Course Scheme and Syllabus for Minor Degree in Electrical Engineering

Department of Electrical & Instrumentation Engineering

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Scheme of Minor Degree Program in Electrical Engineering

Semester-IV

S. No.	Sub Code	Subject Name	L	T	P	Hrs.	Credits
1	MDEE-521	Instrumentation and Control	3	1	0	4	4
		Total	3	1	0	4	4

Semester-V

S. No.	Sub Code	Subject Name	L	T	P	Hrs.	Credits
1	MDEE-611	Electromechanical Energy Conversion	3	1	0	4	4
		Total	3	1	0	4	4

Semester-VI

S. No.	Sub Code	Subject Name	L	T	P	Hrs.	Credits
1	MDEE-621	Elements of Power System	3	1	0	4	4
		Total	3	1	0	4	4

Semester-VII

S. No.	Sub Code	Subject Name	L	T	P	Hrs.	Credits
1	MDEE-711	Industrial Electronics	3	1	0	4	4
		Total	3	1	0	4	4

Semester-VIII

S. No.	Sub Code	Subject Name	L	T	P	Hrs.	Credits
1	MDEE-721	Solar and Wind Energy Systems	3	1	0	4	4
		Total	3	1	0	4	4

Subject Code : MDEE-521
Title of the course : INSTRUMENTATION AND CONTROL

L	T	P	Credits	Hrs
3	0	0	3	3

Course Outcomes:
After successful completion of course, the students should be able to
CO 1: describe knowledge of basics of instrumentation systems
CO 2: classify various display and recording devices
CO 3: explain instrument selection
CO 4: describe basic of control engineering and modeling
CO 5: describe the time response and frequency response analysis

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1, BL2	BL2, BL4	BL2,BL3,BL4	BL2	BL1, BL2

CO/PO Mapping : (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	1	-	-	-	1	1	3	2
CO2	1	-	1	1	1	1	-	-	2	2	3	2
CO3	1	-	-	1	1	1	-	-	2	2	3	2
CO4	3	2	2	2	2	2	-	-	2	3	3	2
CO5	1	1	2	3	2	2	-	-	2	3	3	2

Theory:

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Generalized Instrumentation Systems:** Scope and necessity of instrumentation, Building blocks of instrumentation system, Various test signals, Errors, Sources and classification of errors.	4
	Display and Recording Devices: Operating mechanism in indicators, PMMC instruments, Moving iron instruments, Multi-meter, Dynamometer instruments.	8
	Instrument Selection: Factors affecting instrument selection, accuracy, precision, linearity, resolution, sensitivity, hysteresis, reliability, serviceability, Static and dynamic response, Environmental effects, Calibration of instruments.	8
Unit-2	**Introduction to control system:** Basic elements of a feedback control system, open loop, feedback and feed-forward, linear and non-linear, continuous and sampled-data control systems, digital control.	7
	Mathematical models for Physical Systems: Differential equations of simple mechanical, electrical, thermal, linearization of a non-linear mathematical model, transfer function derivation of physical systems, Block diagram, Signal flow graphs.	8
	Time response and frequency response analysis: Standard test signals, time response of first and second-order systems, time response specifications, steady-state errors and error constants, Stability of Systems, Concept of stability, condition for stability, Routh's Hurwitz's ability criteria, Co-relations between time and frequency response, frequency response specification.	7

Recommended Books: -

1. A.K. Sawhney, Puneet Sawhney, A Course in Electrical And Electronic Measurements And Instrumentation. Dhanpat Rai, 2012.
2. Nagrath, I.J., and M. Gopal, Control System Engineering. India, New Age International Publisher, 2017.

