



Integral University, Lucknow

Effective from Session:

Course Code	EC 701	Title of the Course	Advanced VLSI	L	T	P	C
Year		Semester		3	1	0	4
Pre-Requisite		Co-requisite					
Course Objectives	- To provide foundational knowledge of modern VLSI technology and MOS transistor fundamentals. - To impart understanding of advanced fabrication techniques and their influence on VLSI circuit design. - To develop skills in designing and analysing combinational and sequential CMOS circuits. - To introduce system-level VLSI design methodologies including design hierarchy and modularity. - To familiarize students with VLSI design economics, verification, and testing principles.						

Course Outcomes

CO1	Explain VLSI technology trends, MOS transistor principles, and inverter operations.
CO2	Describe and apply advanced fabrication processes, design rules, and power estimation.
CO3	Design and realize CMOS-based combinational and sequential circuits using stick notation and Boolean function expansion.
CO4	Develop system-level VLSI solutions utilizing hierarchical, modular design strategies and SoC options.
CO5	Analyze VLSI project economics, including costing, scheduling, and apply principles of manufacturing test and design-for-testability.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	VLSI Technology	Introduction -VLSI technology trends, Moore's law. Difference between MOS and BJT's, MOS transistor characteristics, types of MOS transistors, NMOS & CMOS inverters, and transmission gated structure. Operation of inverter circuits.	8	1
2	Fabrication Techniques	VLSI fabrication techniques, Lithographic process, Twin-tub and SOS process, Design rules, specification of layers. Delay and timing calculation, power estimation.	8	2
3	Combinational & Sequential Circuits	NMOS & CMOS circuits for combinational and sequential logics, stick notation, Shannon's expansion theorem, realization of Boolean functions using CMOS. PLA generators, Pseudo NMOS circuits, Clocked logic, Simple flip flop realization, Shift registers, dynamic shift registers, super buffers, RAMs and ROM5.	8	3
4	System Design	System design: VLSI Design level system, design examples. VLSI System Design Methodology: Structure Design, Strategy, Hierarchy, Regularity, Modularity, and Locality. System on Chip Design options: programmable logic and structures, programmable interconnect, programmable gate arrays, Sea of gate and gate array design, standard cell design, full custom mask design.	8	4
5	Design Economics	Design Economics: Nonrecurring and recurring engineering Costs, Fixed Costs, Schedule, Person power, example VLSI System Testing & Verification: Introduction, A walk through the Test Process, Reliability, Logic Verification Principles, Silicon Debug Principles, Manufacturing Test Principles, Design for Testability.	8	5

Text Books:

1. Neil H.E. Weste, Davir Harris, "CMOS VLSI Design: A Circuits and System Perspectives" Addison Wesley - Pearson Education, 3rd Edition, 2004.
2. Mukherjee Amar, "Introduction to NMOS and CMOS VLSI System Design", Prentice Hall India.

Reference Books:

1. Mead, Conway, "Introduction to VLSI Systems", Addison Wesley.
2. Niel H E Weste, Kamran Eshranghiafl, "Principles of VLSI design", Pearson Edu Asia.1993.
3. Wayne, Wolf, "Modern VLSI Design: System on Silicon" Prentice Hall PTR/Pearson Education, Second Edition, 1998
4. Douglas A Pucknell & Kamran Eshragiafl, "Basic VLSI Design" PHI 3rd Edition.

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2									1	1	1	2
CO2	3	2	2	1	1							2	1	
CO3	3	3	3	2	2				1			1		2
CO4	2	2	2	3	2			1	1				1	
CO5	2	2	3	2	1					3	2	1	2	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Integral University, Lucknow

Effective from Session: 2015-16							
Course Code	EC702	Title of the Course	Instrumentation Sensors and Transducers	L	T	P	C
Year	I	Semester	I	3	1	0	4
Pre-Requisite		Co-requisite					
Course Objectives	- To make students understand the basics of sensors and instrumentation. - To familiarize with working of different sensors. - To understand the concepts of temperature measure and calibration of thermometer. - To study the design consideration of sensors. - To understand the application of transducers.						

