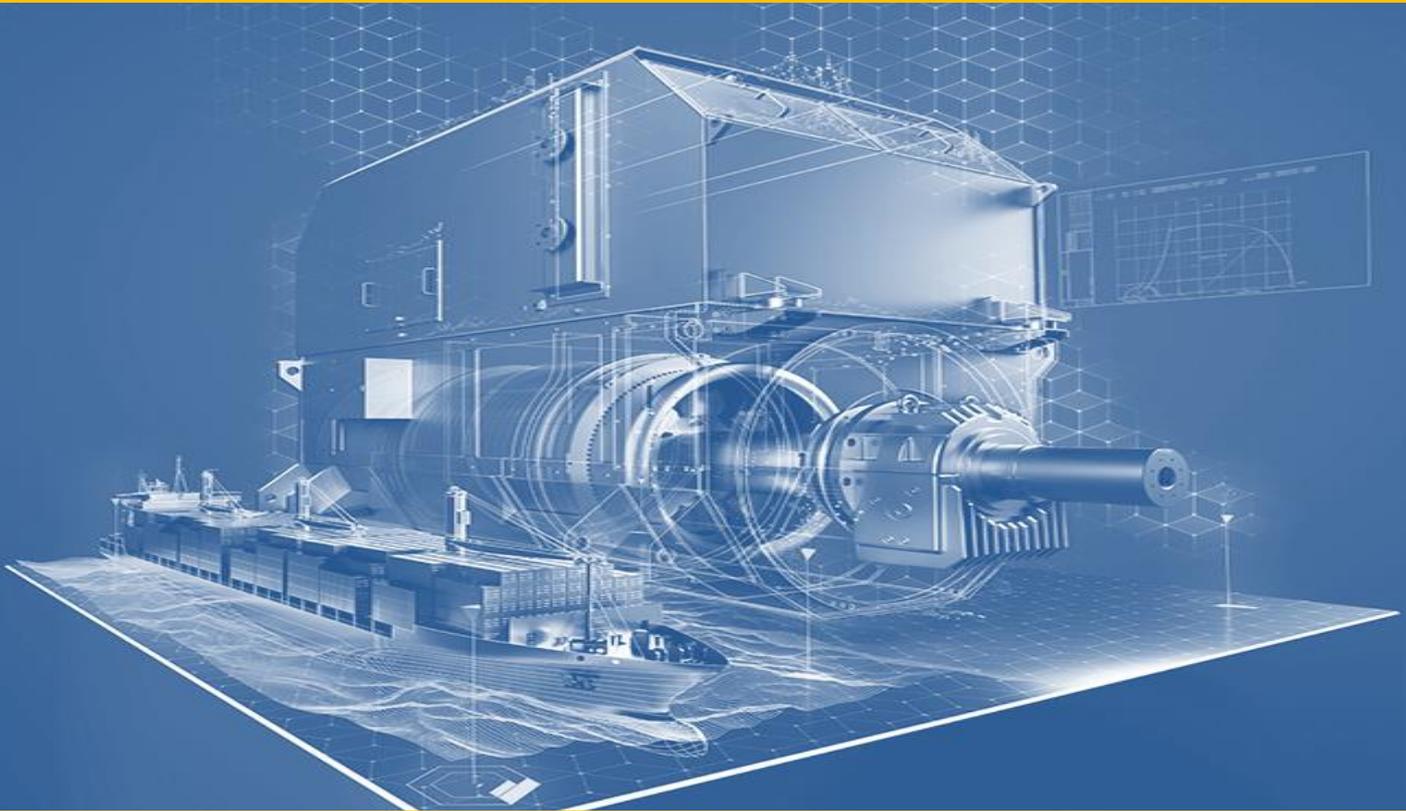


M.I.E.T. ENGINEERING COLLEGE
(Autonomous)
Tiruchirappalli-620007

Curriculum & Syllabus
(Regulations 2024)



M.E. Power Electronics
and Drives



M.I.E.T. ENGINEERING COLLEGE

(AUTONOMOUS)

(Approved by AICTE, New Delhi and Affiliated to Anna University, Chennai)

Accredited by NBA (CIVIL, CSE, ECE, EEE & MECH)

Accredited with 'A+' grade by NAAC

(An ISO 9001:2015 Certified Institution)

(Recognized by UGC under section 2(f) & 12(B) of UGC Act, 1956)

TRICHY - PUDUKKOTTAI MAIN ROAD, TRICHY - 620 007



DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING



CURRICULUM AND SYLLABUS

M.E. POWER ELECTRONICS AND DRIVES

(Regulations 2024)

Vision

To be recognized as a centre of excellence in Electrical and Electronics Engineering, contribution to the needs of stakeholders.

Mission

- ❖ To impart Quality Education through comprehensive exposure, value additions and effective teaching learning process.
- ❖ To facilitate learning environment in view of challenges in the field of Electrical and Electronics Engineering.
- ❖ To provide platform for students to update the contemporary knowledge with professional quality and commitment to lifelong learning.

Program Outcomes (POs)

1. An ability to independently carry out research/investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
4. Apply knowledge of basic science and engineering in design and testing of power electronic systems and drives.
5. Interact with Industry in a professional and ethical manner to meet the requirements of societal needs and to contribute sustainable development of the society.
6. Implement cost effective and cutting-edge technologies in power electronics and drives system.

Program Educational Objectives (PEO)

1. To prepare the students for successful career in power electronic industry, research and teaching institutions.
2. To analyze, design and develop the power electronic converters/drives.
3. To design power electronic systems for efficient extraction and utilization of various renewable energy sources.
4. To promote student awareness for the lifelong learning in the field of power electronics and drives.

PEO/PO Mapping

Program Educational Objectives	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
PEO1	3	3	3	3	2	3
PEO2	3	3	3	2	2	3
PEO3	3	3	3	2	3	2

1 - Low, 2 - Medium, 3 – High



CHOICE BASED CREDIT SYSTEM
CURRICULUM AND SYLLABUS FOR SEMESTER I TO IV

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
THEORY								
1.	24PE1101	Analysis of Power Converters	PCC	3	1	0	4	4
2.	24PE1102	Analysis of Electrical Machines	PCC	3	1	0	4	4
3.	24PE1103	Renewable Energy Technologies	PCC	3	0	2	5	4
4.	24PE1104	Modeling of SMPS & UPS	PCC	3	0	2	5	4
5.	24RE1101	Research Methodology and IPR	RMC	2	0	0	2	2
6.	-	Professional Elective I	PEC	3	0	0	3	3
7.	24PE1201	Seminar2	EEC	0	0	2	2	1
							Total	22

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
THEORY								
1.	24PE2101	Industrial Electrical Drives	PCC	3	0	0	3	3
2.	24PE2102	Advanced Processors for Power Converters	PCC	3	0	0	3	3
3.	24PE2103	Electric Vehicles and Power Management	PCC	3	0	0	3	3
4.	-	Professional Elective II	PEC	3	0	0	3	3
5.	-	Professional Elective III	PEC	3	0	0	3	3
6.	24RE2101	Scientific Report Writing	RMC	2	0	0	2	2
7.	24PE2201	Industrial Electrical Drives Laboratory	PCC	0	0	4	4	2
8.	24PE2202	Advanced Processors for Power Converters laboratory	PCC	0	0	4	4	2
							Total	21

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	-	Professional Elective IV	PEC	3	0	0	3	3
2.	-	Professional Elective V	PEC	3	0	0	3	3
3.	-	Open Elective	OEC	3	0	0	3	3
4.	24RE3201	Research Article Review	RMC	0	0	4	2	2
5.	24PE3501	Project Work Phase I	EEC	0	0	12	12	6
Total							17	

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24PE4501	Project Work Phase II	EEC	0	0	24	24	12
Total							12	

PROFESSIONAL CORE COURSES (PCC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24PE1101	Analysis of Power Converters	PCC	3	1	0	4	4
2.	24PE1102	Analysis of Electrical Machines	PCC	3	1	0	4	4
3.	24PE1103	Renewable Energy Technologies	PCC	3	0	2	5	4
4.	24PE1104	Modeling of SMPS & UPS	PCC	3	0	2	5	4
5.	24PE2101	Industrial Electrical Drives	PCC	3	1	0	4	4
6.	24PE2102	Advanced Processors for Power Converters	PCC	3	0	0	3	3
7.	24PE2103	Electric Vehicles and Power Management	PCC	3	0	0	3	3
8.	24PE2201	Industrial Electrical Drives Laboratory	PCC	0	0	4	4	2
9.	24PE2202	Advanced Processors for Power Converters Laboratory	PCC	0	0	4	2	2
Total							30	

**PROFESSIONAL ELECTIVES COURSES (PEC)
POWER SYSTEMS**

SEMESTER I & II, PROFESSIONAL ELECTIVE I & II

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24PE1301	Smart Grid Technologies	PEC	3	0	0	3	3
2.	24PE1302	Electrical Systems in Wind Energy	PEC	3	0	0	3	3
3.	24PE1303	Power System Restructuring & Deregulation	PEC	3	0	0	3	3
4.	24PE1304	Distributed Generation and Micro-Grids	PEC	3	0	0	3	3
5.	24PE1305	Flexible AC Transmission System	PEC	3	0	0	3	3
6.	24PE1306	High Voltage DC Transmission	PEC	3	0	0	3	3

**SEMESTER II & III, PROFESSIONAL ELECTIVE III & IV
RENEWABLE ENERGY**

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24PE1307	Energy Storage Systems	PEC	3	0	0	3	3
2.	24PE1308	Power Electronics for Renewable Energy Systems	PEC	3	0	0	3	3
3.	24PE1309	Advanced Power Converters	PEC	3	0	0	3	3
4.	24PE1310	Wind Energy Conversion System	PEC	3	0	0	3	3
5.	24PE1311	Grid Integration of Renewable Energy Sources	PEC	3	0	0	3	3
6.	24PE1312	Microcontroller Applications in Power Converters	PEC	3	0	0	3	3

SEMESTER III, PROFESSIONAL ELECTIVE V

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24PE1313	Fuzzy Systems	PEC	3	0	0	3	3
2.	24PE1314	Python Programming for Machine Learning	PEC	3	0	0	3	3
3.	24PE1315	Optimization Techniques	PEC	3	0	0	3	3
4.	24PE1316	IoT for Smart Systems	PEC	3	0	0	3	3
5.	24PE1317	Intelligent Control	PEC	3	0	0	3	3
6.	24PE1318	Embedded Systems Design for Power Electronic Applications	PEC	3	0	0	3	3

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24RM1101	Research Methodology and IPR	RMC	2	0	0	2	2
2.	24RM2101	Scientific Report Writing	RMC	2	0	0	2	2
3.	24RM3101	Research Article Review	RMC	0	0	4	2	2

EMPLOYABILITY ENHANCEMENT COURSES (ECC)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24PE1201	Seminar	EEC	0	0	2	2	1
2.	24PE3501	Project Work I	EEC	0	0	12	12	6
3.	24PE4501	Project Work II	EEC	0	0	24	24	12

OPEN ELECTIVE COURSES (OEC)

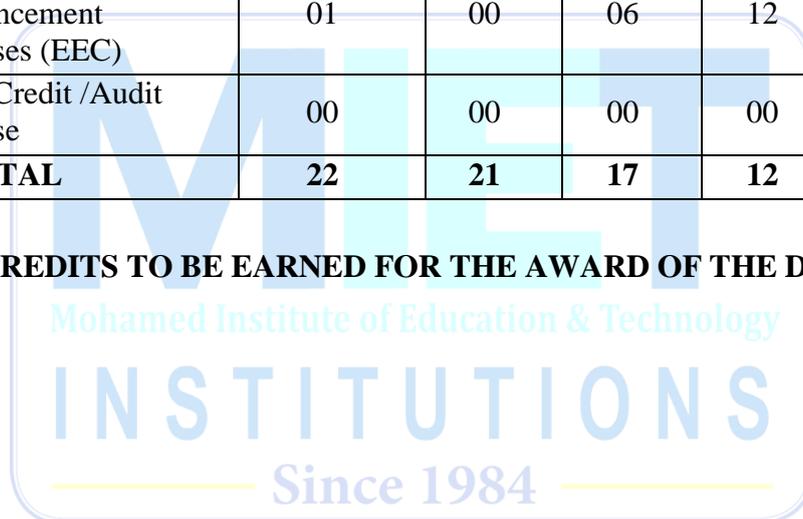
S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS PER WEEK	CREDITS
				L	T	P		
1.	24OEMF01	Green Supply Chain Management	OEC	3	0	0	3	3
2.	24OEMF02	Renewable Energy Technologies	OEC	3	0	0	3	3
3.	24OEMF03	Medical Robotics	OEC	3	0	0	3	3

4.	24OEMF04	Textile Reinforced Composites	OEC	3	0	0	3	3
5.	24OEMF05	Nanocomposite Materials	OEC	3	0	0	3	3
6.	24OEMF06	New Product Design and Development	OEC	3	0	0	3	3
7.	24OEVL01	VLSI Architecture for Image Processing	OEC	3	0	0	3	3
8.	24OEVL02	Data Acquisition	OEC	3	0	0	3	3
9.	24OEVL03	Advanced VLSI Design	OEC	3	0	0	3	3
10.	24OEVL04	Embedded System Design	OEC	3	0	0	3	3
11.	24OEVL05	System on Chip	OEC	3	0	0	3	3
12.	24OEVL06	Wireless Sensor Networks	OEC	3	0	0	3	3
13.	24OECS01	Speech Signal Processing	OEC	3	0	0	3	3
14.	24OECS02	Digital Forensics	OEC	3	0	0	3	3
15.	24OECS03	IT & Agricultural System	OEC	3	0	0	3	3
16.	24OECS04	Machine Learning	OEC	3	0	0	3	3
17.	24OECS05	IoT for Smart Systems	OEC	3	0	0	3	3
18.	24OECS06	Software Testing and Automation	OEC	3	0	0	3	3
19.	24OEST01	Integrated Water Resources Management	OEC	3	0	0	3	3
20.	24OEST02	Water, Sanitation and Health	OEC	3	0	0	3	3
21.	24OEST03	Principles of Sustainable Development	OEC	3	0	0	3	3
22.	24OEST04	Environmental Impact Assessment	OEC	3	0	0	3	3
23.	24OEST05	Environmental Sustainability	OEC	3	0	0	3	3
24.	24OEST06	Green building design	OEC	3	0	0	3	3

SUMMARY

S.NO	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	Foundation Course (FC)	00	00	00	00	00
2.	Professional Core Courses (PCC)	16	13	00	00	29
3.	Professional Elective Courses (PEC)	03	06	06	00	15
4.	Research Methodology and Ipr Course(RMC)	02	02	02	00	06
5.	Open Elective Courses (OEC)	00	00	03	00	03
6.	Employability Enhancement Courses (EEC)	01	00	06	12	19
7.	Non Credit /Audit Course	00	00	00	00	00
TOTAL		22	21	17	12	72

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 72



COURSE OBJECTIVES

- To provide the mathematical fundamentals necessary for deep understanding of power converter operating modes.
- To introduce the electrical circuit concepts behind the different working modes of power converters so as to enable deep understanding of their operation.
- To impart required skills to formulate and design inverters for generic load and for machine loads.

