	
CO5			M								

Unit 1 INTRODUCTION

Electrical System: Introduction to Electric Power Supply Systems-Electricity Billing- Electrical Load Management and Maximum Demand Control -Power Factor Improvement and Benefits– Transformers-Energy Efficient Transformers- System Distribution Losses- Harmonics – Analysis of Electrical Power Systems-Maximum Demand Controllers-Automatic Power Factor Controllers.

Electric Motors: Introduction- Motor Types - Motor Characteristics - Motor Efficiency -Motor Selection -Energy Efficient Motors- Factors Affecting Energy Efficiency and Minimizing Motor-Losses in Operation- Rewinding Effects on Energy Efficiency- Speed Control of AC Induction Motors-Motor Load Survey: Methodology

-Energy Efficient Motors-Soft Starter-Variable Speed Drives

Unit 2 ELECTROMECHANICAL EQUIPMENTS–I

Compressed Air System: Introduction-Compressor Types-Compressor Performance-Compressed Air System Components-Efficient Operation of Compressed Air Systems-Compressor Capacity Assessment-Checklist for Energy Efficiency in Compressed Air System.

HVAC And Refrigeration System: Introduction –Types of Refrigeration System- Common Refrigerants and Properties- Compressor Types and Application- Selection of a Suitable Refrigeration System-Performance Assessment of Refrigeration Plants- Factors Affecting Performance and Energy Efficiency of –Refrigeration Plants- Energy Savings Opportunities

Unit 3 ELECTROMECHANICALEQUIPMENTS–II

Fans and Blowers: Introduction - Fan Types - Fan Performance Evaluation and Efficient System Operation-Fan Design and Selection Criteria-Flow Control Strategies- Fan Performance Assessment-Energy Saving Opportunities

Pumps and Pumping System: Pump Types –System Characteristics-Pump Curves- Factors Affecting Pump Performance-Efficient Pumping System Operation-Flow ControlStrategies-EnergyConservationOpportunitiesinPumpingSystems.

Unit 4 DG SET SYSTEM AND COOLING TOWERS

DG set system: Introduction-Selection and Installation Factors-Operational Factors-Energy Performance Assessment of DG Sets-Energy Savings Measures for DG Sets. **Cooling Towers:** Introduction - Cooling Tower Performance - Efficient System Operation-FlowControlStrategies-EnergySavingOpportunitiesinCoolingTowers

Unit 5 LIGHTING SYSTEM

Introduction –Basic Terms in Lighting System and Features –Lamp Types and their Features-Recommended Illuminance Levels for Various-Tasks/Activities/Locations – Methodology of Lighting System Energy Efficiency Study-Case Examples-Some Good Practices in Lighting-Electronic Ballasts-Energy Efficient Lighting Controls

TEXT BOOKS

1. Openshaw Taylor, E., Utilization of Electrical Energy, Orient Longman (P) Ltd, 2003.
2. Wadhwa, C.L., Generation,Utilisation and Distribution, New age International, 2003.
3. Modern Power System analysis by D.P. Kothari (Author), I Nagrath (AuthorMcGraw Hill Education (India) Private Limited; 4 edition (29 June 2011)

REFERENCE BOOKS

1. Partab, H., Art and Science of Utilisation of Electrical Energy, DhanpatRai and Co, New Delhi, 2004.
2. Gupta, B.R., Generation of Electrical Energy, Eurasia Publishing House (P) Ltd, New Delhi, 2003.
3. Gupta, J.B., Utilization of Electric Power and Electric Traction, S.K.Kataria and Sons, 2002.

EEE18R6001 Distributed Generation and Micro Grid	*Credits*			
	L	***T***	***P***	***Total***
	3	**0**	**0**	**3**
Course Category: Program Electives– Theory				

COURSE OUTCOMES:

After successful completion of course, the students will be able,

CO1 - To understand the energy crises and its remedies

CO2 - To understand the principles and standards of Distributed generation

CO3 - To analyze the impact of DG with grid

CO4 - To understand the concept of microgrid

CO5 - To analyze the issues for power quality in microgrid

CO / PO Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S				S						
CO2	S	S					S				
CO3	S	M		M	S	S					S
CO4	S	S	S	S			S				S

CO5	S		S		S						

Unit-I Introduction

Conventional power generation: advantages and disadvantages, Energy crises, Non-conventional energy (NCE) resources: review of Solar PV, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources.

Unit-II Distributed Generations (DG)

Concept of distributed generations, topologies, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547. DG installation classes, security issues in DG implementations. Energy storage elements: Batteries, ultra-capacitors, flywheels. Captive power plants.

Unit-III Impact of Grid Integration

Requirements for grid interconnection, limits on operational parameters,: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.

Unit-IV Microgrids

Concept and definition of microgrid, microgrid drivers and benefits, review of sources of microgrids, typical structure and configuration of a microgrid, AC and DC microgrids, Power Electronics interfaces in DC and AC microgrids, communication infrastructure, modes of operation and control of microgrid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques.

Unit-V Power Quality Issues in Microgrids

Modelling and Stability analysis of Microgrid, regulatory standards, Microgrid economics, smart microgrids.

TEXT BOOKS

1. AmirnaserYezdani, and Reza Iravani, "Voltage Source Converters in Power Systems: Modeling, Control and Applications", IEEE John Wiley Publications, 2009.
2. DorinNeacsu, "Power Switching Converters: Medium and High Power", CRC Press, Taylor & Francis, 2006.
3. Chetan Singh Solanki, "Solar Photo Voltaics", PHI learning Pvt. Ltd., New Delhi, 2009.

REFERENCE BOOKS:

1. J.F. Manwell, "Wind Energy Explained, theory design and applications," J.G. McGowan Wiley publication, 2002.
2. D. D. Hall and R. P. Grover, "Biomass Regenerable Energy", John Wiley, New York, 1987.
3. John Twidell and Tony Weir, "Renewable Energy Resources" Tyalor and Francis Publications, 2005.

EEE18R5004 SMART GRID TECHNOLOGY	*Credits*			
	L	***T***	***P***	***Total***
	3	**0**	**0**	**3**
Course Category: Program Electives– Theory				

COURSE OUTCOMES:

After successful completion of course, the students will be able,

CO1 - To understand the challenges and the benefits of the smart grid system.

CO2 - To apply the knowledge of PMU and WAMS in the power system operation.

CO3 - To understand the benefits, standards and initiatives of AMI, IoT in smart grid system.

CO4 - To apply the high performance computing techniques in the smart grid environment.

CO5 – To acquire knowledge in the communications and measurement technologies, from the power-line communications to wireless.