Course Outcomes	
CO1	Students shall be able to define and explain flow visualization and its measurement
CO2	Students shall be able to define and explain Measurement of Acceleration, Vibration and Density.
CO3	Students shall be able to define and explain pressure measurement and different types of pressure gauges.
CO4	Standards of thermometers and their calibration.
CO5	Students shall be able to define and explain sensors, their types

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Measurement of Flow	Local flow velocity, magnitude and direction. Flow visualization. Velocity magnitude from pilot static tube. Velocity direction from yaw tube, pivoted vane, servoed sphere, dynamic wind vector indicator. Hot wire and hot film anemometer. Hot-film shock-tube velocity sensor. Laser Doppler velocimeter gross volume flow rate: calibration and standards. Constant-area, variable-pressure drop meters (obstruction meters). Averaging pitot tubes. Constant drop, variable area meters (rotameters), turbine meters, and positive displacement meters. Metering pumps. Electromagnetic flow meters. Ultrasonic flow meters.	8	1
2	Measurement of Acceleration, Vibration and Density	Accelerometers- LVDT, Piezo electric, strain gauge and variable reluctance type accelerometers mechanical type vibration instruments seismic instrument as an accelerometer and vibrometer, calibration of vibration pickups, units of density, specific gravity and viscosity used in industries Baume scale API code pressure head type densitometer-float type densitometer- ultrasonic densitometer bridge type gas densitometer.	8	2
3	Pressure Measurement	Units of pressure, manometers, different types : elastic type pressure gauges- Bourde type bellows diaphragms,	8	3

		Electrical methods-elastic elements with LVDT and strain gauges, capacitive type pressure gauge- piezo resistive pressure sensor-resonator pressure sensor, measurement of vacuum, McLeod gauge, thermal conductivity gauges.		
4	Temperature Measurement	Definitions and standards — primary and secondary fixed points, calibration of thermometers different types of filled system thermometer — sources of errors in filled in systems and their compensation, Bimetallic thermometers, Electrical methods of temperature measurement Thermocouple, RTD, Thermister, signal conditioning of industrial RTDs and their characteristics. 3 lead and 4 lead RTDs. IR sensors and bolometer.	8	4
5	Classification of sensors	Classification of sensors, sensors type, classification of semiconductor sensors, sensor characterization. Acoustic sensors, SAW technique. Emerging sensor technologies: CNTs sensors and Graphene sensors.	8	5

Reference Books:

1.	I . D.PatranabiS, Principles of Industrial Instrumentation, Tata McGraw Hill, New Delhi, 1999.
2.	A.K.Sawhney, A course in Electrical and Electronic Measurement and Instrumentation — Dhanpat Rai and Sons, New Delhi, 1999.
3.	P.Holman, Experimental Methods for Engineers International Student Edition, McGraw Hill, 1971.
4.	Semiconductor sensor: Ed. S.M. Sze, JohnWiley & Sons
5.	D.Patranabi S, Principles of Industrial Instrumentation, Tata McGraw Hill, New Delhi, 1999.

Course Articulation Matrix: (Mapping of COs with POs and PSOs)																		
PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO																		
CO1	3	1	1		1				3			2	3			1		
CO2	3	2	3		1				3			1	3	2	2			
CO3	3	3	1	1	1				3			2	3	2	2	1		
CO4	3	3	2		1				3			1	3	1				
CO5	3	2	2	1	1				3			1	3	1		1		

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Integral University, Lucknow

Effective from Session: 2017-18							
Course Code	EC703	Title of the Course	DIGITAL IMAGE PROCESSING	L	T	P	C
Year	I	Semester	I	3	1	0	4
Pre-Requisite	Signal & System	Co-requisite					
Course Objectives	- To make students understand the basics of Digital Image Processing. - To understand and analyze various techniques on compression.						