UNIT I SINGLE PHASE AC- DC CONVERTER**9+3**

Static Characteristics of power diode, SCR and GTO, half controlled and fully controlled converters with R-L, R-L-E loads and freewheeling diodes—continuous and discontinuous modes of operation inverter operation and its limit –Sequence control of converters—performance parameters –effect of source impedance and overlap-reactive power and power balance in converter circuit.

UNIT II THREE PHASE AC-DC CONVERTER**9+3**

Half controlled and fully controlled converters with R, R-L, R-L-E loads and freewheeling diodes—inverter operation and its limit—performance parameters—effect to source impedance and overlap 12 pulse converter—Applications-Excitation system, DC drive system.

UNIT III SINGLE PHASE INVERTERS**9+3**

Introduction to self-commutated switches: MOSFET and IGBT - Principle of operation of half and full bridge inverters – Performance parameters – Voltage control of single phase inverters using various PWM techniques – various harmonic elimination techniques -Design of UPS – VSR operation.

UNIT IV THREE PHASE INVERTERS**9+3**

180 degree and 120 degree conduction mode inverters with star and delta connected loads –voltage control of three phase inverters: single, multi pulse, sinusoidal, space vector modulation techniques – VSR operation-Application – Induction heating, AC drive system – Current source inverters.

UNIT V MODERN INVERTERS**9+3**

Multilevel concept – diode clamped – flying capacitor – cascaded type multilevel inverters -Comparison of multi-level inverters-application of multilevel inverters—PWM techniques for MLI—Single phase & Three phase Impedance source inverters—Filters.

TOTAL: 60 PERIODS**COURSE OUTCOMES**

On successful completion of this course, the student will be able to

- CO1: Acquire and apply knowledge of mathematics in power converter analysis.
- CO2: Model, analyze and understand power electronic systems and equipment's.
- CO3: Formulate, design and simulate phase-controlled rectifiers for generic load and for machine loads.

CO4: Design and simulate switched mode inverters for generic load and for machine loads.

CO5: Select device and calculate performance parameters of power converters.

TEXT BOOKS

1. Jai P. Agrawal, “Power Electronics System Theory and Design”, Pearson Education, First Edition, 2015.
2. Bin Wu, Mehdi Narimani, "High-Power Converters and AC Drives", Wiley, 2nd Edition, 2017.
3. Ned Mohan, T.M.Undeland and W.P.Robbins, “Power Electronics :converters, Application and design”, 3rd edition Wiley, 2007.

REFERENCE BOOKS

1. Rashid M.H., “Power Electronics Circuits, Devices and Applications”, Pearson, fourth Edition, 10th Impression 2021.
2. Bimal.K.Bose“ Modern Power Electronics and AC Drives”, Pearson Education, Second Edition, 2003.
3. Philip T.Krein, “Elements of Power Electronics” Indian edition Oxford University Press-2017.
4. P.C.Sen, “Modern Power Electronics”, S.Chand Publishing 2005.
5. BinWu, Mehdi Narimani, "High-Power Converters and AC Drives", Wiley, 2nd Edition, 2017.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	2	2
CO2	3	-	3	3	2	2
CO3	3	-	3	3	2	2
CO4	3	-	3	3	2	2
CO5	3	-	3	3	2	2
AVG	3	-	3	3	2	2

1 - Low, 2 - Medium, 3 – High, ‘-’ No correlation

24PE1102 ANALYSIS OF ELECTRICAL MACHINES

L T P C

3 1 0 4

COURSE OBJECTIVES

- To providing knowledge about the principles of magnetic circuits as well as the energy, force, and torque of multi-excited systems, the conversion of three phase variables into two phase variables.
- To use mathematical modelling and computer simulation to examine the DC machine's steady state and dynamic state operations.
- To analyze the steady state and dynamic state operation of three-phase induction machines using transformation theory based mathematical modelling and digital computer simulation.

UNIT I ELECTROMECHANICAL ENERGY CONVERSION**9+3**

Magnetic circuits, permanent magnet, stored magnetic energy, co-energy - force and torque in singly and multiple excited systems – machine windings and air gap mmf - winding inductances and voltage equations.

UNIT II DC MACHINES**9+3**

Fundamental DC machine and analysis of steady state operation - Voltage and torque equations – dynamic characteristics of permanent magnet and shunt DC motors – Time domain block diagrams - solution of dynamic characteristic by Laplace transformation – simulation of shunt DC machines.

UNIT III REFERENCE FRAME THEORY**9+3**

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

UNIT IV INDUCTION MACHINES**9+3**

Three phase induction machine, equivalent circuit and analysis of steady state operation – free acceleration characteristics – voltage and torque equations in machine variables and arbitrary reference frame variables – analysis of dynamic performance for load torque variations – Transformation theory for ‘n’ phase induction machine.

UNIT V SYNCHRONOUS MACHINES**9+3**

Three phase synchronous machine and analysis of steady state operation - voltage and torque equations in machine variables and rotor reference frame variables (Park's equations) – analysis of dynamic performance for load torque variations –Kron's primitive machine.

TOTAL: 60 PERIODS**COURSE OUTCOMES**

On successful completion of this course, the student will be able to

- CO1: Explain the fundamentals of electromechanical energy conversion and DC motor properties.
- CO2: Know the concepts related with dc machines and their dynamic characteristics.
- CO3: Explain the different types of reference frame theories.
- CO4: Apply procedures to develop induction machine model in both machine variable form and reference variable forms.
- CO5: Apply the procedures to develop synchronous machine model in machine variables form and reference variable form.

TEXT BOOKS

1. R. Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Pearson Education, 1st Imprint, 2015.
2. R.Ramanujam, Modeling and Analysis of Electrical Machines, I.k. International Publishing House Pvt.Ltd,2018.
3. Stephen D. Umans, "Fitzgerald & Kingsley's Electric Machinery", Tata McGraw Hill, 7th Edition, 2020.

REFERENCE BOOKS

1. Stephen D. Umans, "Fitzgerald & Kingsley's Electric Machinery", Tata McGraw Hill, 7th Edition, 2020.
2. M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition, Power Electronics and Motor Drives, CRC Press, 2011.
3. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek, "Analysis of Electric Machinery and Drive Systems", 3rd Edition, Wiley-IEEE Press, 2013.
4. Arthur R Bergen and Vijay Vittal, "Power System Analysis", 2nd Edition, Pearson, 2009.
5. Prabha Kundur, "Power System Stability and Control", TMH, 2010.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	3	3	3
CO2	2	3	3	3	3	3
CO3	2	3	3	3	3	3
CO4	2	3	3	3	3	3
CO5	2	3	3	3	3	3
AVG	2	3	3	3	3	3

1 - Low, 2 - Medium, 3 – High

24PE1103 RENEWABLE ENERGY TECHNOLOGIES

L T P C
3 0 2 4

COURSE OBJECTIVES

- To impart knowledge on the various concepts and working principles of renewable energy sources.
- To understand fundamental theory governing solar PV and the aerodynamic principle of turbine blade design.
- To design and analyze power conditions of solar PV system, different types of renewable energy technologies.

UNIT I INTRODUCTION

6

Classification of energy sources -Features of Renewable energy - Renewable energy scenario in India -Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment- Per Capital Consumption - CO₂ Emission importance of renewable energy sources-Applications

UNIT II SOLAR PHOTOVOLTAICS

6

Solar cell array system analysis and performance prediction, Shadow analysis: Reliability, Solar cell array design concepts, PV system design, Design process and

optimization: Detailed array design, Voltage regulation, Maximum tracking, Quick sizing method, Array protection.

UNIT III PHOTOVOLTAIC SYSTEM DESIGN AND ADVANCED TECHNOLOGIES **6**

PV systems classification- standalone PV systems - Photovoltaic industries in India and World. International certification of solar panels and Indian scenario. Block diagram of Centralized and decentralized SPV systems, Stand alone, Grid-tied and grid interactive inverters- grid connection issues. Array design, inverter types and characteristics, Power conditioning system: design of standalone, hybrid and grid interactive plants, commissioning of solar PV plant.

UNIT IV WIND ENERGY CONVERSION SYSTEMS **6**

Energy content in wind, Energy Conversion at the Blade -Rotor Blades, Gearboxes, Synchronous or Asynchronous Generators, Towers, Miscellaneous components, Turbine Selection- Derivation of Betz's limit-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine- Aerodynamic Efficiency-Tip Speed Ratio- Solidity-Blade Count-Power curve of wind turbine - Grid connection Issues - Gridintegrated SCIG and PMSG based WECS.

UNIT V QUALITATIVE STUDY OF OTHER RENEWABLE ENERGY RESOURCES **6**

A qualitative study of different renewable energy resources: Ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy, and Geothermal Energy Magneto-hydro-dynamic (MHD) energy conversion, Fuel Cells, Waste to Energy Conversion, Hydrogen Energy Resources.

TOTAL: 30 PERIODS

LIST OF EXPERIMENTS

1. Simulation on modelling of Solar PV System V-I Characteristics.
2. Simulation of self- excited Induction Generator.
3. Simulation of DFIG/ PMSG based Wind turbine.
4. Simulation of intelligent controllers for hybrid energy systems.
5. Simulation on Grid integration of RES.
6. Simulation study on Hydel Power.

TOTAL: 30 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Realize the need for renewable energy systems.
- CO2: Explain the working principle of solar photovoltaic cells.
- CO3: Design a stand-alone and Grid connected PV system.
- CO4: Analyse the different configurations of the wind energy conversion systems.
- CO5: Identify the working principle of different resources of energy sources.

TEXT BOOKS

1. S.N.Bhadra, D. Kasta, & S. Banerjee “Wind Electrical Systems”, Oxford University Press, 2009.
2. Gray, L. Johnson, “Wind energy system”, prentice hall of India, 1995.
3. Chetan Singh Solanki, “Solar Photovoltaics: Fundamentals, Technologies and Applications”, PHI Learning Private Limited, 2012.

REFERENCE BOOKS

1. Rai. G.D, “Non-conventional energy sources”, Khanna publishes, 1993.
2. Rai. G.D,” Solar energy utilization”, Khanna publishes, 1993.
3. John Twideu and Tony Weir, “Renewal Energy Resources” BSP Publications, 2006
4. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
5. "Renewable Energy: Fundamentals and Applications" by Ramesh K. Gupta,2014.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	2	2	1
CO2	3	-	2	3	3	3
CO3	3	-	2	3	3	3
CO4	3	-	2	3	3	2
CO5	3	-	2	2	2	2
AVG	3	-	2	2.6	2.6	2.2

1 - Low, 2 - Medium, 3 – High, ‘ - ’ No correlation

24PE1104 MODELLING OF SMPS & UPS

L T P C

3 0 0 3

COURSE OBJECTIVES

- To inculcate knowledge on the steady state analysis of both non-isolated and isolated DC-DC converters.
- To educate on the various dynamics of DC-DC converters and their operational principles.
- To understand how to design controllers for DC-DC converters and describe the operation of power conditioners, UPS, and filters.

UNIT I ANALYSIS OF NON-ISOLATED DC-DC CONVERTERS

6

Buck, Boost, Buck- Boost, and Cuk converters: Principles of operation – Continuous conduction mode and discontinuous conduction mode. –Concepts of Inductor Volt-Second Balance, Capacitor Charge Balance– Analysis and design based on steady- state relationships -SEPIC topologies – design examples.

UNIT II ANALYSIS OF ISOLATED DC-DC CONVERTERS **6**
Introduction-classification- Forward converter, flyback converter, Push Pull, half bridge and full bridge converter, Isolated version of buck converter and their analysis and design.

UNIT III CONVERTERS DYNAMIC ANALYSIS **6**
AC equivalent circuit analysis – State space averaging – Circuit averaging – Averaged switch modeling – Transfer function model for buck, boost, buck-boost and buck converter – Input filters.

UNIT IV CONTROLLER DESIGN **6**
Review of P, PI, and PID control concepts – gain margin and phase margin – Bode plot based analysis – Design of controller for buck, boost, buck-boost and buck converter.

UNIT V POWER CONDITIONERS, UPS & FILTERS **6**
Introduction- Power line disturbances- Power conditioners –UPS: offline UPS, Online UPS, Applications – Filters: Voltage filters, Series-parallel resonant filters, filter without series capacitors, filter for PWM VSI, current filter, DC filters – Design of inductor and transformer for PE applications – Selection of capacitors.

TOTAL: 30 PERIODS

LIST OF EXPERIMENTS

1. Simulation of Basic converters.
2. Simulation of bidirectional DC-DC converter (both non-isolated and isolated).
3. Battery operated vehicle, PV system as an example application.
4. Simulation of basic topologies using state space model derived and Comparison with the circuit model.
5. Simulation study of controller design for basic topologies.
6. Simulation of battery charger for EV applications.

TOTAL: 30 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Analyze and design Non-Isolated DC-DC converter.
- CO2: Analyze and design Isolated DC-DC converter.
- CO3: Derive transfer function of different converters.
- CO4: Design controllers for DC-DC converters.
- CO5: Comprehend the concepts of power conditioners, UPS & filters.