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S					L				M	

CO2		M			L			M			
CO3						S					
CO4			M							M	
CO5	S					M					

Unit 1 INTRODUCTION TO SMART GRID

Evolution of Electric Grid - Concept, Definitions and Need for Smart Grid - Smart grid drivers, functions, opportunities, challenges and benefits - Difference between conventional & Smart Grid- Microgrid and Smart Grid Comparison - Concept of Resilient &Self-Healing Grid - Present development & International policies in Smart Grid - Smart Grid Roadmap for India.

Unit 2 PMU, SAS, DAS and WIDE AREA MONITORING

Phasor Measurement Unit (PMU): Requirements, RTU limitations, GPS Time Synchronization, Location & Placement, Features - Wide Area Monitoring Systems (WAMS) - Sub-station Automation Systems (SAS) - Distribution Automation Systems (DAS)

Unit 3 SMART METERS AND ADVANCED METERING INFRASTRUCTURE

Introduction to Smart Meters - Advanced Metering infrastructure (AMI) drivers and benefits - AMI protocols - standards and initiatives - AMI needs in the smart grid –smart meter data analytics ,Big Data, IoT

Unit 4 HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS

Local Area Network (LAN) - House Area Network (HAN) - Wide Area Network (WAN) - Broadband over Power line (BPL) - IP based Protocols - Basics of Web Service and CLOUD Computing to make Smart Grids smarter - Cyber Security for Smart Grid.

Unit 5 SMART GRID COMMUNICATIONS AND MEASUREMENT TECHNOLOGY

Communication and Measurement - Monitoring, PMU, Smart Meters, and Measurements Technologies - GIS and Google Mapping Tools - Multiagent Systems (MAS) Technology

TEXT BOOKS

1. Smart Grid: Fundamentals of design and analysis, James Momoh, John Wiley & sons Inc, IEEE press 2012.
2. Smart Grid: Technology and Applications, JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, John Wiley & Sons, 2012

REFERENCE BOOKS

1. Smart Grid: Integrating Renewable, Distributed & Efficient Energy, Fereidoon P. Sioshansi, Academic Press, 2011.
2. Stuart Borlase, "Smart Grid: Infrastructure, Technology and Solutions", CRC Press 2012.
3. Ali Keyhani and Muhammad Marwali, "Smart Power Grids 2011", Springer Publications, 2011.
4. Christine Hertzog, "Smart Grid Dictionary", Springer publications, 2009.
5. Tony Flick, Justin morehouse, "Securing the smart grid: Next generation power grid security", Elsevier, 2010.

EEE18R6217 POLICY AND REGULATORY ASPECTS OF RENEWABLE POWER GENERATION	*Credits*			
	L	***T***	***P***	***Total***
	3	**0**	**0**	**3**
Course Category: Program Electives– Theory				

COURSE OUTCOMES:

After successful completion of course, the students will be able to,

CO1: Understand the renewable energy regulations in India.

CO2: Understand the policy & regulatory aspects of renewable power generation.

CO3: Understand the need and advantage of decentralized energy solutions.

CO4: Understand the policy & regulatory aspects of rural sectors

CO5: Understand the development renewable power generation through case study.

CO / PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S	M	S	S							
CO2	S	S	S		S	S					
CO3		S	S	M	M						
CO4	S	S				M					
CO5	S	S	S	S	M	S					

Unit 1 RENEWABLE ENERGY REGULATIONS

Renewable energy credit schemes, statuary requirements, activities of various states in this regards, tariff determination issue, National Solar Mission, Regulations regarding grid interconnections of renewable energy systems.

Unit 2 POLICY AND REGULATORY FRAMEWORK FOR DECENTRALIZED ELECTRICITY

Emergence of policy and regulatory framework for decentralized electricity (Gokak Committee on DDG under MoP, REST Mission, Power for All, Electricity Act, 11th plan WG on DDG, RGGVY guidelines on DDG, and others, policy framework in other select countries e.g. Sri Lanka, China, Thailand etc).

Unit 3 DECENTRALIZED ENERGY SOLUTIONS

Status of grid connected and off grid distributed generation (national and International).Electrification and off grid status/scenario in India.

Unit 4 POLICY & REGULATORY ASPECTS OF RURAL SECTORS

Scope and challenges in implementing off grid solutions. Policy & regulatory Framework for rural electrification, Relevant policies and frameworks in other countries. Recent off grid programs started by Govt. of India for enhancing the rural electrification through off-grid solutions. DDG scheme under Rajiv Gandhi GrameenVidyutikaranYojana (RGGVY).Remote Village Electrification Program. Village Energy Security Programme (VESP) Off grid programme under JNNSM.

Unit 5 SIMULATION STUDIES OF POLICY AND REGULATIONS

Seminar on policy framework, outcomes, advantages/disadvantages. Planning tools used for design and sizing of DDG systems (RET Screen, HOMER). - case study and analysis its policy framework, outcomes, advantages/disadvantages.

TEXT BOOKS

1. Distributed Power Generation Planning and Evaluation, H.Lee Willis, Walter G. Scott, IET Power Marcel Dekker, Inc. (2000).

REFERENCES

1. Comparative Study on Rural Electrification Policies in Emerging Economies: Keys To Successful Policies; International Energy Agency.
2. Best practices of the Alliance for Rural Electrification: what renewable energy can achieve in developing countries; Alliance for Rural Electrification.
3. Gokak Committee Report on DDG & Report on the Working Group on Power for Eleventh Plan (2007-12).

EEE18R6218 ENERGY MANAGEMENT IN FURNACE & HEAT EXCHANGERS	*Credits*			
	L	***T***	***P***	***Total***
	3	**0**	**0**	**3**
Course Category: Program Electives– Theory				

COURSE OUTCOMES:

After successful completion of course, the students will be able to,

CO1: Understand the basics of furnaces.

CO2: Apply the energy performance assessment of furnaces.

CO3: Understand the insulation and refractory.

CO4: Apply the energy performance assessment of heat exchangers.

CO5: Apply the waste heat recoveryin different industrial sectors.

CO / PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11

CO1	S		S	S					S		
CO2	S	S	M		M						
CO3	S	S	S	M	S		M	S	S		S
CO4	S	S	S	S	M	M	M	M	M		
CO5	S		S	S							S

Unit 1 FURNACES

Classification, General fuel economy measures in furnaces, Excess air, Heat distribution, Temperature control, Draft control, Waste heat recovery.

Unit 2 ENERGY PERFORMANCE ASSESSMENT OF FURNACES

Industrial Heating Furnaces, Purpose of the Performance Test, Performance Terms and Definitions, Furnace Efficiency Testing Method, Direct Method Testing, Indirect Method Testing, Measurement Parameters, Energy Efficiency by Indirect Method, Factors Affecting Furnace Performance, Useful Data.

Unit 3 INSULATION AND REFRACTORY

Insulation-types and application, Economic thickness, of insulation, Heat savings and application criteria, Refractory-types, selection and application of refractory, Heat loss.