Course Outcomes	
CO1	Student shall be able to understand the Image digitization, Fourier & Z-transform.
CO2	For a given image, student shall be able to design and analyze the Optimal filter, data processing, computing, truncation, optics and system.
CO3	For a given image, student shall be able to understand the application of enhancement, restoration and segmentation techniques.
CO4	Student shall be able to measures the shape, size and classifies the stereometric, stereoscopic image display.
CO5	Student shall be able understand the concept of modeling and coding of image.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Unit-I	Introduction to Digital Signal processing: Fourier & Z-transform, Multidimensional sequence, Image digitizing, image processing soare, Histograms, point operations.	8	1
2	Unit-II	Introduction to algebraic operations, filtering: Convolution, optimal filter design, data processing, computing, truncation, optics and system analysis, diffraction limited optical systems, aberrations.	8	2
3	Unit-III	Application: Image restoration, approaches and models, image segmentation, various segmentation approaches, segmented image structure.	8	3
4	Unit-IV	Measurement and classification of size, shape measurement feature selection, classification, CAT Stereometric imaging, Stereoscopic Image Display, Shaded surface display.	8	4
5	Unit-V	Image Coding, entropy coding, Loss less / Lossy image compression, Measures of predominance, Modeling and coding, international standards for image coding (JPEG, JPEG 2000)	8	5

Text Books:

1. Kenneth R. Castleman, Digital Image processing/PHI.

Reference Books:

1. A. K. Jan/Image processing/ Pearson Education 2003.

2. Gonzalez R.C. & P. Wintel Digital Image processing, Addison Wesley.

e-Learning Source:

Digital Image Processing - Course (nptel.ac.in): https://onlinecourses.nptel.ac.in/noc21_ee78/preview

Image Signal Processing - Course (nptel.ac.in): https://onlinecourses.nptel.ac.in/noc22_ee86/preview

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO4	PSO5	PSO6	PSO7
CO1	3	3		2		2							2	2	2			
CO2	3		2	3		2								1	2			
CO3	3	2	3										2		1			
CO4	3	2		3		2							1	2				
CO5	3		3										2					

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Integral University, Lucknow

Effective from Session:							
Course Code	EC 704	Title of the Course	MOBILE AD-HOC AND SENSOR NETWORKS	L	T	P	C
Year		Semester		3	1	0	4
Pre-Requisite	Digital Communication & Networks (EC-312)	Co-requisite					
Course Objectives	- To make students understand the basics of Wireless sensor Networks. - To familiarize with learning of the Architecture of WSN. - To understand the concepts of Networking and Networking in WSN. - To study the design consideration of topology control and solution to the various problems.						