TEXT BOOKS

1. "Switched-Mode Power Supplies: Modeling, Design, and Simulation" by D. S. K. H.N. Rao Year: 2015.
2. "Power Electronics: Converters, Applications, and Design" by N. Mohan, T. Undeland, and W. Robbins Year: 2006 (while this book is co-authored by an Indian author, it's widely used in India).
3. "Modeling and Control of Power Electronics Converters" by S. K. Gupta year: 2017.

REFERENCE BOOKS

1. Robert W. Erickson & Dragon Maksimovic, " Fundamentals of Power Electronics", Third Edition, 2020.
2. Ned Mohan," Power Electronics: A First Course", Johnwiley, 2013.
3. Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, First Edition 2017.
4. V. Ramanarayanan, "Course material on Switched mode power conversion", 2008.
5. M.H. Rashid – "Power Electronics circuits, devices and applications"-Third edition- Prentice Hall of India New Delhi, 2007.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	3	3	3	3
CO2	3	2	-	2	2	3
CO3	3	-	2	2	-	2
CO4	2	-	1	-	-	3
CO5	1	2	2	2	2	2
AVG	2	2	2	2.25	2.33	2.6

1 - Low, 2 - Medium, 3 – High, '-' No correlation

24RE1101 RESEARCH METHODOLOGY AND IPR

L T P C
2 0 0 2

COURSE OBJECTIVES

- To acknowledge the importance of intellectual property and teach students the fundamental concepts of Intellectual Property Rights (IPR).
- To highlight the significance of understanding the practices and procedures for obtaining patents, copyrights, trademarks, and industrial designs.
- To simplify the statutory provisions of various forms of IPR and empower students to effectively maintain and manage their intellectual property rights.

UNIT I RESEARCH DESIGN

6

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys, Research problem formulation, Research gap identification, Formulation of materials and methods.

UNIT II DATA COLLECTION AND SOURCES

6

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying, Advanced tools and techniques.

UNIT III DATA ANALYSIS AND REPORTING

6

Overview of Multivariate analysis, Hypotheses testing and Measures of Association- Presenting Insights and findings using written reports and oral presentation, Computer aided Research – Simulation – Case study.

UNIT IV INTELLECTUAL PROPERTY RIGHTS

6

Intellectual Property - The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Biodiversity, Role of WIPOB and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT V PATENTS

6

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filing, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licenses, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL: 30 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Differentiate and describe various types of intellectual property rights (IPRs).
- CO2: Determine how to classify one's own intellectual work under specific forms of IPRs.
- CO3: Apply legal provisions to safeguard particular forms of IPRs.
- CO4: Examine the rights and responsibilities associated with patents, copyrights, trademarks, industrial designs, and other IPRs.
- CO5: Identify the procedures for protecting different forms of IPRs at both national and international levels.

TEXT BOOKS

1. "Research Methodology: Concepts and Cases" by Deepak Chawla and Neena Sondhi Year: 2011.
2. "Research Methodology: A Step-by-Step Guide for Beginners" by Ranjit Kumar Year: 2019.
3. "Intellectual Property Rights: Unleashing the Knowledge Economy" by Prabha Shukla Year: 2018.

REFERENCE BOOKS

1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, TradeSecrets", Entrepreneur Press, 2007.

3. Daniel Riordan - Technical Report Writing Today (1998).
4. Darla-Jean Weatherford - Technical Writing for Engineering Professionals (2016) Penwell Publishers.
5. "Intellectual Property Rights: A Global Vision" by R. P. Singh Year: 2016.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	2
CO2	3	3	3	2	1	2
CO3	2	3	2	2	1	2
CO4	3	3	3	2	1	2
CO5	2	3	2	2	1	2
AVG	2.2	3	2.2	2	1	2

1 - Low, 2 - Medium, 3 – High, ‘-’ No correlation

24PE1201 SEMINAR

L T P C
0 0 2 1

COURSE OBJECTIVES

- To encourage the students to study advanced engineering developments.
- To prepare and present technical reports.
- To encourage the students to use various teaching aids such as overhead projectors, power point presentation and demonstrative models.

METHOD OF EVALUATION

During the seminar session each student is expected to prepare and present a topic on engineering/technology, for duration of about 8 to 10 minutes. In a session of three periods per week, 15 students are expected to present the seminar. Each student is expected to present atleast twice during the semester and the student is evaluated based on that. At the end of the semester, he / she can submit a report on his / her topic of seminar and marks are given based on the report. A Faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also. Evaluation is 100% internal.

TOTAL: 30 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Review, prepare and present technological developments.
- CO2: Face the placement interviews.
- CO3: Develop presentation skills.
- CO4: Develop report writing.
- CO5: Present ideas in conferences.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	1	1	2	2
CO2	2	1	1	1	2	2
CO3	-	-	-	-	-	-
CO4	-	-	-	-	-	-
CO5	-	-	-	-	-	-
AVG	2	1	1	1	2	2

1 - Low, 2 - Medium, 3 – High, '-' No correlation

24PE2101 INDUSTRIAL ELECTRICAL DRIVES

L T P C
3 1 0 4

COURSE OBJECTIVES

- To introduce basic concepts of load and drive interaction.
- To control speed of AC and DC drives.
- To analyze and design the speed reversal, regenerative braking aspects, methodology for the drive system.

UNIT I DRIVE DYNAMICS AND POWER RATINGS

9+3

Dynamics of Electric Drives: Multi quadrant operation, Moment of inertia, Torque and power for rotational and linear motion loads; Selection of motor power rating: Classes of duty, thermal model heating and cooling; Selection of power converters: Direct converters, converters with intermediate circuit, Converter rating from motor specification, Factors for drive selection, Overload capacity, Control range, Derating factor, Efficiency.

UNIT II CONTROL OF DC MOTOR DRIVE

9+3

Factors governing speed and torque of DC motors, Controlled rectifier-based speed control: Single quadrant, Two quadrant and four quadrant-controlled DC motor drive; Chopper fed speed control: Four quadrant operations; Closed loop control.

UNIT III CONTROL OF INDUCTION MOTOR DRIVE

9+3

Stator side control: Characteristics and equivalent circuit of poly-phase induction motor; Speed control techniques: Stator voltage control, variable frequency control, V/f control; Soft starting methods, braking methods; Rotor side control: static rotor resistance control, Kramer's drive, Scherbius drive, doubly fed induction motor drive.

UNIT IV VECTOR CONTROL OF INDUCTION MOTOR DRIVE

9+3

Principle of vector control, types of vector control, direct vector control, indirect vector control, rotor flux-oriented control, stator flux-oriented control, air gap flux-oriented control, decoupling circuits speed sensor less control, Concept of space vectors, DTC control strategy of induction motor.

UNIT V CONTROL OF SYNCHRONOUS MACHINE DRIVES

9+3

Steady-state equivalent circuits and dynamic model of synchronous machine; Zero d-axis current control, maximum torque per ampere control, direct torque control, and power factor control

TOTAL: 60 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Develop the capability to understand and apply mathematical principles and converter / machine dynamics in electrical engineering.
- CO2: Formulate, design, and simulate power supplies for both general and machine-specific loads.
- CO3: Analyze, understand, design, and simulate adjustable speed drives based on direct current motors.
- CO4: Analyze, understand, design, and simulate adjustable speed drives based on induction motors.
- CO5: Design a closed-loop motor drive system incorporating controllers for current and speed control operations.

TEXT BOOKS

1. R.Raja Singh, Energy Conservation Strategies for Asynchronous Machine Drives, Lap Lambert Academic Publishing, Germany, 2021.
2. Bimal K Bose, "Modern Power Electronics and AC Drives", Pearson Education Asia, 2012.
3. R.Krishnan, Electric Motor Drives: Modelling, Analysis, and Control, 2015, Second edition, Pearson Education India.

REFERENCE BOOKS

1. Gopal K Dubey, "Fundamentals of Electrical Drives", CRC Press, Second Edition, 2015. Peter vas, Vector control of AC Machines –Oxford university press, 1990.
2. "Electric Motor Drives: Modeling, Analysis, and Control" by R. Krishnan Publisher: Prentice Hall Year: 2001.
3. "Electric Drives: An Integrative Approach" by C. V. Jones Publisher: Prentice Hall Year: 2002.
4. "Fundamentals of Electric Drives" by G. B. Gharehpetian and A. R. D. K. Zare Publisher: Cengage Learning Year: 2010.
5. "Control of Electric Drives" by W. Leonhard Publisher: Springer Year: 2001.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	3	1
CO2	3	3	3	3	3	2
CO3	2	3	3	3	3	2
CO4	3	3	3	3	3	2
CO5	3	3	3	3	3	2
AVG	2.8	3	2.8	2.8	3	1.8

1 - Low, 2 - Medium, 3 – High, '-' No correlation

24PE2102 ADVANCED PROCESSORS FOR POWER CONVERTERS

L T P C

3 0 0 3

COURSE OBJECTIVES

- To introduce ARM Processor and DSP controller.
- To analyze the resources available in ARM Processor and DSP-controller which will be used to generate pulses.
- To overview of programming frame work, software building blocks and Interrupt structures, event manager, and compare unit in processors.

UNIT I ARM PROCESSORS

9

Arm processor architecture and pipelining; Programmer's model; Data paths and instruction decoding; Advanced Microcontroller Bus architecture; ARM instruction set; Addressing modes; General Purpose Input and Output (GPIO); Analog to Digital Converter; Digital to Analog Converter; Simple programming.

UNIT II TIMERS AND PWM

9

Different modes of operation of Timers; Match Registers; Generation of PWM using Compare registers; Capture Control; Single and Double Edge Controlled PWM; programming to generate triggering pulses for power converters.

UNIT III COMPONENT INTERFACING AND NETWORKS

9

System Control; RTC, Watch Dog Timer, USB 2.0 Full-Speed device controller with DMA, Communication interface; UART, I2C Bus Serial Interface, SPI, SSP Serial Interfaces.

UNIT IV EXCEPTION AND INTERRUPT HANDLING

9

Exception Handling Overview; Interrupts; Interrupt Handling Schemes; External Interrupt, Timer Interrupt, PWM Interrupt, ADC Interrupt; Utility Of Interrupts In Closed Loop Control Of A Real Time System; Programming.

UNIT V DIGITAL SIGNAL PROCESSING WITH ARM

9

Representing a Digital Signal; Introduction to DSP on the ARM; Industry needs from the digital implementation perspective on the processors.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Explain the Arm processor architecture.
- CO2: Use the Timers and PWM to generate triggering pulses for power electronic circuits.
- CO3: Experiment with the exceptions of ARM processor to vary the triggering pulses for power electronic circuits.
- CO4: Apply digital signal processing in ARM processor.
- CO5: Experiment with the peripherals of DSP processor for power electronics applications.

TEXT BOOKS

1. "Power Electronics" by A. K. Singh and B. M. Gupta Publisher: PHI Learning, 2016.
2. "Advanced Power Electronics Converters" by M. S. J. M. K. Ranjan Publisher: Springer Year: 2021.
3. "Power Electronics: Essentials and Applications" by D. S. Kumar and S. S. Gupta Publisher: Wiley Year: 2015.

REFERENCE BOOKS

1. Andrew N.Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide Designing and Optimizing System Software" Morgan Kaufmann Publishers, 2011.
2. Hamid A. Toliyat, Steven Campbell, "DSP based electromechanical motion control", CRC press, New York, Washington Dc, 2012.
3. William Hohl, Christopher Hinds "ARM Assembly Language – Fundamentals and Techniques" Second Edition, CRC Press Taylor & Francis Group 2015.
4. Ata Elahi, Trevor Arjeski "ARM Assembly Language with Hardware Experiments", Springer 2015.
5. "Control of Power Converters" by B. G. Fernandes and K. R. K. R. Rao Publisher: CRC Press Year: 2020.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	2	3	2	1
CO2	2	-	2	3	2	1
CO3	2	-	2	3	2	1
CO4	2	-	2	3	2	1
CO5	2	-	2	3	2	1
AVG	2	-	2	3	2	1

1 - Low, 2 - Medium, 3 – High, '-' No correlation

24PE2103 ELECTRIC VEHICLES AND POWER MANAGEMENT

L T P C
3 0 0 3

COURSE OBJECTIVES

- To understand the concept and operations of electric and hybrid electric vehicles (EVs and HEVs), including their architecture.
- To explore the need for energy storage in hybrid vehicles and the technologies available for energy storage.
- To provide an overview of various energy storage technologies applicable to electric vehicles.

UNIT I ELECTRIC VEHICLES AND VEHICLE MECHANICS

9

Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings- Comparisons of EV with internal combustion Engine vehicles- Fundamentals of vehicle mechanics.

UNIT II ARCHITECTURE OF EV's AND POWER TRAIN COMPONENTS

9

Architecture of EV's and HEV's – Plug-n Hybrid Electric Vehicles (PHEV) - Power train components and sizing, Gears, Clutches, Transmission and Brakes.

UNIT III POWER ELECTRONICS AND MOTOR DRIVES

9

Electric drive components – Power electronic switches- four quadrant operation of DC drives Induction motor and permanent magnet synchronous motor-based vector control operation Switched reluctance motor (SRM) drives- EV motor sizing.

UNIT IV BATTERY ENERGY STORAGE SYSTEM

9

Battery Basics- Different types- Battery Parameters-Battery life & safety impacts -Battery modeling-Design of battery for large vehicles.

UNIT V ALTERNATIVE ENERGY STORAGE SYSTEMS

9

Introduction to fuel cell – Types, Operation and characteristics- proton exchange membrane (PEM) fuel cell for E-mobility– hydrogen storage systems –Super capacitors for transportation applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Understand the concept of electric vehicle and energy storage systems.

CO2: Describe the working and components of Electric Vehicle and Hybrid Electric Vehicle.

CO3: Know the principles of power converters and electrical drives.

CO4: Illustrate the operation of storage systems such as battery and super capacitors.

CO5: Analyze the various energy storage systems based on fuel cells and hydrogen storage.

TEXT BOOKS

1. "Electric Vehicles: Technology, Policy, and Business" by A. K. Jain and A. B. Shukla Publisher: PHI Learning Year: 2020.
2. "Electric and Hybrid Vehicles: Design Fundamentals" by J. K. Gupta and R. P. Gupta Publisher: New Age International Year: 2015.
3. "Electric Vehicles: An Overview" by K. R. Rao and S. K. Jain Publisher: Wiley Year:2018.