Unit 4 ENERGY PERFORMANCE ASSESSMENT OF HEAT EXCHANGERS

Purpose of the Performance Test, Performance Terms and Definitions, Methodology of Heat Exchanger Performance Assessment, Instruments for monitoring, Terminology used in Heat Exchangers.

Unit 5 WASTE HEAT RECOVERY

Classification, Advantages and applications, commercially viable, waste heat recovery devices, Saving potential.

TEXT BOOKS

1. Book II – Energy Efficiency in Thermal Utilities, Second Edition, Bureau of Energy Efficiency, Second Edition 2005.

2. Book IV – Energy Performance assessment for Equipment and Utility Systems, Second Edition, Bureau of Energy Efficiency, Second Edition 2005.

EEE18R6219 INDUSTRIAL & COMMERCIAL ASPECTS OF RENEWABLE ENERGY SOURCES	*Credits*			
	L	***T***	***P***	***Total***
	3	**0**	**0**	**3**
Course Category: Program Electives– Theory				

COURSE OUTCOMES:

After successful completion of course, student will be able to,

CO1: Understand the basics of Commercial and industrial energy demand.

CO2: Develop renewable energy system for industrial applications.

CO3: Analyze the renewable energy generation to meet the needs.

CO4: Apply the renewable energy generation for different kinds of loads.

CO5: Analyze renewable energy installations both commercial and industrial installations.

CO / PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S		S	S			M		S		
CO2	S	S			M	S		S	S		S
CO3		S	S				S	S	S		
CO4	S	S	S	S	M	S		M			
CO5	S		S	S					M		S

Unit 1 COMMERCIAL AND INDUSTRIAL ENERGY DEMAND

Commercial and industrial energy demand; Qualitative and quantitative features and characteristics.

Unit 2 RENEWABLE HEATING SYSTEMS

Renewable & electricity for a growing economy. Water heating, process heating and drying applications; Solar, Biomass and geothermal energy based systems, Combined space and building service hot water systems.

Unit 3 RENEWABLE ENERGY SYSTEMS

Electricity generation from renewable to meet commercial and industrial power requirement. Stand alone and grid connected systems.

Unit 4 FORMS OF RENEWABLE ENERGY

Ethanol and methanol from cellulosic biomass, Use of renewable in commercial and industrial buildings for load leveling, lighting and space heating and cooling.

Unit 5 RENEWABLE ENERGY ECONOMICS

Economics of renewable energy based commercial and industrial installations case studies.

TEXT BOOKS

1. Godfrey Boyle., Renewable Energy: Power for a Sustainable Future, Second Edition, Oxford University Press, 2004.
2. Sunggyu Lee, James G. Speight, Sudarshan K. Loyalka, Handbook of Alternative Fuel Technologies, CRC Press,Taylor and Franics Group, 2007.

REFERENCE BOOKS

1. 1. Renewable Energy Engineering and Technology – A Knowledge Compendium, ed. VVN Kishore, TERI Press, 2008.

EEE18R6220 ENERGY PERFORMANCE OF PUMPS, FANS AND BLOWERS	*Credits*			
	L	***T***	***P***	***Total***
	3	**0**	**0**	**3**
Course Category: Program Electives– Theory				

COURSE OUTCOMES:

After successful completion of course, student will be able to,

CO1: Analyze the knowledge of fans and blowers.

CO2: Apply the energy performance assessment of fans and blowers**.**

CO3: Understand characteristics of pumps and pumping system.

CO4: Apply the energy performance assessment of water pumps.

CO5: Apply the energy performance assessment of diesel conservation system.

CO / PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	S	S	S	S			M	S	S		
CO2	S	S	S		M	S	S	S			S
CO3	S	S		S	S		S	S		S	
CO4	S	S	S	S	M	S		M			
CO5	S		S	S		S	S		M		S

Unit 1 FANS AND BLOWERS

Types, Performance evaluation, efficient system operation, Flow control strategies and energy conservation opportunities.

Unit 2 ENERGY PERFORMANCE ASSESSMENT OF FANS AND BLOWERS

Purpose of the Performance Test, Performance Terms and Definitions, Field Testing, Measurement of Air Velocity on Site, Determination of Flow, Determination of Fan Pressure, Determination of Power Input, Example: Performance Test Report on Cooling Air Fan, Factors that Could Affect Performance

Unit 3 PUMPS AND PUMPING SYSTEM

Types, Performance evaluation, efficient system operation, Flow control strategies and energy conservation opportunities.

Unit 4 ENERGY PERFORMANCE ASSESSMENT OF WATER PUMPS

Purpose of the Performance Test, Performance Terms and Definitions, Field Testing for Determination of Pump Efficiency, Flow Measurement, Determination of total head, Determination of hydraulic power, Example of pump efficiency calculation, Determining the System resistance and Duty point-Case study for Energy performance analyze of water pumps in agriculture industries

Unit 5 DIESEL GENERATING SYSTEM

Factors affecting selection, Energy performance assessment of diesel conservation avenues.

TEXT BOOKS

1. Book II – Energy Efficiency in Thermal Utilities, Second Edition, Bureau of Energy Efficiency, Second Edition 2005.
2. Book III – Energy Efficiency in Electrical Utilities, Second Edition, Bureau of Energy Efficiency, Second Edition 2005.
3. Book IV – Energy Performance assessment for Equipment and Utility Systems, Second Edition, Bureau of Energy Efficiency, Second Edition 2005.

GENERAL ELECTIVE COURSES

CSE18R5051 CLOUD COMPUTING	***Credits***			
	L	***T***	***P***	***Total***
	3	***0***	***0***	***3***
Pre-requisite: --	**Course Category: General Elective** **Course Type: Theory**			

Unit-1 Introduction Cloud Computing

Nutshell of cloud computing, Enabling Technology, Historical development, Vision, feature Characteristics and components of Cloud Computing. Challenges, Risks and Approaches of Migration into Cloud. Ethical Issue in Cloud Computing, Evaluating the Cloud's Business Impact and economics, Future of the cloud. Networking Support for Cloud Computing. Ubiquitous Cloud and the Internet of Things

Unit-2 Cloud Computing Architecture

Cloud Reference Model, Layer and Types of Clouds, Services models, Data center Design and interconnection Network, Architectural design of Compute and Storage Clouds. Cloud Programming and Software: Fractures of cloud programming, Parallel and distributed programming paradigms-MapReduce, Hadoop , High level Language for Cloud. Programming of Google App engine,

Unit-3 Virtualization Technology

Definition, Understanding and Benefits of Virtualization. Implementation Level of Virtualization, Virtualization Structure/Tools and Mechanisms, Hypervisor VMware, KVM, Xen. Virtualization: of CPU, Memory, I/O Devices, Virtual Cluster and Resources Management, Virtualization of Server, Desktop, Network, and Virtualization of data-center

Unit-4 Securing the Cloud

Cloud Information security fundamentals, Cloud security services, Design principles, Policy Implementation, Cloud Computing Security Challenges, Cloud Computing Security Architecture . Legal issues in cloud Computing.
Data Security in Cloud: Business Continuity and Disaster Recovery , Risk Mitigation , Understanding and Identification of Threats in Cloud, SLA-Service Level Agreements, Trust Management

Unit-5 Cloud Platforms in Industry

Amazon web services Google AppEngine, Microsoft Azure Design, Aneka Cloud Application Platform -Integration of Private and Public Clouds Cloud applications: Protein structure prediction, Data Analysis, Satellite Image Processing, CRM and E ,Social networking . Cloud Application- Scientific Application, Business Application. Advance Topic in Cloud Computing: Federated Cloud/InterCloud, Third Party Cloud Services.