Course Outcomes	
CO1	Students shall be able to Define Wireless and Radio. Determine networks. Understand challenges, technologies and standards for wireless networks
CO2	Students shall be able to understand the concept of mobile ad hoc networks (MANETs) and wireless sensor networks (WSNs), concepts, Routing-proactive routing, reactive routing (on-demand), hybrid routing, and power aware routing
CO3	Describe the sensors, energy consumption of sensor nodes, operating system and execution Environments, design principles for WSN
CO4	Students shall be able to define physical layer and transceiver in WSN, MAC Protocols- Time synchronization.
CO5	Students shall be able to design Localization and positioning procedures and impact of anchor placement.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Introduction to Wireless Standards	Broadcasting and multicasting: broadcast storm, network flooding avoidance, multicast routing, TCP over mobile ad hoc networks: IP address acquisition, effects of partitions on TCP, provisions for mobility and fairness, Wireless LAN (WiFi): 802.11 specifications, Medium Access Control Protocol issues; power control, spatial reusability, and QoS, Bluetooth: specifications, Piconet synchronization and master-slave switch, scatternet formations, interference issues, interoperability with WiFi.	8	1
2	Mobile Ad-hoc and Sensor Networks	Introduction to mobile ad hoc networks (MANETs) and wireless sensor networks (WSNs), concepts, Routing-proactive routing, reactive routing (on-demand), hybrid routing, and power aware routing.	8	2
3	Architecture of WSN	Introduction to sensors- Definition of sensor & its difference from transducer, Classification of sensors, internal architecture of sensors, application of sensors in various fields Architecture-single node architecture-hardware components, energy consumption of sensor nodes, operating system and execution environments, Network architecture-optimization goal and figure of merit-design principles for WSN, service interface of WSN and Gateway concept challenges of WSN.	8	3
4	Communication Protocols	Wireless channel and communication fundamental, physical layer and transceiver design consideration in WSN, MAC Protocols-Fundamental of MAC Protocol, low duty cycle protocol and wakeup concepts, schedule based protocols, Link layer protocols, routing protocols naming and addressing, Time synchronization.	8	4
5	Localization and Positioning	Properties of Localization and positioning procedures, single hop localization, positioning in multihop environments, and impact of anchor placement.	8	5

Reference Books:

1. Holger Karl & Andreas Willig, Protocols and Architectures for Wireless Sensor Networks, Wiley.

2. Anna Hac, Wireless Sensor Network Designs, John Wiley & Sons Ltd., 2003.
3. Nirupama Bulusu and Sanjay Jha, Wireless Sensor Networks : A systems perspective, Artech House, August 2005.
4. Jr.,Edgar H. Callaway, Wireless Sensor Networks : Architecture and Protocols, Auerbach, 2003.
5. C.S.Raghavendra, Krishna M. Sivalingam and Taieb Znati, Wireless Sensor Networks, Springer, 2005.

Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO- PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	3						3			3		
CO2	3	2	3						3			3	2	2
CO3	3	3	3	1	1				3			3	2	2
CO4	3	3	2						3			3	1	
CO5	3	2	2	1	1				3			3	1	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD



Integral University, Lucknow

Effective from Session:

Course Code	EC 705	Title of the Course	LASER TECHNOLOGY	L	T	P	C
Year		Semester		3	1	0	4
Pre-Requisite		Co-requisite					
Course Objectives	- To provide a foundational understanding of quantum principles relevant to laser operation. - To explain the working principles, types, and construction of various lasers. - To introduce the concepts and technology of semiconductor lasers and their applications. - To familiarize students with the classification and properties of different laser light sources. - To explore important modern applications of lasers in fusion, chemistry, and industry						

Course Outcomes

CO1	Understand quantum processes underlying laser action, including stimulated and spontaneous emission, and population inversion.
CO2	Differentiate between types of lasers (three-level, four-level, CW, pulsed lasers) and describe the components of laser systems.
CO3	Explain the working, structure, and applications of semiconductor lasers and quantum well/dot lasers.
CO4	Classify various laser sources (ionic, molecular, solid state, liquid) and comprehend short pulse generation and measurement techniques.
CO5	Analyze significant laser applications such as in fusion, chemistry, isotope separation, and LIDAR

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Introduction	Review of elementary quantum physics, Schrodinger equation, concept of Coherence, absorption, spontaneous emission, stimulated emission processes. Relation between Einsteins A and B coefficients, Population inversion.	8	1
2	Laser and laser systems	Main components of laser, Principle of laser action, Introduction of general laser and their types. Three and four level lasers, CW and pulsed laser. Optical cavities.	8	2
3	Semiconductor Laser	111-V group semiconductors laser, Heterojunction laser, Principle and structure, Losses in heterostructure laser, Heterostructure laser materials, Quantum well laser, separate confinement heterostructure laser, quantum dot laser. Applications of semiconductor laser.	8	3
4	Laser light source	Classification of laser, ionic, molecular, liquid and solid-state lasers and systems, short pulse generation and measurement.	8	4
5	Some Important Application of lasers	Laser induced fusion: Introduction, the fusion process, The laser induced Fusion Reactors. Lasers in Science: Harmonic Generation, Self-focusing, Lasers in Chemistry, Rotation of the Earth, Lasers in Isotope Separation. Lasers for light detection and ranging (LIDAR).	8	5