REFERENCE BOOKS

1. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Second Edition" CRC Press, Taylor & Francis Group, Second Edition (2011).
2. Ali Emadi, Mehrdad Ehsani, John M. Miller, "Vehicular Electric Power Systems", Special Indian Edition, Marcel Dekker, Inc 2010.
3. Mehrdad Ehsani, Yimin Gao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.
4. C.C. Chan and K.T. Chau, 'Modern Electric Vehicle Technology', OXFORD University Press, 2001.
5. "Electric Vehicle Technology Explained" by H. M. Tiwari and S. S. Jain Publisher: Tata McGraw-Hill Year: 2017.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	2
CO2	3	3	3	2	3	2
CO3	3	3	3	2	3	2
CO4	3	3	3	2	3	2
CO5	3	3	3	2	3	2
AVG	3	3	3	2	3	2

1 - Low, 2 - Medium, 3 – High, '-' No correlation

COURSE OBJECTIVES

- To understand the essentials of project writing and the structure of technical and project reports.
- To recognize the differences between general writing and technical writing.
- To assimilate the fundamental features of report writing and its unique characteristics.

UNIT I WRITING SKILL**6**

Writing Skills – Essential Grammar and Vocabulary – Passive Voice, Reported Speech, Concord, Signpost words, Cohesive Devices – Paragraph writing - Technical Writing vs. General Writing.

UNIT II PROJECT REPORT**6**

Project Report – Definition, Structure, Types of Reports, Purpose – Intended Audience – Plagiarism – Report Writing in STEM fields – Experiment – Statistical Analysis.

UNIT III STRUCTURE OF PROJECT REPORT**6**

Structure of the Project Report: Framing a Title – Content – Acknowledgement – Funding Details -Abstract – Introduction – Aim of the Study – Background - Writing the research question –Need of the Study/Project Significance, Relevance – Determining the feasibility – Theoretical Framework.

UNIT IV REPORT WRITING**6**

Literature Review, Research Design, Methods of Data Collection - Tools and Procedures - Data Analysis - Interpretation - Findings –Limitations -Recommendations – Conclusion – Bibliography.

UNIT V PROOF READNG**6**

Proof reading a report – Avoiding Typographical Errors – Bibliography in required Format – Font –Spacing – Checking Tables and Illustrations – Presenting a Report Orally – Techniques.

TOTAL: 30 PERIODS**COURSE OUTCOMES**

On successful completion of this course, the student will be able to

CO1: Write effective project reports.

CO2: Use statistical tools with confidence.

CO3: Explain the purpose and intension of the proposed project coherently and with clarity.

CO4: Create writing texts to suit achieve the intended purpose.

CO5: Master the art of writing winning proposals and projects.

TEXT BOOKS

1. "Scientific Writing and Communication in Agriculture and Natural Resources" by R.C. Choudhury Publisher: New India Publishing Agency Year: 2018.
2. "Technical Writing: A Practical Guide for Engineers and Scientists" by Phillip A. Laplante (with contributions from Indian authors) Publisher: Wiley Year: 2016.
3. "Effective Technical Communication" by M. Ashraf Rizvi Publisher: Tata McGraw- Hill Year: 2008.

REFERENCE BOOKS

1. Gerson and Gerson - Technical Communication: Process and Product, 7th Edition, Prentice Hall (2012).
2. Virendra K. Pamecha - Guide to Project Reports, Project Appraisals and Project Finance (2012).
3. Daniel Riordan - Technical Report Writing Today (1998).
4. Darla-Jean Weatherford - Technical Writing for Engineering Professionals (2016) Penwell Publishers.
5. "Writing Scientific Research Articles: Strategy and Steps" by S. R. K. Rao Publisher: Springer Year: 2019.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	-	-	1	-
CO2	3	3	-	-	1	-
CO3	3	3	-	-	1	-
CO4	3	3	-	-	1	-
CO5	3	3	-	-	1	-
AVG	3	3	-	-	1	-

1 - Low, 2 - Medium, 3 – High, '-' No correlation

24PE2201 INDUSTRIAL ELECTRICAL DRIVES LABORATORY

L T P C

0 0 4 2

COURSE OBJECTIVES

- To understand the performance of electrical drives experimentally under various operating conditions and improve knowledge of power electronic drive applications.
- To regulate the speed of DC motor-based drive systems and manage stepper and BLDC motor-based drive systems.
- To implement various speed control strategies for electric drives.

LIST OF EXPERIMENTS

1. Design and speed control of AC to DC converter fed DC motor drive.
2. Design and speed control of DC to DC converter fed DC motor drive.
3. Speed control of induction motor drive using V/f control.

4. Simulation of Speed control of induction motor drive using field-oriented control.
5. Design and control of induction motor drive under four quadrants.
6. Micro controller based speed control of Stepper motor.
7. Simulation of Speed control of BLDC motor.
8. Simulation of Speed control of induction motor drive using flux sensor less control.
9. Simulation of Speed control of slip ring induction motor using static rotorresistance control.
10. Simulation of Speed control of permanent magnet synchronous motor (PMSM) drive.

TOTAL: 60 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Build simulation circuits for closed-loop control of drive systems.
- CO2: Capability to design and develop speed controllers for DC motor-based drive systems.
- CO3: Proficiency in performing load tests on electrical drive systems.
- CO4: Design and implement speed controllers for AC motor-based drive systems.
- CO5: Creating control algorithms for electrical drive systems using microcontrollers and digital signal processors.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	3	2
CO2	3	-	3	3	3	2
CO3	3	-	3	3	3	2
CO4	3	-	3	3	3	2
CO5	3	-	3	3	3	2
AVG	3	-	3	3	3	2

1 - Low, 2 - Medium, 3 – High, '-' No correlation

24PE2202 ADVANCED PROCESSORS FOR POWER CONVERTERS LABORATORY

**L T P C
0 0 4 2**

COURSE OBJECTIVES

- To utilize ARM and DSP controllers to generate and optimize control signals for power converters.
- To apply the resources of ARM and DSP controllers to enhance control signal precision.
- To integrate ARM and DSP controller capabilities to improve the performance of power converters.

LIST OF EXPERIMENTS

1. Single phase single quadrant DC-DC converter and its control.
2. Control of a single phase single quadrant bridge type AC-DC converter.
3. Single phase two quadrant AC-DC converter controlled through ARM processor.
4. Control of a High power two quadrant bridge type AC-DC converter.
5. ARM processor based control of a residential UPS.
6. Single phase step down cycloconverter and its control.
7. PWM control of single quadrant DC chopper.
8. DSP based implementation of PWM techniques to control an inverter.
9. Control of single phase half controlled converter using DSP processor.
10. Control of chopper circuit in TRC and variable frequency method.

TOTAL: 60 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Build simulation circuits for timers and PWM to generate triggering pulses for power electronic circuits.
- CO2: Capability to experiment with the functionalities of ARM processors to vary the triggering pulses for power electronic circuits.
- CO3: Proficiency in utilizing DSP processors for various power electronics applications.
- CO4: Design speed controllers for drive systems.
- CO5: Implementing and testing the performance of speed controllers in drive systems.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	-	-
CO2	3	3	2	2	-	-
CO3	3	3	3	3	-	-
CO4	3	3	3	3	-	-
CO5	-	-	-	-	-	-
AVG	3	3	2.5	2.5	-	-

1 - Low, 2 - Medium, 3 – High, '-' No correlation

24RE3101 RESEARCH ARTICLE REVIEW

L T P C

0 0 4 2

COURSE OBJECTIVES

- To gain knowledge on collecting the research articles.
- To read and understand the various literatures related to the research.
- To write the review article for publication

STAGES OF REVIEW

Stage-1	Collection of latest Research articles
Stage-2	Read the entire article and take a note in his/her own words.
Stage-3	Summarize the literature in his/her own words.
Stage-4	Classify and arrange the literatures with template
Stage 5	Preparation of review article
Stage 6	Plagiarism checked by the department and it must be less than 10%
Stage 7	Article must be communicated to the journal.

The students must do the above work individually by the guidance of faculty members and one coordinator is required to monitor the work progress. The evaluation will be done based on the following

- Review of work after stage 3 10%
- Review of work after stage 5 20%
- Review of work after stage 7 20%
- Final examination 50%

TOTAL: 60 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Explain the technique to collect the literatures from various resources.
- CO2: Apply the knowledge for collecting the required research data from the articles.
- CO3: Formulate the research problem.
- CO4: Analyze the research gap from various researchers work.
- CO5: Create the new article to publish in the research journals.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	-	-	2	-
CO2	2	2	-	-	-	-
CO3	2	2	-	-	-	-
CO4	2	2	-	-	2	-
CO5	2	2	-	-	2	-
AVG	2	2	-	-	2	-

1 - Low, 2 - Medium, 3 – High, '-' No correlation

COURSE OBJECTIVES

- To study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high-performance computing for Smart Grid application.

UNIT I INTRODUCTION TO SMART GRID 9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Micro grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

UNIT II SMART GRID TECHNOLOGIES 9

Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/VAR control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit (PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

UNIT V HIGH PERFORMANCE COMPUTING FOR SMART GRID 9

Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Relate with the smart resources, smart meters and other smart devices.
- CO2: Describe the functions of the Smart Grid.
- CO3: Investigate the power quality issues within the Smart Grid.
- CO4: Evaluate the performance of the Smart Grid.
- CO5: Suggest appropriate communication networks for Smart Grid.

TEXT BOOKS

1. Stuart Borlase ‘Smart Grid: Infrastructure, Technology and Solutions’, CRC Press 2012.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, ‘Smart Grid: Technology and Applications’, Wiley, 2012.
3. D. Kirschen and G. Strbac, Fundamentals of Power System economics, John Wiley & Sons Ltd, 2019, 2nd Edition.

REFERENCE BOOKS

1. Mini S. Thomas, John D McDonald, ‘Power System SCADA and Smart Grids’, CRC Press, 2015.
2. Kenneth C. Budka, Jayant G. Deshpande, Marina Thottan, ‘Communication Networks for Smart Grids’, Springer, 2014.
3. SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.
4. Vehbi C. Güngör, Dilan Sahin, Taskin Kocak, Salih Ergüt, Concettina Buccella, Carlo Cecati and Gerhard P. Hancke, ‘Smart Grid Technologies: Communication Technologies and Standards’, IEEE Transactions on Industrial Informatics, Vol. 7, No. 4, November 2011.
5. Lars T. Berger and Krzysztof Iniewski, “Smart Grid applications, communications and security”, Wiley, 2015.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	3	3	3	3
CO2	3	2	-	2	2	2
CO3	3	-	2	2	-	2
CO4	2	-	1	-	-	3
CO5	1	2	2	2	2	2
AVG	2	2	2	2.25	2.33	2.4

1 - Low, 2 - Medium, 3 – High, ‘-’ No correlation

COURSE OBJECTIVES

- To understand the basic scientific principles, design components, and efficiency computation theories of wind turbines.
- To learn the design, control principles, and concepts of both fixed and variable speed wind energy conversion systems.
- To analyze grid integration of wind turbines and identify related challenges and issues.

UNIT I WIND POWER BASICS**9**

Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory- Power coefficient-Sabinin's theory-Aerodynamics of Wind turbine.

UNIT II WIND TURBINE**9**

HAWT-VAWT-Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations- Tip speed ratio-No. Of Blades-Blade profile-Power Regulation-yaw control Pitch angle control- stall control-Schemes for maximum power extraction.

UNIT III TECHNOLOGY OF WIND ENERGY CONVERSION SYSTEM**9**

Fixed speed and variable speed systems. Electrical machines for wind energy systems, synchronous and asynchronous generators and power electronics. Integration of wind energy systems to electrical networks, converters, inverters, directly connected, wind energy storage solutions.

UNIT IV CONTROL SYSTEMS**9**

Requirements, components and strategies. Small wind turbines special considerations and designs, testing, noise issues, Off-shore turbines.

UNIT V GRIDCONNECTED SYSTEMS**9**

Wind interconnection requirements, Low-Voltage Ride Through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, current practices and industry trends wind interconnection impact on steady-state and dynamic performance of the power system including modeling issue.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

On successful completion of this course, the student will be able to

- CO1: Gain an understanding of the fundamental concepts of wind energy conversion systems.
- CO2: Acquire knowledge in the mathematical modeling and control of wind turbines.
- CO3: Deepen understanding of the design principles for fixed-speed systems.
- CO4: Explore the necessity and modeling of variable-speed systems.
- CO5: Learn about grid integration challenges and current practices for connecting wind energy to power systems.

TEXT BOOKS

1. Joshua Earnest Wind Power Technology, PHI Learning Pvt. Ltd., 2014.
2. S. N. Bhadra, D. Kastha, and S. Banerjee Wind Electrical Systems, Oxford University Press, 2005.
3. S. S. Rao and B. B. Parekh, Wind Energy: Theory and Practice, PHI Learning Pvt. Ltd., 2018.

REFERENCE BOOKS

1. L.L.Freris “Wind Energy conversion Systems”, Prentice Hall, 1990.
2. S.N.Bhadra, D.Kastha, S.Banerjee, ”Wind Electrical Systems”, Oxford University Press,2010.
3. Ion Boldea, “Variable speed generators”, Taylor & Francis group, 2006.
4. E.W.Golding “The generation of Electricity by wind power”, Redwood burn Ltd., Trowbridge, 1976.
5. B. H. Khan, Non-Conventional Energy Resources, McGraw Hill Education, 2017.

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	3	1
CO2	3	1	3	2	3	1
CO3	3	1	3	2	3	1
CO4	3	1	3	2	3	1
CO5	3	1	3	2	3	1
AVG	3	1	3	2	3	1

1 - Low, 2 - Medium, 3 – High, ‘-’ No correlation

24PE1303 POWER SYSTEM RESTRUCTURING & DEREGULATION

L T P C

3 0 0 3

COURSE OBJECTIVES

- To impart knowledge about the restructuring and deregulation of power sector.
- To introduce the fundamental concepts relevant to congestion management.
- To enable the students to understand the factors related with deregulation of power industry in different countries.