Text/Reference Books :

1. "Distributed and Cloud Computing " By Kai Hawang , GeofreyC.Fox, Jack Dongarra Pub: Elservier
2. Cloud Computing ,Principal and Paradigms, Edited By RajkumarBuyya, Jemes Broberg, Goscinski, Pub.- Wiley
3. Kumar Saurabh, "Cloud Computing" , Wiley Pub
4. Krutz , Vines, "Cloud Security " , Wiley Pub
5. Velte, "Cloud Computing- A Practical Approach" ,TMH Pub

CSE18R5052 IOT AND APPLICATIONS	***Credits***			
	L	***T***	***P***	***Total***
	3	***0***	***0***	***3***
Pre-requisite: --	**Course Category: General Elective** **Course Type: Theory**			

Unit 1

IoT& Web Technology The Internet of Things Today, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization, Recommendations on Research Topics.

Unit 2

M2M to IoT – A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

Unit 3

IoT Architecture -State of the Art – Introduction, State of the art, Architecture Reference Model-Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture-Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views

Unit 4

IoT Applications for Value Creations Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT For Oil and Gas Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth.

Unit 5

Internet of Things Privacy, Security and Governance Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security

Reference Books:

1. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1 st Edition, VPT, 2014

2. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1 st Edition, Apress Publications, 2013

3. CunoPfister, Getting Started with the Internet of Things, O"Reilly Media, 2011, ISBN: 978-1-4493-9357-1

CSE18R5053 BIG DATA ANALYTICS	***Credits***			
	L	***T***	***P***	***Total***
	3	***0***	***0***	***3***
Pre-requisite: --	**Course Category: General Elective** **Course Type: Theory**			

UNIT I – INTRODUCTION TO DATA ANALYTICS

Data analytics process – roles, stages in data science project – working with data from files – working - with relational databases – exploring data – managing data – cleaning and sampling for modeling and validation – introduction to NoSQL.

UNIT II – MODELING METHODS

Choosing and evaluating models – mapping problems to machine learning, evaluating clustering models, validating models – cluster analysis – K-means algorithm, Naïve Bayes – Memorization Methods – Linear and logistic regression – unsupervised methods.

UNIT III – INTRODUCTION TO R

Reading and getting data into R – ordered and unordered factors – arrays and matrices – lists and data frames – reading data from files – probability distributions – statistical models in R - manipulating objects – data distribution.

UNIT IV – MAP REDUCE

Introduction – distributed file system – algorithms using map reduce, Matrix-Vector Multiplication by Map Reduce – Hadoop - Understanding the Map Reduce architecture - Writing Hadoop MapReduce Programs - Loading data into HDFS - Executing the Map phase - Shuffling and sorting - Reducing phase execution.

UNIT V- DELIVERING RESULTS

Documentation and deployment – producing effective presentations – Introduction to graphical analysis – plot () function – displaying multivariate data – matrix plots – multiple plots in one window - exporting graph - using graphics parameters. Case studies.

REFERENCES

1. Nina Zumel, John Mount, “Practical Data Science with R”, Manning Publications, 2014.
2. Jure Leskovec, Anand Rajaraman, Jeffrey D. Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2014.
3. 3. Mark Gardener, “Beginning R - The Statistical Programming Language”, John Wiley & Sons, Inc., 2012.
4. W. N. Venables, D. M. Smith and the R Core Team, “An Introduction to R”, 2013.
5. Tony Ojeda, Sean Patrick Murphy, Benjamin Bengfort, AbhijitDasgupta, “Practical Data Science Cookbook”, Packt Publishing Ltd., 2014.
6. Nathan Yau, “Visualize This: The FlowingData Guide to Design, Visualization, and Statistics”, Wiley, 2011.
7. Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, “Professional Hadoop Solutions”, Wiley, ISBN: 9788126551071, 2015.
8. http://www.johndcook.com/R_language_for_programmers.html
9. http://bigdatauniversity.com/
10. http://home.ubalt.edu/ntsbarsh/stat-data/topics.htm#rintroduction

EEE18R5020 SOFT COMPUTING TECHNIQUES	*Credits*			
	L	***T***	***P***	***Total***
	3	***0***	***0***	***3***
Course Category: General Elective - Theory				

Course Outcome(s):

After completing this course, the student will be able to:

CO1: To understand the basic concepts of soft computing techniques
CO2: To solve real world problems using neural network
CO3: To analyse the functioning of recurrent neural network
CO4: To apply genetic algorithm to solve the optimization problem
CO5: To develop fuzzy logic controller and ANN for the given system

Course Topics:

Unit 1: INTRODUCTION AND FEEDFORWARD NEURAL NETWORK

Introduction to soft computing -soft computing vs hard computing-various types of soft computing techniques-applications of soft computing-Neuron-Nerve structure and synapse- Artificial Neuron and its model-activation functions-Neural network architecture-single layer and multilayer feed forward networks-McCullochPitts neuron model-perceptron model -Adaline and Madaline-multilayer perception model-back propagation learning algorithm- Implement back propagation learning algorithm using Matlab Toolbox.

Unit 2: RECURRENT NEURAL NETWORKS

Counter propagation network-architecture-functioning & characteristics of counter-Propagation network-Hopfield/ Recurrent network-configuration-stability constraints-associative memory- and characteristics-limitations and applications-Hopfield v/s Boltzman machine-Adaptive Resonance Theory-Architecture-classifications-Implementation and training-Associative Memory- Design of multilayer feed forward network using MATLAB Toolbox..

Unit 3: FUZZY LOGIC SYSTEM

Introduction to crisp sets and fuzzy sets-basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control-Fuzzification-inferencing and defuzzification- Fuzzy knowledge and rule bases-Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control-Fuzzy logic control for nonlinear time delay system- Development of Neuro fuzzy system using MATLAB tool box.