Subject Code : MDEE-611
Title of the course : Electromechanical Energy Conversion

L	T	P	Credits	Hrs
3	1	0	4	4

Course Outcomes:
After successful completion of course, the students should be able to
CO 1: **describe** knowledge of AC machines
CO 2: **classify** various types DC machines
CO 3: **explain** rotary electromagnetic energy conversion systems
CO 4: **identify** application of different machines

Mapping COs/Bloom's Taxonomy Level (BLs)				
COs	CO1	CO2	CO3	CO4
BLs	BL1, BL2	BL2, BL4	BL2,BL3,BL4	BL2

CO/PO Mapping: (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	2	2	-	-	3	-	2	2
CO2	1	-	-	2	3	3	-	-	3	-	2	2
CO3	1	2	-	2	2	2	1	-	2	-	2	2
CO4	1	2	-	2	2	2	1	-	2	-	2	2

Theory:

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**General Description of Electrical Machines:** Constructional details of dc and ac machines, description of magnetic and electric circuits in cylindrical rotor and salient pole machines, mmf distribution of current carrying single and multiple coils; Armature winding as a current sheet, associated mmf and flux density waves; Torque as a function of flux and mmf.	10
	DC Machines: Emf and torque equations, interaction of the fields produced by field and armature circuits. Commutation. DC Generators: Methods of excitation, shunt, series and compound generators, characteristics, testing. DC Motors: Methods of excitation, characteristics, starting and speed control methods; Losses and their estimation, efficiency.	12
Unit-2	**Induction Machines:** Classification and constructional features of wound rotor and squirrel cage induction machines. Equivalent circuit, phasor diagram, torque-speed characteristic.	10
	Synchronous Machines: Classification and constructional features of salient pole and cylindrical rotor three-phase synchronous machine. Power-angle equations cylindrical rotor synchronous machines. Voltage regulation.	10

Recommended Books-

1. Fitzgerald A. E., Kingsley C. and Kusko A., "Electric Machinery",6th Ed., McGraw-Hill International Book Company.2008
2. Say M. G., "The Performance and Design of Alternating Current Machines", CBS Publishers and Distributors. 2005
3. Say M. G. and Taylor E. O., "Direct Current Machines", 3rd Ed., ELBS and Pitman. 1986
4. Nagrath I. J. and Kothari D. P., "Electrical Machines", 3rd Ed., Tata McGraw-Hill Publishing Company Limited.
5. Melkebeek, Jan A.. Electrical Machines and Drives: Fundamentals and Advanced Modelling. Germany, Springer International Publishing, 2018.
6. Boldea, Ion, and Tutelea, Lucian N.. Electric Machines: Transients, Control Principles, Finite Element Analysis, and Optimal Design with MATLAB®. United States, CRC Press, 2021.

Subject Code : MDEE-621
Title of the course : Elements of Power System

L	T	P	Credits	Weekly Load
3	1	0	4	4

Course Outcomes:
After successful completion of course, the students should be able to
CO 1: describe knowledge of basics of electric energy generation
CO 2: classify various types of generating stations
CO 3: explain the load behavior and tariffs
CO 4: **identify** effect of power factor in power system
CO 5: **describe** the knowledge of voltage control methods

Mapping COs/Bloom's Taxonomy Level (BLs)					
Cos	CO1	CO2	CO3	CO4	CO5
BLs	BL1, BL2	BL2, BL4	BL2,BL3,BL4	BL2	BL1, BL2

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):														
COs	Program Outcomes (POs)/Program Special Outcome (PSO's)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	1	-	3	-	-	2	2	-	3	1	1
CO2	3	2	2	-	-	3	2	-	3	3	3	2	2	2
CO3	3	2	-	1	2	2	-	-	3	3	3	2	3	2
CO4	3	2	2	1	1	3	2	-	3	3	2	-	3	1
CO5	3	3	3	1	-	2	2	-	3	3	3	2	3	1