UNIT I INTRODUCTION

9

Basic concept and definitions, privatization, restructuring, transmission open access, wheeling, deregulation, components of deregulated system, advantages of competitive system. Power System Restructuring: An overview of the restructured power system, Difference between integrated power system and restructured power system, Explanation with suitable practical examples.

UNIT II DEREGULATION OF POWER SECTOR **9**

Separation of owner ship and operation, Deregulated models, pool model, pool and bilateral trades model, multilateral trade model. Competitive electricity market: Independent System Operator activities in pool market, Wholesale electricity market characteristics, central auction, single auction power pool, double auction power pool, market clearing and pricing, Market Power and its Mitigation Techniques, Bilateral trading, Ancillary services.

UNIT III TRANSMISSION PRICING **9**

Marginal pricing of electricity, nodal pricing, zonal pricing, embedded cost, Postage stamp method, Contract Path method, Boundary flow method, MW-mile method, MVA-mile method, Comparison of different methods.

UNIT IV CONGESTION MANAGEMENT **9**

Congestion management in normal operation, explanation with suitable example, Total Transfer Capability (TTC), Available Transfer Capability (ATC), Transmission Reliability Margin (TRM), Capacity Benefit Margin (CBM), Existing Transmission Commitments (ETC).

UNIT V CASE STUDY **9**

Different Experiences in deregulation: England and Wales, Norway, China, California, New Zealand and Indian power system.

TOTAL:45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Identify various concepts of restructuring and deregulation of power sector.
- CO2: Describe important concepts related with deregulation like models, market power, OASIS, congestion management etc.
- CO3: Apply different transmission pricing concepts to real-world scenarios.
- CO4: Apply different congestion management techniques to case studies and practical examples to address congestion issues.
- CO5: Analyze case studies of deregulation in various countries and assess their outcomes and impacts on the power sector.

TEXT BOOKS

1. Loi Lei Lai, Power System Restructuring and Deregulation: Trading, Performance and Information Technology, Wiley India Pvt. Ltd., 2001.
2. K. Bhattacharya, M. H. J. Bollen, and J. E. Daalder, Operation of Restructured Power Systems, Springer India, 2012.
3. S. A. Khaparde and A. R. Abhyankar, Restructured Power Systems, Narosa Publishing House, 2019.

REFERENCE BOOKS

1. Power System Restructuring and Deregulation by Loi Lei Lai, John Wiley & Sons Ltd.

2. Understanding Electric Utilities and Deregulation by Lorrin Philipson and H. Lee Willis, Marcel Dekker Inc, New York, CRC Press.
3. Power System Restructuring Engineering & Economics by Marija Ilic by Francisco Galiana and Lestor Fink, Kulwer Academic Publisher, USA.
4. Ashikur Bhuiya: Power System Deregulation: Loss Sharing in Bilateral Contracts and Generator Profit Maximization, VDM Verlag Publisher, 2008.
5. S. Hunt., Making competition work in electricity, John Wiley & Sons, Inc., 2002, 1st Edition.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	2
CO2	3	3	3	2	3	2
CO3	3	3	3	2	3	2
CO4	3	3	3	2	3	2
CO5	3	3	3	2	3	2
AVG	3	3	3	2	3	2

1 - Low, 2 - Medium, 3 – High, '-' No correlation

24PE1304 DISTRIBUTED GENERATION AND MICRO GRID

L T P C

3 0 0 3

COURSE OBJECTIVES

- To explain the concept of distributed generation, explore its various topologies, and evaluate the effects of its integration with the grid.
- To study concept of Microgrid and its configuration.
- To understand various modes of operation and control of micro grid.

UNIT I INTRODUCTION TO DISTRIBUTED GENERATION

9

Need for Distributed generation, renewable sources in distributed generation, current scenario in Distributed Generation, Planning of DGs – Siting and sizing of DGs – optimal placement of DG sources in distribution systems.

UNIT II GRID INTEGRATION OF DISTRIBUTED GENERATION

9

Different types of interfaces - Inverter based DGs and rotating machine based interfaces - Aggregation of multiple DG units. Energy storage elements: Batteries, ultra capacitors, flywheels.

UNIT III TECHNICAL IMPACTS OF DISTRIBUTED GENERATION

9

Transmission systems, Distribution systems, De-regulation – Impact of DGs upon protective relaying – Impact of DGs upon transient and dynamic stability of existing distribution systems.

UNIT IV ECONOMIC AND CONTROL ASPECTS OF DISTRIBUTED GENERATION

9

Market facts, issues and challenges - Limitations of DGs. Voltage control techniques, Reactive power control, Harmonics, Power quality issues. Reliability of DG based systems – Steady-state and Dynamic analysis.

UNIT V INTRODUCTION TO MICRO-GRIDS

9

Types of micro-grids – autonomous and non-autonomous grids – Sizing of micro-grids-modeling & analysis- Micro-grids with multiple DGs – Micro- grids with power electronic interfacing units. Transients in micro-grids - Protection of micro-grids – Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Comprehend the concepts of Distributed Generation and Microgrids.

CO2: Learn about the different Distributed Generation (DG) resources.

CO3: Become familiar with the planning and protection strategies for Distributed Generation.

CO4: Understand the concept of Microgrids and their operational modes.

CO5: Associate different types of micro-grids and analyse the transients and protection related issues in micro-grids.

TEXT BOOKS

1. S. N. Singh, Electric Power Generation, Transmission, and Distribution: Distributed Generation and Microgrid, PHI Learning Pvt. Ltd., 2011.
2. R. C. Bansal, Distributed Generation and Microgrids, CRC Press India, 2017.
3. S. Chowdhury, P. Crossley, and S. P. Chowdhury, Microgrids and Active Distribution Networks, IET India, 2009.

REFERENCE BOOKS

1. Nick Jenkins, Janaka Ekanayake , Goran Strbac , “Distributed Generation”, Institution of Engineering and Technology, London, UK,2010.
2. S. Chowdhury, S.P. Chowdhury and P. Crossley, “Microgrids and Active Distribution Networks”, The Institution of Engineering and Technology, London, United Kingdom, 2009.
3. Math H. Bollen , Fainan Hassan, “Integration of Distributed Generation in the Power System”, John Wiley & Sons, New Jersey, 2011.
4. Magdi S. Mahmoud, Fouad M. AL-Sunni, “Control and Optimization of Distributed Generation Systems”, Springer International Publishing, Switzerland, 2015.
5. Nadarajah Mithulananthan, Duong Quoc Hung, Kwang Y. Lee, “Intelligent Network Integration of Distributed Renewable Generation”, Springer International Publishing, Switzerland, 2017.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	3	3
CO2	3	3	2	2	3	3
CO3	3	3	2	2	3	3
CO4	3	3	2	2	3	3
CO5	3	3	2	2	3	3
AVG	3	3	2	2	3	3

1 - Low, 2 - Medium, 3 – High

24PE1305 FLEXIBLE AC TRANSMISSION SYSTEMS

L T P C

3 0 0 3

COURSE OBJECTIVES

- To explore Smart Grid technologies, including smart meters and advanced metering infrastructure.
- To understand the functions of the Smart Grid and power quality management challenges.
- To gain knowledge of high-performance computing and communication networks used in Smart Grid applications.

UNIT I FACTS CONCEPTS

9

Transmission interconnections power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters, basic types of FACTS controllers, benefits from FACTS controllers.

UNIT II VOLTAGE SOURCE CONVERTERS

9

Single Phase Three Phase Full Wave Bridge Converter Transformer Connections for 12 Pulse 24 And 48 Pulse Operation. Three Level Voltage Source Converter, Pulse Width Modulation Converter, Basic Concept of Current Source Converters, and Comparison of Current Source Converters with Voltage Source Converters.

UNIT III STATIC SHUNT COMPENSATION

9

Objectives of Shunt Compensation, Midpoint Voltage Regulation Voltage Instability Prevention, Improvement of Transient Stability, Power Oscillation Damping, Methods of controllable VAR Generation, Variable Impedance Type Static VAR Generators Switching Converter Type VAR Generators Hybrid VAR Generators.

UNIT IV SVC AND STATCOM

9

The Regulation and Slope Transfer Function, Dynamic Performance, Transient Stability Enhancement and Power Oscillation Damping, Operating Point Control and Summary of Compensator Control.

UNIT V STATIC SERIES COMPENSATORS

9

Concept of Series Capacitive Compensation, Improvement of Transient Stability, Power Oscillation Damping, Subsynchronous Oscillation Damping. Functional Requirements of GTO Thyristor Controlled Series Capacitor (GCSC), Thyristor Switched Series Capacitor (TSSC), And Thyristor Controlled Series Capacitor (TCSC) Control Schemes for GCSC, TSSC and TCSC.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Explain various types of power controllers in transmission lines.
- CO2: Familiarize the high-performance computing for Smart Grid applications
- CO3: Enumerate the static VAR compensator and its applications.
- CO4: Explain the TCSC controller and its applications.
- CO5: Analyze the transient stability and modeling of STATCOM.

TEXT BOOKS

1. Narain G. Hingorani and L. Gyugyi, Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems, Wiley India Pvt. Ltd., 2011.
2. S.Rao, EHV-AC, HVDC Transmission & Distribution Engineering, Khanna Publishers, 2011.
3. D. P. Kothari and I. J. Nagrath, Modern Power System Analysis, McGraw Hill Education, 2013.

REFERENCE BOOKS

1. R.Mohan Mathur, Rajiv K.Varma, “Thyristor – Based Facts Controllers for Electrical Transmission Systems”, IEEE press and John Wiley & Sons, Inc, 2002.
2. Narain G. Hingorani, “Understanding FACTS -Concepts and Technology of Flexible AC Transmission Systems”, Standard Publishers Distributors, Delhi- 110 006, 2011.
3. K.R.Padiyar,” FACTS Controllers in Power Transmission and Distribution”, New Age International (P) Limited, Publishers, New Delhi, 2008.
4. N. G. Hingorani, L. Gyugyi, Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems, Wiley, 2000.
5. Suman Bhowmick, Flexible AC Transmission Systems (FACTS), CRC Press, 2023, First Edition.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	-	1	1
CO2	3	1	3	-	1	1
CO3	3	3	3	-	1	1
CO4	3	3	3	-	1	1
CO5	3	3	3	-	1	1
AVG	3	2.2	3	-	1	1

1 - Low, 2 - Medium, 3 – High, '-' No correlation

24PE1306 HIGH VOLTAGE DC TRANSMISSION

L T P C
3 0 0 3

COURSE OBJECTIVES

- To emphasize the need for HVDC transmission and understand the characteristics, applications, and modeling of HVDC controllers.
- To analyze the interaction of different HVDC controllers and perform control coordination.
- To gain knowledge on the operation, modeling, and control of HVDC links, including steady-state analysis of AC/DC systems.

UNIT I DC POWER TRANSMISSION TECHNOLOGY 9

Introduction, Comparison of HVAC and HVDC transmission system, Applications of DC transmission, Description of DC transmission system, Configurations, Modern trends in DC transmission. Pulse number, Choice of converter configuration, Simplified analysis of Graetz circuit, Converter bridge characteristics, Characteristics of a twelve-pulse converter.

UNIT II CONVERTER AND HVDC SYSTEM CONTROL 9

General, Principles of DC link control, Converter control characteristics, System control hierarchy, Firing angle control, Current and extinction angle control, Starting and stopping of DC link, Power control, Higher level controllers.

UNIT III POWER FLOW ANALYSIS 9

DC system model for load flow studies, Load flow study of AC-DC system sequential method, simultaneous method. Reactive power requirements in steady state, conventional control strategies, alternate control strategies, equipment for reactive power.

UNIT IV FAULTS AND PROTECTION 9

Short circuit ratio, Effective short circuit ratio, dynamic over voltages, power modulation, commutation failure, disturbances on AC side, disturbances on DC side, Characteristic harmonics, derivation of relevant equations for 12 pulse converter. AC filters single tuned, doubled tuned filters, brief introduction to DC circuit breakers.

UNIT V MULTI TERMINAL DC TRANSMISSION

9

Introduction, potential applications of MTDC systems, Types of MTDC systems, control and protection.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Choose intelligently AC and DC transmission systems for the dedicate applications.
- CO2: Identify the suitable two-level/multilevel configuration for high power converters.
- CO3: Select the suitable protection method for various converter faults.
- CO4: Identify suitable reactive power compensation method.
- CO5: Decide the configuration for harmonic mitigation on both AC and DC sides.

TEXT BOOKS

1. K. R. Padiyar, HVDC Power Transmission Systems: Technology and System Interactions New Age International Publishers, 2011.
2. S. Kamakshaiyah and V. Kamaraju, HVDC Transmission, McGraw Hill Education, 2011.
3. J. Arrillaga and B. S. R. Murthy, High Voltage Direct Current Transmission, IET India, 2015.

REFERENCE BOOKS

1. Arrillaga, J., HVDC Transmission, IEE Press (2007).
2. Edwart, K., Direct Current Transmission (Vol. 1), John Wiley and Sons (2008).
3. Padiyar, K.R., HVDC Power Transmission System, New Age International (P) Limited, Publishers (2008).
4. Arrillaga, J. and Smith, B.C., AC to DC Power System Analysis, IEE Press (2008).
5. Turan Gonen, Electric Power Transmission System Engineering Analysis and Design, CRC Press, 2014, Third Edition.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	2	2
CO2	3	3	2	2	3	2
CO3	3	3	2	2	3	3
CO4	3	3	2	3	3	3
CO5	3	3	2	3	3	3
AVG	3	3	2	2.4	2.8	2.6

1 - Low, 2 - Medium, 3 - High

COURSE OBJECTIVES

- To understand different types of energy storages.
- To analyze different battery storage technologies and thermodynamics of Fuel Cell.
- To study the various applications of energy storage system.

UNIT I ENERGY STORAGE**9**

Necessity and types of energy storage, Mechanical, electrical and chemical energy storage systems and its application; Available energy; Energy analysis: Second law efficiency; Helmholtz & Gibb's function; Recent trends in energy storage systems.

UNIT II STORAGE SYSTEMS**9**

Fundamental concept of batteries – Measuring of battery performance: charging and discharging of battery, storage density, energy density and safety issues; Modeling of batteries; Zinc-air, Nickel hydride, Lithium battery; State of charge; Technology challenges.