Unit 4: GENETIC ALGORITHM

Basic concept of Genetic algorithm and detail algorithmic steps-adjustment of free Parameters-Solution of typical control problems using genetic algorithm-Concept on some other search techniques like tabu search and ant colony search techniques for solving optimization problems- Implementation of optimization problem using MATLAB Toolbox.

Unit 5: APPLICATIONS

GA application to power system optimization problem-Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab-Neural Network toolbox. Stability analysis of Neural Network interconnection systems-Implementation of fuzzy logic controller using Matlab fuzzy logic toolbox-Stability analysis of fuzzy control systems.

Text Book(s):

1. S.N. Sivanandam, S.N. Deepa, “Principles of Soft Computing” 2nd Edition, Wiley, 2011.
2. Fakhreddine O. Karray and Clarence De Silva, “Soft Computing & Intelligent System: Theory, Tools and Applications”, First edition, Pearson Education, 2009.

Reference(s):

1. Laurene V. Fausett, Fundamentals of Neural Networks: Architectures, Algorithms And Applications, Pearson Education. 2004
2. Timothy J. Ross, “Fuzzy Logic with Engineering Applications” Wiley India., 2010.

EEE18R6013 EVOLUTIONARY COMPUTATION TECHNIQUES	*Credits*			
	L	***T***	***P***	***Total***
	3	***0***	***0***	***3***
Course Category: General Elective - Theory				

Course Outcome(s):

After successful completion of course, the students will be able,

CO1 - To understand the working principle of evolutionary computation.

CO2 - To apply Genetic Algorithm to solve optimization problems.

CO3 - To recognize the powerfulness of EC Techniques and the ability to apply EC algorithms to solve optimization problem.

CO4 - To understand the principle of PSO and to solve optimization problems.

CO5 - To understand the principle of ACO and to solve optimization problems.

Course Topics:

Unit 1: EVOLUTIONARY COMPUTATION (EC): THE BACKGROUND

Outline of Evolutionary Algorithms (EA) – EA Terminologies – Robust adaptation and Machine Intelligence – Principles of Evolutionary Processes – Principles of Genetics – No-free Lunch theorem for EA – Advantages of EA over other approaches.

Unit 2: GENETIC ALGORITHM (GA)

Binary GA – genetic operators – Tournament, Proportionate and Ranking Selection – Single point, two-point and uniform crossover – Elitism – Real Parameter GA – Linear, naïve, blend and Simulated Binary Crossover – Random, Non-uniform, Normally distributed and Polynomial Mutation – Constraint Handling Techniques in GA.

Unit 3: EVOLUTIONARY STRATEGIES (ES) & EVOLUTIONARY PROGRAMMING (EP)

Non-Re combinative ES – Re combinative ES – Self Adaptive ES – Connection between RGA and Self adaptive ES – Evolutionary Programming(EP) – EP and ES: Similarities and Differences – Genetic Programming (GP) – Population size and Dynamics – Convergence and Stopping Criteria – Exploration and Exploitation.

Unit 4: PARTICLE SWARM OPTIMIZATION (PSO)

Concepts and formulation – Simulating the Social behavior – PSO algorithm – Topology – Parameter Selection and Improvements for Convergence – Maximum Velocity – Acceleration Constants - Constriction factor - Inertia weight – Advantages of PSO.

Unit 5: ANT COLONY OPTIMIZATION (ACO)

Ants' Foraging Behavior – Stigmergy – Double Bridge Experiment – Real Ants to Artificial Ants – Behavioral Differences – Properties of Artificial Ants – ACO Algorithms – Ant System - MAX–MIN Ant System – Ant Colony System (ACS) – Advances of ACO.

Text Book(s):

1. S.N. Sivanandam, S.N. Deepa, "Principles of Soft Computing" 2nd Edition, Wiley, 2011.
2. Fakhreddine O. Karray and Clarence De Silva, "Soft Computing & Intelligent System: Theory, Tools and Applications", First edition, Pearson Education, 2009.

Reference(s):

1. Kalyanmoy Deb, "Multi-Objective Optimization using Evolutionary Algorithms", 3rd Edition, John Wiley & Sons, 2008.
2. Thomas Back, David BFogel and ZbigniewMichalewicz, "Evolutionary Computation 1 &2 : Basic/advanced Algorithms and Operators", Institute of Physics Publishing, 2000.
3. Marco Dorigo and Thomas Stutzle, "Ant Colony Optimization", MIT Press, 2004.
4. JurgenBranke, Kalyanmoy Deb, KaisaMiettinen and Roman Slowinski (Eds.), "MultiObjective Optimization: Interactive and Evolutionary Approaches", Springer-Verlag, 2008.

	Credits			
EEE18R5021 OPTIMIZATIONTECHNIQUES	***L***	***T***	***P***	***Total***

	3	***0***	***0***	***3***
Course Category: General Elective - Theory				

Course Outcome(s):
After successful completion of course, the students will be able,
CO1- To understand the importance of optimization for solving engineering applications.
CO2 - To solve the linear optimization problems using conventional mathematical methods.
CO3 - To understand the NewtonsMethod, Sequential quadratic programming and Penalty function method for solving the nonlinear optimization problems.
CO4 - To solve optimality problems using dynamic programming methods.
CO5 - To formulate genetic algorithm to solve optimization problems.

Course Topics:

Unit 1: INTRODUCTION

Definition, Classification of optimization problems, Classical Optimization Techniques, Single and Multiple Optimization with and without inequality constraints.

Unit 2: LINEAR PROGRAMMING (LP)

Simplex method of solving LPP, revised simplex method, duality, constrainedoptimization,Theorems and procedure, Linear programming, mathematical model, solution technique, duality.

Unit 3: NON LINEARPROGRAMMING

Steepest descent method, conjugates gradient method, NewtonsMethod, Sequential quadratic programming, Penalty function method, augmented Lagrange multiplier method.,

Unit 4:DYNAMICPROGRAMMING (DP)

Multistage decision processes, concept of sub-optimization and principle of optimality, Recursive relations, Integer Linear programming, Branch and bound algorithm

Unit 5: GENETIC ALGORITHM

Introduction to genetic Algorithm, working principle, coding of variables, fitness function, GA operators; Similarities and differences between Gas and traditional methods; Unconstrained and constrained optimization using genetic Algorithm, real coded gas, Advanced Gas, global optimization using GA, Applications to power system.