Text Books:

- Optical Electronics, A. Yariv Saunders
- Optical Electronics, Ghatak & Thyagarajan, Cambridge U.K.
- Essentials of Optoelectronics, A. Rogers (Chapman Hall)
- Lasers Theory and Applications: K.Thyagrajan and A.K.Ghatak, Macmillan Publication

Reference Books:

- W.T. Silfvast, Laser fundamentals, Cambridge University Press
- Laser Physics by P. W. Miloni, John Wiley and Sons.

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2									1	1		2
CO2	3	2	1		1							2	1	
CO3	3	3	2	1	2							1		2
CO4	2	2		1	2								2	1
CO5	2	3			2	2					2	2	3	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Integral University, Lucknow

Effective from Session:							
Course Code	EC 706	Title of the Course	Renewable Energy and its future Prospects	L	T	P	C
Year		Semester		3	1	0	4
Pre-Requisite		Co-requisite					
Course Objectives	- Understand the fundamental concepts of energy, sustainability, and renewable resources. - Explore the working principles and technologies of solar, wind, biomass, ocean, and hybrid energy systems. - Analyze the technical, environmental, and economic aspects of renewable energy conversion. - Evaluate renewable energy systems for performance, feasibility, and sustainability. - Develop an understanding of future prospects, legal frameworks, and innovations in renewable energy.						

Course Outcomes	
CO1	Explain the concepts of sustainable energy, environmental impact, and global energy needs.
CO2	Analyze biomass energy systems and evaluate conversion technologies for waste-to-energy processes.
CO3	Design and assess solar photovoltaic systems, battery integration, and MPPT techniques
CO4	Examine the principles and performance of wind, ocean, and hybrid renewable systems.
CO5	Assess techno-economic feasibility and propose sustainable solutions considering societal and environmental factors.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Introduction	Energy, sustainability & environment; understanding human energy needs, alternative generation systems; renewable energy sources including wind, solar, biomass, hydro, ocean and geothermal; socio-economic implications of sustainable energy; climate change controversy.	8	1
2	Biomass Energy	Availability of biomass-agro, forest, animal and municipal waste; Total Volatile solids; Principles of Bio-Conversion, Biomass Conversion technologies; urban waste to energy conversion; biomass gasification; Biogas production from waste biomass; classification of biogas plants; biomass system economics in India, Dual fuel generator.	8	2
3	Solar Energy	Definition, Energy available from Sun, Solar radiation data, solar energy conversion into heat, Flat plate and Concentrating collectors, Principle of natural and forced convection, Solar cell model. Solar cell losses, Solar cell efficiency, Battery basics, Losses, classification of batteries, battery parameters, factors affecting battery performance, batteries for PV systems, DC-DC converters for PV systems, Charge controllers, Algorithms for MPPT, Stand Alone system, grid connected systems.	8	3
4	Ocean Energy & Hybrid Systems	Ocean Energy: Principle of utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants Hybrid Systems: PV-Diesel hybrid systems, PV-wind hybrid systems, PV-Fuel cell hybrid systems, Issues with hybrid systems, Payback period, Lifecycle costing, legal aspects, Future trends and possibilities.	8	4
5	Wind Energy	Energy available from wind, General formula, Lift and drag. Basis of Wind energy conversion, Effect of density, Frequency variances, Angle of attack, Wind speed, Windmill rotors, Horizontal axis and Vertical axis rotors, Working principle of wind power plant.	8	5

Reference Books:

- Boyle, Godfrey, Renewable Energy Power for a Sustainable Future, 2nd Edition, Oxford University Press, 2004.
- Chetan Singh Solanki, Solar Photovoltaics's Fundamentals, technologies and Applications, PHI New Delhi, 2009.