Theory

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Introduction:** Importance of Electrical Energy, Generation of Electrical Energy, Sources of Energy, Comparison of Energy Sources, Units of Energy, Relationship among Energy Units, Efficiency, Calorific value of Fuels, Advantages of Liquid Fuels Over Solid Fuels, Advantages of Solid Fuels Over Liquid Fuels.	06
	Generating Stations: Steam Power Station, Schematic Arrangement of Steam Power Station, Choice of Site for Steam Power Stations, Efficiency of Steam Power Station, Equipment of Steam Power, Station, Hydroelectric Power Station Schematic Arrangement of Hydroelectric Power Station Choice of Site for Hydroelectric Power Stations, Constituents of Hydroelectric Plant, Diesel Power Station, Schematic Arrangement of Diesel Power Station, Nuclear Power Station, Schematic Arrangement of Nuclear Power Station, Selection of Site for Nuclear Power Station, Gas Turbine Power Plant, Schematic Arrangement of Gas Turbine Power Plant, Comparison of the Various Power Plants.	10
	Structure of Electric Power System: Load Curves, Important Terms and Factors, Units Generated per Annum, Load Duration Curves, Types of Loads, Typical demand and diversity factors, Load curves and selection of Generating Units, Important points in the selection of Units, Base load and Peak load on Power Station, Method of meeting the Load, interconnected grid system.	08
Unit-2	**Tariff**: Desirable characteristics of a Tariff, Types of Tariff.	06
	Power Factor: Power Triangle, Disadvantages of Low Factor, Causes of Low Power Factor, Power Factor Improvement, Power Factor, Improvement Equipment, Calculations of Power Factor Correction, Importance of Power Factor improvement, Most Economical	08

	Power Factor, Meeting the Increased kW demand on Power Stations.	
	Voltage control: Importance of Voltage Control, Location of Voltage Control Equipment, Methods of Voltage Control, Excitation Control, Tirril Regulator, Brown-Boveri Regulator, Tap Changing Transformers, Autotransformer tap changing, Booster Transformer, Induction Regulators, Voltage control by Synchronous Condenser.	10

Recommended Books-

1. J. Grainger and W. D. Stevenson, "Power System Analysis", McGraw Hill Education,1994.
2. O. I. Elgerd, "Electric Energy Systems Theory", McGraw Hill Education, 1995.
3. A. R. Bergen and V. Vittal, "Power System Analysis", Pearson Education Inc., 1999.
4. B. M. Weedy, B. J. Cory, N. Jenkins and G. Strbac, "Electric Power Systems", Wiley, 2012.
5. V. K. Mehta and Rohit Mehta, "Principles of Power System", S. Chand publication, 2003
6. van der Sluis, Lou, and Schavemaker, Pieter. Electrical Power System Essentials. United Kingdom, Wiley, 2017.

Subject Code : MDEE-711
Title of the course : Industrial Electronics

L	T	P	Credits	Hrs
3	0	0	3	3

Course Outcomes:
After successful completion of course, the students should be able to
CO1: Observe the characteristics and operation of the various semiconductor devices.
CO2: Focus on different power electronic converters.
CO3: Classify resonant converters and their control techniques.
CO4: Describe the practical application of the different type of converters.
CO5: Explain the operation and control of multilevel inverters.

Mapping COs/Bloom's Taxonomy Level (BLs)					
COs	CO1	CO2	CO3	CO4	CO5
BLs	BL1, BL2	BL4	BL2, BL4	BL1, BL2	BL2, BL3, BL4

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	2	2	-	1	-	-	-	2	2	1
CO2	1	-	-	1	1	1	1	-	1	2	-	1
CO3	1	2	2	3	1	1	1	-	1	2	2	1
CO4	1	1	1	1	-	1	-	-	1	-	1	1
CO5	1	1	-	1	1	1	1	-	1	2	1	1