UNIT III SUPER CAPACITORS**9**

Super capacitors; Types of electrodes and electrolytes; Electrode materials: high surface area activated carbons, metal oxide and conducting polymers; Electrolyte: aqueous or organic, disadvantages and advantages of super capacitors; Modeling of super capacitors; Application of super capacitors.

UNIT IV FUEL CELLS**9**

Fuel Cell – History of Fuel cell, Principles of Electrochemical storage – Types: Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, Alkaline fuel cell - Modeling of Fuel Cells, maximum intrinsic efficiency of an electrochemical converter; Physical interpretation; Carnot efficiency factor in electrochemical energy converters; – Advantages and disadvantages –Fuel Cell Thermodynamics.

UNIT V ENERGY STORAGE APPLICATIONS**9**

Application of Power Electronics Converters in Energy Storage Systems; Standalone photovoltaic systems; Grid connected systems; Power smoothing, grid ancillary services, energy management case studies and simulation.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

On successful completion of this course, the student will be able to

- CO1: Explain the concept of energy storage system.
- CO2: Explore the physics of energy storage.
- CO3: Model the different energy technologies.
- CO4: Recognize the applications of various techniques.
- CO5: Design and analyze the energy storage technologies.

TEXT BOOKS

1. Andrei G. Ter-Gazarian, "Energy storage systems for Power systems", Second edition, IET 2011.
2. James Larmini 1. Yves Brunet, "Energy Storage", Wiley-ISTE, 1st Edition, 2010. M.TECH (C&A).
3. Andrei G. Ter-Gazarian, "Energy storage systems for Power systems", Second edition, IET 2011.

REFERENCE BOOKS

1. R M. Dell, D.A.J. Rand, "Understanding Batteries" RSC Publications, 1st edition, 2012.
2. Tetsuya Osaka, Madhav Datta, "Energy Storage Systems in Electronics-New Trends in Electrochemical Technology", CRC Press, 2000.
3. James Larminie and Andrew Dicks, 'Fuel cell systems Explained', Wiley publications, 2003.
4. Lunardini V.J, "Heat Transfer in Cold Climates", John Wiley and Sons 1981.
5. Jiujun Zhang (Editor), Lei Zhang (Editor), Hansan Liu (Editor), Andy Sun (Editor), Ru-Shi Liu (Editor), "Electrochemical technologies for energy storage and conversion", Two Volume Set, Wiley publications, 2012.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	1	-	-	2	-
CO2	2	1	2	-	3	-
CO3	2	2	2	-	3	-
CO4	3	2	3	-	3	2
CO5	2	2	2	2	2	3
AVG	2.25	1.6	2.25	2	2.6	2.5

1 - Low, 2 - Medium, 3 – High, ‘ - ’ No correlation

24PE1308 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS

**L T P C
3 0 0 3**

COURSE OBJECTIVES

- To analyze various electrical Generators used for the Wind Energy Conversion Systems and various maximum power point tracking algorithms.
- To design a power converter used in renewable energy systems such as AC-DC, DC-DC, and AC-AC converters.
- To understand the importance of standalone, grid-connected, and hybrid operation in renewable energy systems.

UNIT I INTRODUCTION TO RENEWABLE ENERGY SYSTEM 9

Classification of Energy Sources – Importance of Non-conventional energy sources – Advantages and disadvantages of conventional energy sources – Environmental aspects of energy – Impacts of renewable energy generation on the environment – Qualitative study of renewable energy resources: Ocean energy, Biomass energy, Hydrogen energy, - Solar Photovoltaic (PV), Fuel cells: Operating principles and characteristics, Wind Energy: Nature of wind, Types, control strategy, operating area.

UNIT II ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION SYSTEMS 9

Review of reference theory fundamentals –Construction, Principle of operation and analysis: Squirrel Cage Induction Generator (SCIG), Doubly Fed Induction Generator (DFIG) – Permanent Magnet Synchronous Generator (PMSG).

UNIT III POWER CONVERTERS & ANALYSIS OF SOLAR PV SYSTEMS 9

Introduction to PV-Cells, Array, Solar power extraction using PV-Cells, I-V Characteristics. Line commutated converters (inversion-mode) – Boost and buck-boost converters- selection of inverter, battery sizing, array sizing. Block diagram of the solar PV systems – Types of Solar PV systems: Stand-alone PV systems, Grid integrated solar PV Systems – Grid connection Issues.

UNIT IV POWER CONVERTERS AND ANALYSIS OF WIND SYSTEMS 9

Three-phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid-Interactive Inverters – Matrix converter. Stand-alone operation of fixed and variable speed WECS-Grid integrated SCIG and PMSG based WECS.

UNIT V HYBRID RENEWABLE ENERGY SYSTEMS 9

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Diesel-PV, Wind PV, Micro hydel-PV, Biomass-Diesel systems – Maximum Power Point Tracking (MPPT).

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Analyze the impacts of renewable energy technologies on the environment and demonstrate them to harness electrical power.
- CO2: Select a suitable electrical machine for Wind Energy Conversion Systems.
- CO3: Design the power converters such as AC-DC, DC-DC, and AC-AC converters for Solar energy systems.
- CO4: Design the power converters such as AC-DC, DC-DC, and AC-AC converters for Wind energy systems.
- CO5: Analyze the hybrid renewable energy system.

TEXT BOOKS

1. N.Bhadra, D. Kasta, & S. Banerjee “Wind Electrical Systems”, Oxford University Press, 2009.
2. Rashid .M. H “Power electronics Hand book”, Academic press, Second Edition, 2006.
3. Rai. G.D, “Non-conventional energy sources”, Khanna publishers, 2010.

REFERENCE BOOKS

1. Rai. G.D,” Solar energy utilization”, Khanna publishers, 5th Edition, 2008.
2. Gray, L. Johnson, “Wind energy system”, prentice hall of India, 1995.
3. B.H.Khan “Non-conventional Energy sources “, Tata McGraw-hill Publishing Company, New Delhi, 2017.
4. Suleiman M. Sharkh, Mohammad A. Abu-Sara, Georgios I. Orfanoudakis, Babar Hussain, “Power Electronic Converters for Microgrids” Wiley-IEEE Press, April 2014.
5. Chakraborty, William E. Kramer, “Power Electronics for Renewable and Distributed Energy Systems” Springer 2013.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	3	2	3	2
CO2	2	1	3	2	2	2
CO3	2	1	3	2	2	2
CO4	1	1	3	2	2	2
CO5	1	1	3	2	2	2
AVG	1.4	1	3	2	2.2	2

1 - Low, 2 - Medium, 3 – High, ‘ - ’ No correlation

24PE1309 ADVANCED POWER CONVERTERS

L T P C

3 0 0 3

COURSE OBJECTIVES

- To learn the operation of ultra-lift converters and multiple quadrant converters.
- To provide knowledge on the principle of bidirectional dual active bridge converters.
- To educate on the working principle of Impedance source converter, voltage lift circuits, super lift circuits.

UNIT I VOLTAGE-LIFT CONVERTERS

9

Introduction- Self-lift and reverse self-lift circuits- Cuk converter, Luo converter and SEPIC converter- continuous and discontinuous conduction mode. - Applications.

UNIT II POSITIVE OUTPUT & NEGATIVE OUTPUT SUPER-LIFT LUO CONVERTER **9**

Main series, -Elementary Circuit, Re-Lift Circuit, Triple-Lift Circuit, Higher-Order Lift Circuit-. Continuous and discontinuous conduction modes- Applications.

UNIT III ULTRA LIFT CONVERTERS AND MULTIPLE QUADRANT OPERATING LUO-CONVERTERS **9**

Ultra-Lift Luo - Converter- Operation – Continuous and discontinuous conduction Modes of Ultra-Lift Luo – Converter - Instantaneous Values- Multiple quadrant operating Luo Converters- Circuit explanations-Modes of operation- Applications.

UNIT IV BIDIRECTIONAL DUAL ACTIVE BRIDGE DC–DC CONVERTERS **9**

Application of Bidirectional DC–DC Converter-Classification of Bidirectional DC–DC Converter – Working Principle of Hybrid-Bridge-Based Dual active bridge (DAB) converter-Performance voltage mode control- Principle of Dual-Transformer based DAB converter-Three-Level bidirectional DC–DC converter- Applications.

UNIT V IMPEDANCE SOURCE CONVERTER **9**

Voltage Fed Z source inverters –Topologies –Steady state and dynamic model- Current fed Z source inverter –Topology –Modification and operational principles. Modulation Methods- Sine PWM- SVPWM and Pulse width Amplitude Modulation- Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Explain the working of voltage lift circuits.
- CO2: Design the super lift converters.
- CO3: Explain the working and applications of ultra-lift converters.
- CO4: Acquire knowledge on working and design of bi-directional DC-DC converters.
- CO5: Explore the concepts related with impedance source converter.

TEXT BOOKS

1. Ned Mohan, Tore M.Undeland and William P. Robbins, “Power Electronics – Converters, Applications and Design”, John Willey & sons, Inc., 3rd ed., 2003.
2. Muhammad H. Rashid, “Power Electronics - Circuits, Devices and Applications”, Prentice Hall of India, 3rd ed., 2009.
3. Derek A. Paice “Power Electronic Converter Harmonics – Multi pulse Methods for Clean Power”, IEEE Press, 1996.

REFERENCE BOOKS

1. Muhammad H. Rashid , “Power Electronics Handbook”, Elsevier, 3rd ed., 2011.
2. P.C.Sen, “Modern Power Electronics ”, S. Chand and Co. Ltd., New Delhi, 2000.

3. Vijay K. Sood, "HVDC and FACTS Controllers Applications of Static Converters in Power Systems", Kluwer Academic Publishers, Boston, 2004.
4. L. Umanand, "Power Electronics Essentials and Applications", Wiley India Ltd., 2009 Recent Literature.
5. Dubey G.K. "Power Semiconductor Controlled Drives", PRENTICE- Hall of India Pvt, New Jersey, 2002.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	2	3	2	1
CO2	2	-	2	3	2	1
CO3	2	-	2	3	2	1
CO4	2	-	2	3	2	1
CO5	2	-	2	3	2	1
AVG	2	-	2	3	3	1

1 - Low, 2 - Medium, 3 – High, ‘-’ No correlation

24PE1310 WIND ENERGY CONVERSION SYSTEM

L T P C
3 0 0 3

COURSE OBJECTIVES

- To learn about the basic concepts of wind energy conversion system and design and control principles of Wind turbine.
- To understand the concepts of fixed speed wind energy conversion and Variable speed wind energy conversion systems.
- To model the grid integration.

UNIT I FUNDAMENTALS OF WIND ENERGY GENERATION SYSTEM 9

Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory- Power coefficient - Sabinin’s theory-Aerodynamics of Wind turbine-wind resources worldwide and in India, wind energy forecast.

UNIT II WIND TURBINES 9

Types and characteristics of wind turbine-HAWT-VAWT-Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations- Tip speed ratio-No. Of Blades-Blade profile-Power Regulation-yaw control -Pitch angle control- stall control-Schemes for maximum power extraction.

UNIT III FIXED SPEED SYSTEMS 9

Generating Systems- Constant speed constant frequency systems – Choice of Generators Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed- Model wind turbine rotor – Drive Train model- Generator model for Steady state and Transient stability analysis.

UNIT IV VARIABLE SPEED SYSTEMS

9

Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG –Variable speed generators modeling – Variable speed variable frequency schemes.

UNIT V GRID CONNECTED SYSTEMS

9

Wind interconnection requirements, low-voltage ride through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, current practices and industry trends wind interconnection impact on steady-state and dynamic performance of the power system including modeling issue.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Attain knowledge on the basic concepts of Wind energy conversion system.

CO2: Attain knowledge of the mathematical modeling and control of the Wind Turbine .

CO3: Develop more understanding on the design of fixed speed system.

CO4: Study about the need of Variable speed system and its modeling.

CO5: Learn about Grid integration issues and current practices of wind interconnections with power system.

TEXT BOOKS

1. S.N.Bhadra, D. Kasta, & S. Banerjee “Wind Electrical Systems”, Oxford University Press, 2009.
2. Rashid .M. H “Power electronics Hand book”, Academic press, Second Edition, 2006.
3. Rai. G.D, “Non-conventional energy sources”, Khanna publishers, 2010.

REFERENCE BOOKS

1. Rai. G.D,” Solar energy utilization”, Khanna publishers, Fifth Edition, 2008.
2. Gray, L. Johnson, “Wind energy system”, prentice hall of India, 1995.
3. B.H.Khan, “Non-conventional Energy sources”, Tata McGraw Hill Publishing Company, New Delhi, 2017.
4. Earnest Joshua, “Wind Power Technology”, Second edition, PHI Learning Pvt. Ltd., New Delhi, 2015.
5. Johnson G. L., “Wind Energy Systems”, Prentice Hall, 1994.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	3	2	3	1
CO2	3	1	3	2	3	1
CO3	3	1	3	2	3	1
CO4	3	1	3	2	3	1
CO5	3	1	3	2	3	1
AVG	2.6	1	3	2	3	1

1 - Low, 2 - Medium, 3 – High, ‘ - ’ No correlation

24PE1311 GRID INTEGRATION OF RENEWABLE ENERGY SOURCES L T P C 3 0 0 3

COURSE OBJECTIVES

- To understand the concepts and techniques in power systems and renewable energy sources.
- To analyse various equipments used for grid integration.
- To get knowledge about power quality management and grid connected and standalone PV system.

UNIT I INTRODUCTION 9

Various techniques of utilizing power from renewable energy sources, concept of nano/micro/mini grid. Need of integrating large renewable energy sources, issues related to integration of large renewable energy sources, rooftop plants.

UNIT II POWER SYSTEM EQUIPMENTS FOR GRID INTEGRATION 9

Synchronous generator: synchronization/integration to existing grid, load sharing during parallel operation, stability (swing equation and solution). Induction Generator: working principle, classification, stability due to variable speed and counter measures. Power Electronics: need of power electronic equipments in grid integration, converter, inverter, chopper, ac regulator and cycloconverters for AC/DC conversion.

UNIT III POWER QUALITY MANAGEMENT 9

THD, voltage sag, voltage swell, frequency change and its effects, network voltage management, frequency management, system protection, grid codes. Influence of WECS on system transient response - Interconnection standards and grid code requirements for integration.