Reference(s):

1. Computational methods in Optimization, Polak, Academic Press, 1971.
2. Optimization Theory with applications, Pierre D.A.,WileyPublications, 1969.
3. Taha, H. A., Operations Research: An Introduction, Seventh Edition, Pearson Education Edition, Asia, New Delhi ,2002.
4. S.S.Rao,"Optimization–TheoryandApplications",Wiley-Eastern Limited, 1984.
5. G.Luenberger," Introduction of Linear and Non-Linear Programming",Wesley Publishing Company, 2011

INTERDISCIPLINARY ELECTIVE COURSES

ECE18R5141 BASICS OF VLSI DESIGN	***Credits***			
	L	***T***	***P***	***Total***
	3	***0***	***0***	***3***
Pre-requisite: --	**Course Category: Interdisciplinary Elective** **Course Type: Theory**			

COURSE OUTCOME(S):
After completing this course, the student will be able to:

1. Explain the characteristics of CMOS transistors
2. To learn the MOS process technology
3. To learn the basic CMOS circuit design and system design

COURSE TOPICS:

UNIT I: MOS TRANSISTOR THEORY

CMOS logic, CMOS fabrication layout, Design partitioning, Logic design, circuit design, physical design, MOS transistor theory, CV characteristics, Non-ideal IV effects, DC transfer characteristics, pitfalls and fallacies

UNIT II: CMOS PROCESSING TECHNOLOGY

CMOS design rules, CMOS process enhancement, and technology related CAD issues, manufacturing issues. Delay –Transient response, RC delay model and linear delay model, logical efforts of path, Timing analysis and delay fault models.

UNIT III: POWER AND INTERCONNECT

Dynamic power, static power, energy delay optimization, Low power optimization, Interconnect – Wire geometry, Interconnect modelling, Interconnect Engineering, Logical effort with wires, Robustness – variability, Reliability, Scaling, statistical Analysis of variability, variation in tolerant design

UNIT IV: CIRCUIT DESIGN USING CMOS

Combinational circuit design – circuit families, circuit pitfalls, SOI circuit design, threshold circuit design, Sequential circuit design- sequential static circuits, circuit design of latches and flip flops, static sequential element methodology, sequencing dynamic circuits.

UNIT V: SYSTEM DESIGN USING CMOS

Array sub systems – SRAM, DRAM, Read only memory, Serial access memory, CAM, PLA, Robust memory design, Special purpose systems- Overview, packages and cooling, Power distribution, clocks, PLLs and DLLs, I/Os, High speed links, random circuits

REFERENCE(S):

1. Neil H.E. Weste and David Mani Harris CMOS VLSI Design, A circuit and system perceptive, PEARSON publication, 2017.
2. Douglas A. Pucknell and Kamran Eshraghian, BASIC VLSI Design., PHI publication, 2012.
3. Kiran V. G. and Nagesh H.R. Fundamentals of CMOS VLSI Design., Pearson, 2011.

ECE18R5142 CMOS IC DESIGN	***Credits***			
	L	***T***	***P***	***Total***
	3	***0***	***0***	***3***
Pre-requisite: --	**Course Category: Interdisciplinary Elective** **Course Type: Theory**			

COURSE OUTCOME(S):

After completing this course, the student will be able to:

1. To study designs with better precision in data conversion
2. Build Data Conversion circuits
3. To study various ADC and DAC circuit architectures
4. Discuss calibration techniques

COURSE TOPICS:

UNIT I: SAMPLE AND HOLD

Properties of MOS Switches, multiplexed input architectures, recycling architecture, open and closed loop sampling architectures, switched capacitor and current mode architectures.

UNIT II: BUILDING BLOCK OF DATA CONVERSION CIRCUITS

Amplifiers, open loop and closed loop amplifiers, gain boosting, common mode feedback, bipolar, CMOS and BiCMOS comparators.

UNIT III: PRECISION TECHNIQUES

Comparator cancellation, input and output offset storage principles, comparators using offset cancelled latches, op-amp offset cancellation, ADC and DAC calibration techniques.

UNIT IV: ADC/DAC ARCHITECTURES

DAC Performance metrics, reference multiplication and division, switching and logical functions of DACs, Current steering architectures, DAC Performance metrics, Flash ADC architecture, Gray encoding, thermometer encoding and metastability.

UNIT V: OVERSAMPLING CONVERTERS

Delta sigma modulators, alternative modulator architectures, quantization and noise shaping, decimation filtering, implementation of Delta sigma modulators, delta sigma DACs

REFERENCE(S):

1. Razavi "Data Conversion System Design" IEEE Press and John Wiley, 2010
2. Phillip Allen and Douglas Holmberg "CMOS Analog Circuit Design", Oxford University Press, 2011
3. P. Gray, P. Hurst, S. Lewis, R. Meyer, "Analysis and Design of Analog Integrated Circuits", Wiley-India, 2013.
4. Gregorian and Temes, "Analog MOS Integrated Circuits for Signal Processing", Wiley-India, 2012.

ECE18R6041-HIGH SPEED COMMUNICATION NETWORKS	***Credits***			
	L	***T***	***P***	***Total***
	3	***0***	***0***	***3***
Pre-requisite:	**Course Category: Interdisciplinary Elective** **Course Type: Theory**			

Course Outcomes:

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

CO1 Recognize different levels of communication networks

CO2 Reproduce characteristics of high-speed network technologies

CO3 Apply channel models to determine transmission performances

CO4 Analyse signal transmission through communication channels

CO5 Create models of access networks and channels

CO6 Compute performances of multiple access to communication channels

COURSE TOPICS:

UNIT I: LAYERED NETWORK ARCHITECTURES

Review of Open Systems Interconnection (OSI) and Transmission Control Protocol/Internet Protocol, and Internetworking

UNIT II:POINT-TO-POINT PROTOCOLS AND LINKS

Error detection – ARQ: Retransmission strategies – Framing – Point-to-point protocols at the network layer – The Transport layer – Broadband ISDN – Frame Relay – Asynchronous Transfer Mode.

UNIT III:DELAY MODELS IN DATA NETWORKS

M/M/1, M/M/m, M/M/m/m, M/M/8, M/G/1 queuing models – Networks of Transmission lines - Time reversibility (Burke's theorem) – Network of Queues (Jackson's theorem).

UNIT IV: ROUTING IN DATA NETWORKS AND INTERNET ROUTING

Wide area networking – Interconnected network Routing – Shortest path Routing – Multicast/Broadcast Routing information – Flow models – Optimal Routing and Topological design – Characterization of Optimal Routing – Interior and Exterior Routing protocols.

UNIT V:CONGESTION, TRAFFIC MANAGEMENT AND FLOW CONTROL

Congestion control in data networks and Internets – Link-level flow and error control – TCP traffic control – Traffic and Congestion control in ATM networks – Means of Flow control – Main objectives of flow control – Window flow control – Rate control schemes. Lab exercise

REFERENCE(S)

1. Dimitri Bertsekas and Robert Gallager, "Data networks", Second Edition, Prentice Hall, Inc., NJ, USA1992
2. William Stalling, "High Speed Networks and Internets", Second Edition, Pearson Education Inc., New Delhi, India, 2002
3. Leon Garcia and Widjaja, "Communication networks: Fundamental concepts and keyarchitectures", McGraw Hill, Inc., NY, USA, 2006
4. Jean Walrand, "Communication networks", McGraw Hill, Inc., NY, USA, 1998.