Text Books:

- Ashok Desai V, Non-Conventional Energy, Wiley Eastern Ltd, 1990.
- Mittal K.M, Non-Conventional Energy Systems, Wheeler Publishing Co. Ltd, 1997.
- Ramesh R, Kurnar K.U, Renewable Energy Technologies, Narosa Publishing House, New Delhi, 1997.

Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3				2						1	3	
CO2	2	3	3	2									1	1
CO3	3	2	3	2	3							3	2	
CO4	3	3	2	2		3						2	2	1
CO5	2		2			3	3						1	1

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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Integral University, Lucknow

Effective from Session:							
Course Code	EC 707	Title of the Course	Energy Conservation & Audit	L	T	P	C
Year		Semester		3	1	0	4
Pre-Requisite		Co-requisite					
Course Objectives	- To introduce principles and procedures of energy audit for industries, buildings, and thermal power stations. - To impart knowledge on energy management and organization of energy management programs. - To develop understanding of energy efficient motors and their audit. - To familiarize students with power factor improvement, lighting systems, and energy measurement instruments. - To equip students with skills to perform economic analysis of energy conservation measures						

Course Outcomes	
CO1	Explain the concepts, types and procedures of energy audit for various industrial and commercial sectors.
CO2	Organize and manage energy management programs, including demand side management.
CO3	Assess the efficiency, characteristics, and audit steps of energy efficient motors and variable speed systems.
CO4	Apply power factor improvement methods and evaluate lighting systems using appropriate measuring instruments.
CO5	Perform economic analysis for energy conservation measures and evaluate returns on investment.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Basic Principles of Energy Audit	Energy audit- definitions, concept, types of audits, energy index, cost index, pie-charts, Sankey diagrams, load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit.	8	1
2	Energy Management	Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting - Energy manger, Qualities and functions, language, Questionnaire - check list for top management. Demand side management.	8	2
3	Energy Efficient Motors	Energy efficient motors, factors affecting efficiency, loss distribution, constructional details, characteristics - variable speed, variable duty cycle systems, RMS hp- voltage van at ion-voltage unbalance- over motoring- motor energy audit.	8	3
4	Power Factor Improvement, Lighting & Energy Instruments	Power factor - methods of improvement, location of capacitors, PF with nonlinear loads, effect of harmonics on PF, PF motor controllers - good lighting system design and practice, lighting control, lighting energy audit - Energy Instruments- watt meter, data loggers, thermocouples, pyrometers, lux meters, tongue testers, application of PLCs.	8	4
5	Economic Aspects & Analysis	Economics Analysis - Depreciation Methods, time value of money, rate of return, present worth method, replacement analysis, life cycle costing analysis - Energy efficient measures- calculation of simple payback method, net present worth method - Power factor correction, lighting - Applications of life cycle costing analysis, return on investment.	8	5

Text Books:	
1. W.C.Turner, "Energy management hand book", John wiley and sons	
2. W.K. Murphy, G- Mckay Butier worth, "Energy management", Heine mann publications, 2007.	
Reference Books:	
1. Paulo Callaghan, "Energy management", Mc-graw Hill Book company, 1st edition, 1998	
2. Giovanni and Petrecca, "Industrial Energy Management: Principles and Applications", The Kluwer international series-207 (1999)	
3. Howard E.Jordan, "Energy-Efficient Electric Motors and their applications", Plenum pub corp; 2nd ed. (1994)	

Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3		2		2					1	1	1	
CO2	2	3	2	2	1	2	2	1	1		2		1	2
CO3	3	2	2		2							2		2
CO4	2	2		2	3								1	
CO5	2	2	3	2	2	2				3	2		2	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	Sign & Seal of HoD
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