Unit	Main Topics and Course Outlines	Hour(s)
Unit-1	**Power Semiconductor Devices:** power diodes, power transistors, SCRs, TRIAC, GTO, power MOSFETs, IGBTs-Principles of operation, characteristics, ratings, protection and gate drive circuits, dv/dt and di/dt protection, Series and parallel operation of Thyristors.	8
	DC-DC Converters: Buck, Boost, Buck-Boost converters with circuit configuration and analysis, Introduction to Zero Voltage Switching and Zero Current Switching.	6
Unit-2	**DC-AC Converters:** Single phase and Three phase Voltage Source (VSI) and Current Source Inverter (CSI), frequency and voltage control Pulse Width Modulation Techniques (PWM).	12
	AC-AC Converter: Single and Three phase controllers, phase control, PWM AC voltage controller, Principle of ON-OFF control and Cyclo-converters.	8
	Drives: Vector and direct torque control of AC drives.	8

Recommended Books: -

1. M. H. Rashid, *Power Electronics - Circuits, Devices and Applications*, Prentice Hall Publications, 3rd Edition, 2003.
2. Ned Mohan, Tore M. Undeland, William P. Robbins, *Power Electronics*, John Wiley & Sons Publications, 3rd edition, 2006.
3. V. R. Moorthi, *Power Electronics- Devices, Circuits and Industrial Applications*, Oxford University Press, 1st Edition, 2005.
4. Philip T. Krein, *Elements of Power Electronics*, Oxford University Press, 1st Edition, 2012.
5. Industrial Applications of Power Electronics. Switzerland, MDPI AG, 2020.
6. Maksimović, Dragan, Erickson, Robert W. Fundamentals of Power Electronics. Germany, Springer International Publishing, 2020.

Subject Code : MDEE-721
Title of the course : Solar and Wind Energy Systems

L	T	P	Credits	Weekly load
3	0	0	3	3

Course Outcomes:
After successful completion of course, the students should be able to
CO1: Describe the energy scenario and the consequent growth of the power generation from renewable energy sources.
CO2: **Explain** the basic physics of wind and solar power generation.
CO3: Apply the power electronic interfaces for wind and solar generation.
CO4: **Explain** the functioning of different types of lamps and fittings.

Mapping COs/Bloom's Taxonomy Level (BLs)				
COs	CO1	CO2	CO3	CO4
BLs	BL2, BL4	BL2, BL3	BL2	BL2, BL5

CO/PO Mapping : (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):												
COs	**Programme Outcomes (POs)**											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	-	-	-	2	2	1	-	1	-	-	3
CO2	2	2	2	1	2	2	-	1	1	-	1	3
CO3	2	2	2	2	2	2	1	-	1	1	2	3
CO4	2	2	1	-	3	2	2	1	2	1	3	3

UNIT	**Course Outlines**	Hours
Unit-1	**Solar Resources:** Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.	8
	Solar Photovoltaic Generation: Technologies-Amorphous, monocrystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, power electronic converters for solar systems, maximum power point tracking (MPPT) algorithms. converter control.	8
	Network Integration Issues: overview of grid code technical requirements. fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. power quality issues. power system interconnection experiences in the world. hybrid and isolated operations of solar PV and wind systems.	10
Unit-2	**Physics of Wind Power:** History of wind power, Indian and global statistics, wind physics, tip speed ratio, stall and pitch control, wind speed statistics-probability distributions, wind speed and power-cumulative distribution functions.	8
	Wind Generator Topologies: Review of modern wind turbine technologies, fixed and variable speed wind turbines, induction generators, doubly-fed induction generators and their characteristics, permanent-magnet synchronous generators, power electronics converters. generator-converter configurations, converter control.	8

Recommended Books
1. T. Ackermann, "Wind Power in Power Systems", John Wiley and Sons Ltd., 2005.
2. G. M. Masters, "Renewable and Efficient Electric Power Systems", John Wiley and Sons, 2004.
3. S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill,1984.

4. H. Siegfried and R. Waddington, "Grid integration of wind energy conversion systems" John Wiley and Sons Ltd.
5. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004.
6. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons,1991.
7. Patel, Mukund R., and Beik, Omid. Wind and Solar Power Systems: Design, Analysis, and Operation. United States, CRC Press, 2021.

Departmental BOS Committee Members:

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4 Dr. Charanjiv Gupta 5. Dr. Gurmeet Singh