UNIT IV STAND ALONE AND GRID CONNECTED PV SYSTEM 9

Solar modules – storage systems – Basics of batteries – Batteries for PV Systems – Charge Controllers – MPPT and Inverters – Power Conditioning and Regulation – protection – Types of Solar PV systems - standalone PV systems design – sizing – PV systems in buildings –

design issues for central power stations – safety – Economic aspect – efficiency and performance – International PV program.

UNIT V INTEGRATION OF ALTERNATE SOURCES OF ENERGY 9

Introduction, principles of power injection: converting technologies, power flow; instantaneous active and reactive power control approach; integrating multiple renewable energy sources; DC link integration; AC link integration; HFAC link integration; islanding and interconnection.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Know about the techniques for integration of various renewable energy sources into the grid.
- CO2: Analyze various equipment for grid integration.
- CO3: Analyze the power quality management.
- CO4: Analyze and compare stand alone and PV system.
- CO5: Explore the different integration techniques.

TEXT BOOKS

1. S.P. Sukhatme, 'Solar Energy', Tata McGraw Hill, 1987. 7. Chetan Singh Solanki, 'Solar Photovoltaic Technology and Systems' – A Manual for Technicians, Trainees and Engineers, PHI, 2014.
2. Majid Jamil, M. Rizwan, D.P.Kothari," Grid integration of solar photovoltaic systems", CRC Press (Taylor & Francis group), 2017.
3. Allen J. Wood, Bruce F. Wollenberg, Gerald B," Power Generation, Operation, and Control", John Wiley & Sons, New York, 2013.

REFERENCE BOOKS

1. Stuart R.Wenham, Martin A. Green, Muriel E. Watt and Richard Corkish, 'Applied Photovoltaics', Earthscan, UK, 2007.
2. Joshua Earnest, 'Wind power technology', II Edition, PHI, 2015.
3. Olimpo Anaya-Lara, Nick Jenkins, Janaka Ekanayake, Phill Cartwright and Mike Hughes, 'Wind generation Modelling and Control', A John Wiley and Sons, Ltd., Publication, 2009.
4. Brenden Fox, Damian Flynn and Leslie Bryans, 'Wind Power Integration Connection and system operational aspects', Published by The Institute of Engineering and Technology, London, United Kingdom, 2007.
5. Frank S. Barnes & Jonah G.Levine, 'Large Energy Storage Systems Handbook', CRC Press, 2011.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	3	3	1
CO2	3	1	2	3	3	1
CO3	3	1	2	3	3	1
CO4	3	1	2	3	3	1
CO5	3	1	2	3	3	1
AVG	3	1	2	3	3	1

1 - Low, 2 - Medium, 3 – High, ‘ - ’ No correlation

24PE1312 MICROCONTROLLER APPLICATIONS IN POWER CONVERTERS

L T P C

3 0 0 3

COURSE OBJECTIVES

- To analyze the internal structure and operations of the 8051 and PIC16F876 microcontrollers.
- To develop proficiency in assembly language programming for generating firing and control signals with these microcontrollers.
- To explore digital controllers and power electronics, while mastering microcontroller programming using MPLAB.

UNIT I 8051 MICROCONTROLLER

9

8051 microcontroller – Architecture – Addressing modes – I/O ports - Instruction sets – Simple assembly language programming.

UNIT II PULSE GENERATION TECHNIQUES

9

Use of microcontrollers for pulse generation in power converters - Overview of Zero-Crossing Detectors – typical firing/gate-drive circuits – Firing/gate pulses for typical single phase and three phase power converters - PIC16F876 Micro-controller – Device overview – Pin diagrams.

UNIT III PIC16F876 MICRO CONTROLLER

9

PIC16F876 micro-controller memory organization – Special Function Registers - I/O ports – Timers – Capture/ Compare/ PWM modules (CCP).

UNIT IV MICROCONTROLLER PROGRAMMING

9

Analog to Digital Converter module – Instruction set – Instruction description – Introduction to PIC microcontroller programming – Oscillator selection – Reset – Interrupts – Watch dog timer.

UNIT V MICROCONTROLLER PROGRAMMING USING MPLAB

9

Introduction to MPLAB IDE and PICSTART plus – Device Programming using MPLAB and PICSTART plus – Generation of firing / gating pulses for typical power converters.

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Explain the architecture of 8051 microcontroller.
- CO2: Explain the architecture of PIC16F876 microcontroller.
- CO3: Develop assembly language programs employing 8051 microcontroller.
- CO4: Develop assembly language programs employing 16F876 microcontroller.
- CO5: Analyze the microcontroller programming using MPLAB and develop typical programs for power converter applications.

TEXT BOOKS

1. Ramesh S. Chandra, "Microcontrollers in Power Electronics", Laxmi Publications, 2013.
2. A. K. Gupta, "Microcontroller Based Projects", Prentice Hall India, 2014.
3. Mohan, Undeland, and Robbins "Power Electronics: Converters, Applications, and Design, Wiley India, 2015.

REFERENCE BOOKS

1. PIC16F87X Datasheet 28/40-pin 8 bit CMOS flash Microcontrollers, Microchip technology Inc., 2001 and MPLAB IDE Quick start guide, Microchip technology Inc., 2007.
2. John B. Peatman, 'Design with PIC Microcontrollers', Prentice Hall, 2003.
3. MykePredko, 'Programming and customizing the PIC Microcontroller', Tata McGraw-Hill, 3rd Edition, 2008.
4. M.A. Mazidi, J.G. Mazidi and R.D. McKinlay, 'The 8051 microcontroller and embedded systems', Prentice Hall India, 2nd Edition, New Delhi, 2007.
5. James K. P. S. Gupta, "Embedded Systems: A Contemporary Design Tool", Cengage Learning, 2012.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	3	1	1	2
CO2	2	-	2	2	1	3
CO3	1	2	3	1	1	3
CO4	2	-	2	2	1	1
CO5	3	2	2	3	1	1
AVG	1.8	2	2.4	1.8	1	2

1 - Low, 2 - Medium, 3 – High, '-' No correlation

COURSE OBJECTIVES

- To understand the theory and principles of fuzzy logic and fuzzy set theory, and explore real-world applications across various domains.
- To apply fuzzy logic concepts to design and analyze fuzzy systems, including the design of components for fuzzy systems development.
- To implement fuzzy systems using relevant software tools to enhance practical understanding and application of fuzzy logic principles.

UNIT I INTRODUCTION TO FUZZY LOGIC 9

Introduction to Fuzzy Logic: Fuzzy Controllers- Preliminaries – Fuzzy sets and Basic notions – Fuzzy relation calculations – Fuzzy members – Indices of Fuzziness – comparison of Fuzzy quantities – Methods of determination of membership functions-Fundamentals of fuzzy logic systems, Fuzzy Sets, operations, relations.

UNIT II FUZZY LOGIC SYSTEM 9

Fuzzy Sets-Fuzzy Rules - Fuzzy reasoning Introduction-Basis definitions and terminology-Set, theoretic operations-MF formulation and parameterization- More on fuzzy union-Intersection and Complement- Extension principal and fuzzy relations.

UNIT III FUZZY INFERENCE SYSTEMS (FIS) 9

Fuzzy inference System- fuzzy logic,-fuzzy control - other considerations- Neuro- fuzzy Networks,- Artificial Neural Network: Supervised Learning Neural Network-Preceptron-Adaline multi-layer neural network- Fuzzy If- Then rules, fuzzy reasoning.

UNIT IV CLASSICAL SETS AND FUZZY SETS 9

Different faces of imprecision – Inexactness-Ambiguity-Undecidability-Fuzziness and certainty- Probability and fuzzy logic, Intelligent systems-Fuzzy sets and crisp sets - Intersections of Fuzzy sets-Union of Fuzzy sets.

UNIT V FUZZY LOGIC APPLICATION TO ENGINEERING 9

The complement of Fuzzy sets- Fuzzy reasoning - Linguistic variables-Fuzzy propositions-Fuzzy compositional rules of inference-Methods of decompositions- Defuzzification-Methodology of fuzzy design - Direct & Indirect methods with single and multiple experts, Adaptive fuzzy control, Rule base design using dynamic response-Fuzzy logic applications to engineering-Fuzzy decision making, Neuro-Fuzzy systems, Fuzzy Genetic Algorithms.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

On successful completion of this course, the student will be able to

- CO1: Explain Fuzzy Logic Concepts.
- CO2: Design and Implementation of Fuzzy Systems.
- CO3: Develop fuzzy logic based controllers.

CO4: Design fuzzy system to Integrate with Other Systems.

CO5: Apply and analyze fuzzy sets for existing systems.

TEXT BOOKS

1. H. J. Zimmels, "Fuzzy Set Theory and its Applications", Springer India, 2008.
2. Rajasekaran, S. & Pai, G. A. V, "Fuzzy Logic and Neural Networks: A Practical", Prentice Hall India, 2005.
3. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Wiley India, 2010.

REFERENCE BOOKS

1. Zimmermann H. J., 'Fuzzy set theory and its applications', Allied publishers limited, Madras, Fourth Edition, 2001.
2. Klir G. J. and Folger T., 'Fuzzy sets, uncertainty and information', Prentice Hall of India, New Delhi, 1991.
3. EarlCox, 'The Fuzzy Systems Handbook', AP professional Cambridge, 1999.
4. Karray, Fakhreddine O, and Clarence W. De Silva. Soft computing and intelligent systems design: theory, tools, and applications. Pearson Education, 2004.
5. M. Negnevitsky, Artificial Intelligence, A Guide to Intelligent Systems, Pearson Publishing, 2006.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	3	1	1	2
CO2	2	-	2	2	1	3
CO3	1	2	3	1	1	3
CO4	2	-	2	2	1	1
CO5	3	2	2	3	1	1
AVG	1.8	2	2.4	1.8	1	2

1 - Low, 2 - Medium, 3 – High, ‘ - ’ No correlation

COURSE OBJECTIVES

- To understand fundamental programming principles, including data types, variables, conditionals, loops, recursion, and function calls.
- To Gain proficiency in basic data structures such as lists and dictionaries, and develop skills in manipulating text files and images.
- To familiarize students with machine learning concepts and techniques, enabling them to effectively approach and implement machine learning problems using Python.

UNIT I INTRODUCTION TO MACHINE LEARNING AND PYTHON 9

Introduction to Machine Learning: Significance, Advantage and Applications – Categories of Machine Learning – Basic Steps in Machine Learning: Raw Data Collection, Pre-processing, Basics of Python Programming Syntax: Variable Types, Basic Operators, Reading Input from User – Arrays/List, Dictionary and Set – Conditional Statements – Control Flow and loop control statements.

UNIT II PYTHON FUNCTIONS AND PACKAGES 9

File Handling: Reading and Writing Data – Errors and Exceptions Handling – Functions & Modules – Package Handling in Python – Pip Installation & Exploring Functions in python package –various operations on Arrays: Indexing, Slicing, Multi Dimensional Arrays, Joining Numpy Arrays, Array intersection and Difference, Saving and Loading Numpy Arrays – Introduction to Object Oriented Programming with Python.

UNIT III IMPLEMENTATION OF MACHINE LEARNING USING PYTHON 9

Description of Standard Datasets: Coco, ImageNet, MNIST (Handwritten Digits) Dataset, Boston Housing Dataset – Introducing the concepts of Regression – Linear, Polynomial & Logistic Regression with analytical understanding – Python Application of Linear Regression and Polynomial Regression using SciPy – Interpolation, Overfitting and Underfitting concepts & examples using SciPy.

UNIT IV CLASSIFICATION AND CLUSTERING CONCEPTS OF ML 9

Introduction to ML Concepts of Clustering and Classification – Types of Classification Algorithms – Support Vector Machines (SVM) - Decision Tree - Random Forest – Introduction to ML using scikitlearn – Using scikit-learn, Loading a sample dataset, Learning & prediction, interpolation & fitting, Multiclass fitting - Implementation of SVM using Blood Cancer Dataset, Decision Tree using data from csv. Types of Clustering Algorithms & Techniques – K-means Algorithm, Mean Shift Algorithm & Hierarchical Clustering Algorithm – Introduction to Python Visualization using Matplotlib: Plotting 2- dimensional, 3-dimensional graphs; formatting axis values; plotting multiple rows of data in same graph – Implementation of K-means Algorithm and Mean Shift Algorithm using Python.

UNIT V INTRODUCTION TO NEURAL NETWORKS AND EMBEDDED MACHINE LEARNING

9

Introduction to Neural Networks & Significance – Neural Network Architecture – Single Layer Perceptron & Multi-Layer Perceptron (MLP) – Commonly Used Activation Functions Forward Propagation, Back Propagation, and Epochs – Gradient Descent – Introduction to Tensorflow and Keras ML Python packages – Implementation of MLP Neural Network on Iris Dataset – Introduction to Convolution Neural Networks – Implementation of Digit – on-Board AI – ML Edge Devices: Arduino Nano BLE Sense, Google Edge TPU and Intel Movidius.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Develop skill in system administration and network programming by learning Python.
- CO2: Relate to use Python's highly powerful processing capabilities for primitives modeling etc.
- CO3: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design.
- CO4: Demonstrating understanding in concepts of Machine Learning and its implementation using Python.
- CO5: Apply and analyze python for existing systems.

TEXT BOOKS

1. Sebastian Raschka & Vahid Mirjalili, "Python Machine Learning", Packet Publishing, 2019.
2. Mark E. Fenner, "Machine Learning with Python for Everyone", Pearson, 2018.
3. Wes McKinney, "Python for Data Analysis", O'Reilly Media publication, 2018.

REFERENCE BOOKS

1. Mark Lutz, "Learning Python, Powerful OOPs", O'reilly, 2011.
2. Zelle, John "M. Python Programming: An Introduction to Computer Science", Franklin Beedle & Associates, 2003.
3. Andreas C. Müller, Sarah Guido, "Introduction to Machine Learning with Python", O'Reilly, 2016.
4. Sebastian Raschka, Vahid Mirjalili, "Python Machine Learning - Third Edition", Packet, December 2019.
5. Paolo Perrotta, "Programming Machine Learning" Pragmatic Bookshelf, 2020.