MEC18R5153 MECHATRONICS	Credits			
	L	*T*	*P*	*Total*
	3	*0*	*0*	*3*
Pre-requisite:	**Course Category: Interdisciplinary Elective** **Course Type: Theory**			

Course Outcome(s)

CO1 Recognize the basic elements of Measurement and Control Systems.

CO2 Identify the various sensors and transducers that can be used for mechanical applications

CO3 Demonstrate intelligent microprocessor 8085 system employed in real life scenario for Various Domestic applications

CO4 Develop a controller using Programmable Logic Controller for Mechatronics system.

CO5 Design an electronic based mechanical system for domestic applications

Course Topics:

Unit 1: Introduction to Mechatronics

Introduction to Mechatronics systems - measurement systems-control systems-Open Loop-Closed Loop control System-Block Diagram Reduction Techniques, Introduction of bio mechanics, Bio-mircro electrical mechanical system

Unit 2: **Sensors and Transducers**

Introduction-performance terminology-displacement, position and proximity-velocity and motion fluid pressure-temperature sensors-light sensors-selection of sensors-sound Sensor-Image Sensing.

Unit 3: 8085 Microprocessor

Introduction – architecture - pin configuration - instruction set - programming of microprocessors using 8085instructions-Digital Logic Circuits-Addition, Multiply-Subtract –Division-interfacing input and output devices-interfacing D/A converters and A/D converters applications-temperature control-stepper motor control-traffic light controller.

Unit 4: Programming Logic Controllers

Introduction-basic structure-input / output processing-programming - mnemonics-timers, internal relays and counters-data handling-analog input/output-selection of a PLC-Integration of PLC Circuit Using LABVIEW.

Unit *5:* Design of Mechatronic Systems

Stages in designing mechatronic systems - traditional and mechatronic design -possible design solutions-case studies of mechatronic systems - pick and place robot - automatic car park system engine management system-Automatic Dustbin Management system-Automobile Threaten Identification system.

Text Book(s):

1.Bolton, W., Mechatronics, Longman, Second Edition, 1999.

Reference(s):

1. Michael, B.H., and David, G.A., Introduction to Mechatronics and measurement systems, McGraw Hill International Editions, 1999.
2. Bradley, D.A., Dawson, D., Buru, N.C., and Loader, A.J., Mechatronics, Chapman and Hall, 1993.
3. Ram, K., Fundamentals of Microprocessors and Microcomputers, DhanpatRai Publications, Fourth Revised Edition, 1999.

Singh M.D., Joshi J.G., Mechatronics, PHI 2009

MEC18R6151INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS	***Credits***			
	L	***T***	***P***	***Total***
	3	***0***	***0***	***3***
Pre-requisite:	**Course Category: Interdisciplinary Elective** **Course Type: Theory**			

Course Outcome(s)

CO1 Understand the kinematics of robot and its degrees of freedom

CO2 Explain the drive and control units of robot

CO3 Analyze the robot sensor and vision system used

CO4 Design of robot cell and identifying suitable applications

CO5 Apply the robot for intelligence and expert systems

Course Topics:

Unit 1 INTRODUCTION AND ROBOT KINEMATICS

Definition need and scope of industrial robots – robot anatomy – work volume – precision movement – end effectors – sensors - robot kinematics – direct and inverse kinematics – robot trajectories – control of robot manipulators – robot dynamics – methods for orientation and location of objects.

Unit 2 ROBOT DRIVES AND CONTROL

Controlling the robot motion – position and velocity sensing devices – design of drive systems – hydraulic and pneumatic drives – linear and rotary actuators and control valves – electro hydraulic servo valves, electric drives – motors – designing of end effectors – vacuum, magnetic and air operated grippers.

Unit 3 ROBOT SENSORS

Transducers and sensors – sensors in robot – tactile sensor – proximity and range sensors – sensing joint forces – robotic vision system – image gribbing – image processing and analysis – image segmentation – pattern recognition – training of vision system.

Unit 4 ROBOT CELL DESIGN AND APPLICATION

Robot work cell design and control – safety in robotics – robot cell layouts – multiple robots and machine interference – robot cycle time analysis - industrial application of robots.

Unit 5 ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS

Methods of robot programming – characteristics of task level languages lead through programming methods – motion interpolation - artificial intelligence – basics – goals of artificial intelligence – AI techniques – problem representation in AI – problem reduction and solution techniques - application of AI and KBES in robots.

Text Book

1. K. S. Fu, R. C. Gonzalez and C.S.G. Lee, Robotics Control, Sensing, Vision and Intelligence, McGraw Hill, 1987.

References

1. YoramKoren, Robotics for Engineers, McGraw-Hill, 1987.
2. Kozyrey, Yu., Industrial Robots, MIR Publishers Moscow, 1985.
3. Richard, D. Klafter, Thomas, A. Chmielewski, Michael Negin, Robotics Engineering – An Integrated Approach, Prentice-Hall of India Pvt. Ltd., 1984.
4. Deb, S. R., Robotics Technology and Flexible Automation, Tata McGraw-Hill, 1994.
5. Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey, Industrial Robotics Technology, Programming and Applications, McGraw-Hill, Int. 1986.
6. Timothy Jordanides et.al, Expert Systems and Robotics, Springer –Verlag, New York, May 1991.

CSE18R5227WIRELESS NETWORK SECURITY	***Credits***			
	L	***T***	***P***	***Total***
	3	***0***	***0***	***3***
Pre-requisite:	**Course Category: Interdisciplinary Elective** **Course Type: Theory**			

Course Topics:

Unit 1: OVERVIEW

Overview of Wireless Networks - Characteristics of the Wireless Medium - Physical Layer Alternatives for Wireless Networks - Wireless Medium Access Alternatives.

Unit 2: TECHNOLOGY

Principles of Wireless Network Operation: Network Planning - Wireless Network Operation Wireless Wans: GSM and TDMA Technology - CDMA Technology, IS-95, and IMT-2000 Mobile Data Networks

Unit 3: WLAN

Wireless LANs: Overview – Architecture of Wireless LAN – Wireless LAN Configurations Wireless LAN Standards – Benefits of Wireless LAN

Unit 4: STANDARDS

Secure Wireless LANs: Network Security – Securing the IEEE 802.11 Wireless LANs. Building Secure Wireless LANs: Planning Wireless LANs

Unit 5: 802.11

Shopping for the right equipment – Equipment provisioning and LAN Setup – Advanced 802.11 Wireless LANs.

REFERENCES

1. KavehPahlavan, Prashant Krishnamurthy, Principles of Wireless Networks: A Unified Approach, Prentice Hall of India, 1st Edition , 2001

2. Jahanzeb Khan, AnisKhwaja, Jahanzeb Khan, AnisKhwaja, Building Secure Wireless Networks with 802.11, John Wiley and Sons, 1st edition ,2003

INT18R5018CELLULAR MOBILE COMMUNICATION	***Credits***			
	L	***T***	***P***	***Total***
	3	***0***	***0***	***3***
Pre-requisite:	**Course Category: Interdisciplinary Elective** **Course Type: Theory**			

Course Outcome

CO1	Understand the basic concepts of mobile computing
CO2	Analyze about internet protocol and Mobile internet protocol.
CO3	Learn about the different kinds of mobile telecommunication system.
CO4	Analyze the issues involved in adhoc networks and learn the various kinds of adhoc networks.
CO5	Identify, design and implement mobile applications in various platforms.

Course Topics:

Unit 1 CELLULAR CONCEPT

Frequency reuse - Channel Assignment Strategies - Hand off Strategies - Interference and System Capacity - Trunking and Grade of Service - Improving coverage and capacity in cellular systems.

Unit 2 RADIO PROPAGATION

Free Space Propagation Model - Propagation Mechanisms - Reflection - Diffraction and scattering - Models for Path loss - Small scale Multipath Propagation - Parameters of Mobile Multipath Channels - small scale fading types.

Unit 3 MULTIPLE ACCESS TECHNIQUES

FDMA - TDMA - CDMA - Spread Spectrum Multiple Access - Multiplexing and OFDM - Packet Radio Protocols - Capture Effect - Capacity of cellular systems.

Unit 4 EQUALIZATION, DIVERSITY AND CODING

Linear and Nonlinear Equalization - Adaptive Equalization - Diversity techniques - RAKE Receiver - Fundamentals of Channel Coding - Block codes and finite fields - convolutional codes - coding gain - Trellis coded Modulation - Turbo Codes.

Unit 5 WIRELESS STANDARDS

GSM - IS-95 -UMTS - IMT-2000 - Signaling - Call Control - Mobility Management and location tracing.

REFERENCES:

Rappaport T.S., Wireless Communications Principles and Practice, Pearson Education, 2nd Edition, 2008.

Blake R., Wireless Communication Technology, Thomson Delmar, 2nd Edition, 2007.

Lee W.C.Y., Mobile Communications Engineering: Theory and applications, McGraw-Hill International, 2nd Edition, 2009.

Project Work

EEE18R6298 PROJECT WORK PHASE I	***Credits***			
	L	***T***	***P***	***Total***
	0	***0***	***20***	***10***
Course Category: core Project				

Course Objective(s):

The emphasis of this course is to enable master engineering students to apply renewable energy principles to solve open-ended problems that will belongs to Renewable Energy field.

Strategy:

The student works on the topic approved by the project coordinator and Head of the department under the guidance of a faculty member. Student's progress is continuously monitoring by reviews conducted by the department as per the department rubrics. The students will be evaluated based on the report, publication and viva vice examination by examiner.

Course Outcomes:

After Successful completion of course, the students will be able,

CO1	:	Apply the engineering knowledge and identify the project based on energy audit or design related to renewable energy sources.
CO2	:	Design hardware circuits / software/ Audit.
CO3	:	Implement and demonstrate the projects for real time applications/products.

The student works on the topic approved by the project coordinator and Head of the department under the guidance of a faculty member. Student's progress is continuously monitoring by reviews conducted by the department as per the department rubrics. The students will be evaluated based on the report, publication and viva vice examination by examiner. Depends upon resources, students can select their research work from Renewable Energy sources, Hybrid energy sources, integration of energy sources, FACTS devices, Smart grid and energy audit related projects or related to electrical system.

EEE18R6099 PROJECT WORK PHASE II	***Credits***			
	L	***T***	***P***	***Total***
	0	***0***	***32***	***16***
Course Category: core Project				

Course Objective(s):

The emphasis of this course is to enable master engineering students to apply renewable energy principles to solve open-ended problems that will belong to Renewable Energy field.

Strategy:

The student works on the topic approved by the project coordinator and Head of the department under the guidance of a faculty member. Student's progress is continuously monitoring by reviews conducted by the department as per the department rubrics. The students will be evaluated based on the report, publication and viva vice examination by examiner.

Course Outcomes:

After Successful completion of course, the students will be able,

CO1	:	Apply the engineering knowledge and identify the project based on practical applications. It may be extend of previous phase project
CO2	:	Design hardware circuits / software/ Audit.
CO3	:	Implement and demonstrate the projects for real time applications/products.

EEE18R5199 MINI PROJECT	***Credits***			
	L	***T***	***P***	***Total***
	0	***0***	***3***	***2***

Objectives:

To develop ability to solve a specific problems right from its identification and literature till the successful solution of the same

To train the students in preparing project report and to face review and viva voce examination

Strategy:

The students works on a topic approved by the head of the department under the guidance of the

Faculty members and prepares a comprehensive project report after completing the work to satisfaction.

The student will be evaluated based on the report and the viva voce examination by a team of examiners.

Course outcomes:

- On completion of the Mini project work students will be in a position to take up any challenging Practical problems and find solution by formulating proper methodology.
- Students can improve their presentation skills and communication skills.

EEE18R5219 INDUSTRIAL TRAINING	*Credits*			
	L	***T***	***P***	***Total***
	0	***0***	***2***	***2***

Objectives:

The main objective of Industrial Training/Internship is to expose the students to actual working environment and enhance their knowledge and skill from what they have learned in the university. This course enhances student's knowledge with good qualities of integrity, responsibility and self confidence.

Strategy:

The students can choose nearby industries and get approval by department coordinator and placement officer. Students prepare a PPTs report after completing the work to satisfaction. The student will be evaluated based on the presentation, communication and the viva voce examination by examiners.

Course outcomes:

- Understand the basic working environment of industry and relevant to our courses.
- Apply the acquired skills to enrich the inplant training/internship.
- Students can improve their presentation skills and communication skills and also improve their self confidence.

EEE18R5220 SEMINAR	*Credits*			
	L	***T***	***P***	***Total***
	0	***0***	***3***	***2***

Objectives:

To prepare the students engage in the discussion of an academic subject for the aim of gaining a better insight into the subject.

To train the students in preparing project report and to face review and viva voce examination.

Strategy:

The students prepare seminar about recent advancement of their field and get approval by the course teacher. Students prepare a PPTs report after completing the work to satisfaction. The student will be evaluated based on the presentation, communication and the viva voce examination by a examiners.

Course outcomes:

- On completion of the Seminar work , students can enrich their knowledge regarding recent advancement in their field.
- Students can improve their presentation skills and communication skills.