Mapping of COs and POs

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CO1	1	2	3	1	1	2
CO2	2	-	2	2	1	3
CO3	1	2	3	1	1	3
CO4	2	-	2	2	1	1
CO5	3	2	2	3	1	1
AVG	1.8	2	2.4	1.8	5	5

1 - Low, 2 - Medium, 3 – High, ‘ - ’ No correlation

24PE1315 OPTIMIZATION TECHNIQUES

L T P C
3 0 0 3

COURSE OBJECTIVES

- To understand and analyze intermediate languages and program structures.
- To learn and apply optimization techniques.
- To explore inter procedural optimizations and improve resource utilization.

UNIT I INTRODUCTION

9

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

UNIT II LINEAR PROGRAMMING

9

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

UNIT III NON LINEAR PROGRAMMING

9

Steepest descent method, conjugates gradient method, Newton’s Method, Sequential quadratic programming, Penalty function method, augmented Lagrange multiplier method.

UNIT IV DYNAMIC PROGRAMMING

9

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

UNIT V GENETIC ALGORITHM

9

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.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Explore various classifications of optimization problems and techniques.
- CO2: Acquire knowledge of linear programming concepts.
- CO3: Explain the application of non-linear programming within optimization techniques.
- CO4: Grasp the fundamental concepts of dynamic programming.
- CO5: Learn about genetic algorithms and their application in power system optimization.

TEXT BOOKS

1. S.S. Rao, "Optimization Theory and Applications", Wiley Eastern publication, Second edition, 2009.
2. Singiresu S. Rao, "Engineering Optimization: Theory and Practice", Wiley publications, Fifth edition, 2019.
3. Jorge Nocedal and Stephen J. Wright, "Numerical Optimization", Springer, Second edition, 2006.

REFERENCE BOOKS

1. S.S. Rao, "Engineering Optimization – Theory and Practice", John Wiley & Sons, Inc., 2009.
2. Hamdy A. Taha, Operations Research: An Introduction, 10th Edition, Pearson, 2016.
3. David G. Luenberger, "Introduction to Linear and Nonlinear Programming", Addison-Wesley, 1973.
4. E. Polak, "Computational methods in Optimization", Academic Press, 1971.
5. Pierre D.A., "Optimization Theory with Applications", Wiley Publications, 1969.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	1
CO2	3	-	3	-	-	1
CO3	3	-	3	-	-	1
CO4	3	-	3	-	-	1
CO5	3	-	3	-	3	1
AVG	3	-	3	-	3	1

1 - Low, 2 - Medium, 3 – High, ‘-’ No correlation

COURSE OBJECTIVES

- To study Internet of Things (IoT) technologies and their real-time applications.
- To introduce the necessary infrastructure, accessories, and communication techniques for IoT.
- To provide insights on embedded processors, sensors, and IoT platforms.

UNIT I INTRODUCTION TO INTERNET OF THINGS**9**

Introduction to IoT-Sensing- Actuation-Basics of Networking-Communication Protocols-Sensor Networks- Machine-to-Machine Communications -Interoperability in IoT-Technology drivers - Typical IoT applications, Trends and implications.

UNIT II INTRODUCTION TO ARDUINO**9**

Introduction to Arduino Programming-types of sensors and actuators- Integration of Sensors and Actuators with Arduino- Introduction to Raspberry Pi – programming using raspberrypi- Implementation of IoT with Raspberry Pi- Interfacing sensors with microcontrollers Arduino, Raspberry Pi)- Integration of Sensors and Actuators with Raspberry Pi- comparison of Arduino and Raspberry Pi.

UNIT III IoT CLOUD COMPUTATION AND APPLICATIONS**9**

Introduction to SDN-SDN for IoT-Data Handling and Analytics-Cloud Computing - Sensor Cloud-Fog Computing-Role of ML and AI in IoT-Data analysis techniques (statistical analysis, machine learning)- Cloud platforms for IoT (AWS IoT, Azure IoT, Google Cloud IoT).

UNIT IV PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT**9**

PROTOCOLS: RFID, GSM, GPRS- Wireless technologies for IoT: WiFi (IEEE 802.11)- Bluetooth- Smart ZigBee-Smart UWB (IEEE 802.15.4)- LoWPAN- Proprietary systems and Recent trends- Embedded processors for IoT: Introduction to Python programming -Building IOT with RASPERRY PI and Arduino.

UNIT V CASE STUDIES**9**

Smart Cities- Smart Homes- Connected Vehicles- Smart Grid- Agriculture- Healthcare- Activity Monitoring-Industrial IoT- IoT Defense.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

On successful completion of this course, the student will be able to

- CO1: Analyze and evaluate the characteristics of smart home appliances.
- CO2: Explore the behaviour of IoT and their applications.
- CO3: Manage smart communication systems with multiple sensors and protocols.
- CO4: Design and simulate smart homes and smart cities with IoTs and cloud computing.
- CO5: Design embedded processors using sensors and IoT.

TEXT BOOKS

1. Peter Waher, 'Learning Internet of Things', Packet Publishing, 2015 3. Editors Ovidiu Vermesan.
2. Peter Friess, 'Internet of Things – From Research and Innovation to Market Deployment', River Publishers, 2014.
3. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547.

REFERENCE BOOKS

1. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759.
2. Raspberry Pi Cookbook, Software and Hardware Problems and solutions, Simon Monk, O'Reilly (SPD), 2016, ISBN 9789352133895.
3. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press publications, 2017.
4. Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", Wiley publications, 2013.
5. Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri "Internet of Things: Architectures, Protocols and Standards", Wiley publications, 2018.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	3	1	1	2
CO2	2	-	2	2	1	3
CO3	1	2	3	1	1	3
CO4	2	-	2	2	1	1
CO5	-	-	-	-	-	-
AVG	1.5	2	2.5	1.5	1	2.25

1 - Low, 2 - Medium, 3 – High, ‘ - ’ No correlation

24PE1317 INTELLIGENT CONTROL

L T P C

3 0 0 3

COURSE OBJECTIVES

- To understand and implement intelligent control strategies.
- To design, develop, and evaluate controllers.
- To analyze and optimize intelligent control systems.

UNIT I NEURAL NETWORKS

9

Introduction – biological neurons – Artificial neurons – activation function – learning rules – feed forward networks – supervised learning – perception networks – adaline – madaline – back propagation networks – learning factors – linear separability – Hopfield network – discrete Hopfield networks.

UNIT II ARCHITECTURE

9

Types: Recurrent auto association memory, bidirectional associative memory–temporal associative memory - Boltzmann machine Hamming networks Self organizing feature maps adaptive resonance theory network Instar Outsar model counter propagation network – radial basis function networks.

UNIT III FUZZY SETS AND SYSTEMS

9

Crisp set – vagueness – uncertainty and imprecision – fuzzy set – fuzzy operation- properties crisp versus fuzzy relations fuzzy relation cardinality operations, properties – fuzzy Cartesian composition non interactive fuzzy sets tolerance equivalence relations – fuzzy ordering relations – fuzzy morphism – composition of fuzzy relations.

UNIT IV FUZZY LOGIC CONTROLLER

9

Fuzzy to crisp conversion – Lambda cuts for fuzzy sets and relations – definition methods – structure of fuzzy logic controller – database –rule Base Inference engine.

UNIT V APPLICATION AND DESIGN

9

Applications of Neural network and Fuzzy system for single phase fully controlled converter, single phase ac voltage controller, DC Drive and AC Drive, Designing of controllers using Simulation Software Fuzzy Logic Toolbox Modeling of DC Machines using Simulation Software and Simulink Toolbox.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Explain Intelligent Systems Concepts.
- CO2: Apply AI Techniques in various applications.
- CO3: Design and Development of Intelligent Controllers.
- CO4: Integration of Intelligent Systems in Practical Applications.
- CO5: Apply Neural Network Techniques in various applications.

TEXT BOOKS

1. "Intelligent Control Systems with an Introduction to System of Systems Engineering" by H. K. Khalil, second edition,1992.
2. "Introduction to Intelligent Control: Concepts, Methods, and Applications" by S. K. Gupta and K. V. A. V. Rao, Third Edition, 2002.
3. "Neural Networks for Control" by W. S. Levine (Editor), Foruth Edition,2000.

REFERENCE BOOKS

1. Lawrence Fausatt, "Fundamentals of neural networks", Prentice Hall of India, New Delhi, 1994.
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", McGraw Hill International Edition, USA, 1997.
3. Bart Kosko, "Neural Networks and Fuzzy Systems", Prentice Hall of India, New Delhi, 1994.
4. Mo Jamshidi, "Intelligent Control Systems with an Introduction to System of Systems CRC Press Publication, 2009.
5. Guoqing Zhang, "Fuzzy Control: Theory and Applications", Springer Publication, 2018.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	3	1	1	2
CO2	2	-	2	2	1	3
CO3	1	2	3	1	1	3
CO4	2	-	2	2	1	1
CO5	2	-	2	2	1	1
AVG	1.6	2	2.4	1.6	1	2

1 - Low, 2 - Medium, 3 – High, '-' No correlation

24PE1318 EMBEDDED SYSTEMS DESIGN FOR POWER ELECTRONIC APPLICATIONS L T P C
3 0 0 3

COURSE OBJECTIVES

- To impart a comprehensive understanding of control concepts and strategies for power electronics devices and electrical drives, emphasizing the integration of embedded systems in these applications.
- To explore and analyze various embedded system-based control strategies for electrical drives, focusing on their effectiveness and practicality in real-world scenarios.
- To introduce and discuss optimization and machine learning techniques, as well as high-performance computing methodologies, that enhance the performance and efficiency of electrical drives.

UNIT I INTRODUCTION TO EMBEDDED COMPUTING

9

Embedded systems Overview, Characteristics of embedded computing applications, Design Challenges, Common Design Metrics, Processor Technology, IC Technology, Trade-offs. The Process of Embedded System Development: The development process, Requirements, Specification, Architecture Design, Designing Hardware and Software components, system Integration and testing.

UNIT II HARDWARE PLATFORMS

9

Types of Hardware Platforms, Single board computers, PC Add-oncards, custom-built hardware platforms, ARM Processor, CPU performance, CPU power consumption, Bus-based computer systems, Memory devices, I/O devices, component interfacing, Designing with microprocessors, system level performance analysis.

UNIT III PROGRAM DESIGN AND ANALYSIS

9

components for Embedded programs, Models of programs, Assembly, Linking, and loading, basic compilation techniques, software performance optimization, program level energy and Power analysis, Program validation and Testing.

UNIT IV REAL-TIME OPERATING SYSTEMS

9

Architecture of the kernel, Tasks and Task Scheduler, Scheduling algorithms, Interrupt Service Routines, Semaphores, Mutex, Mailboxes, Message queues, Event Registers, Pipes, Signals, Timers, Memory management, Priority Inversion problem. Overview of off-the shelf operating systems.

UNIT V EMBEDDED SYSTEMS FOR POWER ELECTRONICS

9

Power Devices: Power Diodes, BJT, Thyristor, Power MOSFET, IGBT- Line Commutated Converters: Three phase semi controlled & fully controlled converter, Dual converters, Voltage/Current Source Inverters: Voltage source inverters single/multiple-pulse/ SPWM/ modified SPWM methods- multilevel converters.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Apply embedded systems in power electronics.
- CO2: Analyze the System Modeling and Simulation.
- CO3: Apply Embedded System Programming in power electronics.
- CO4: Analyze the performance of embedded systems in power electronic applications.
- CO5: Apply control theory concepts to design effective control algorithms for various power electronic converters and drives.

TEXT BOOKS

1. Vedam Subramanyam, "Electric Drives – Concepts and Applications", Tata McGraw- Hill publishing company Ltd., New Delhi, 2002, Second Edition.
2. K.Venkataratnam, Special Electrical Machines, Universities Press, 2014, First Edition.
3. Steve Furber, 'ARM system on chip architecture', Addison Wesley, Second Edition, 2015.

REFERENCE BOOKS

1. Ron Sass and Andrew G.Schmidt, "Embedded System design with platform FPGAs: Principles and Practices", Elsevier, 2010, First Edition.
2. Tim Wescott, Applied Control Theory for Embedded Systems, Elsevier, 2006, First Edition.

3. David E-Simon: An Embedded software Primer, Pearson Education, 2007. 3.
4. K.V.K.K. Prasad Real-Time Systems: Concepts Design and Programming, Dreamtech Press, 2005.
5. R.Krishnan, “Electric Motor Drives – Modeling, Analysis and Control”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2010, First Edition.
6. James K. Peckol, “Embedded Systems: A Contemporary Design Tool”, Wiley Publication, 2016.

Mapping of COs and POs

COs	POs					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	3	1	1	2
CO2	2	-	2	2	1	3
CO3	1	2	3	1	1	3
CO4	2	-	2	2	1	1
CO5	3	2	2	3	1	1
AVG	1.8	2	2.4	1.8	1	2

1 - Low, 2 - Medium, 3 – High, ‘-’ No correlation

24OEMF01 GREEN SUPPLY CHAIN MANAGEMENT

L T P C

3 0 0 3

COURSE OBJECTIVES

- To introduce the concept and significance of Green Supply Chain Management.
- To equip learners with the knowledge of environmental management practices.
- To develop analytical and strategic skills.

UNIT I INTRODUCTION

9

Concept and importance of Green Supply Chain Management - Evolution of GSCM: Traditional Supply Chains vs. Green Supply Chains. Environmental Impact, Key Drivers and Challenges in GSCM. Green Procurement and Eco-friendly Sourcing - Life Cycle Assessment (LCA) and its role in GSCM.

UNIT II ENVIRONMENTAL MANAGEMENT IN SUPPLY CHAIN

9

Environmental Policies and Regulations Impacting Supply Chains - Green Manufacturing. Role of Technology and Innovation in Reducing Environmental Footprints - Eco-labeling and Certifications in Supply Chains - Reverse Logistics and Recycling - Waste Management and Circular Economy Principles - Carbon Footprint Calculation and Reduction Strategies in SCM.

UNIT III GREEN LOGISTICS AND TRANSPORTATION MANAGEMENT

9

Sustainable Transportation Practices and Eco-friendly Logistics - Green Packaging: Materials, Design, and Processes - Optimizing Distribution and Transportation Networks for

Sustainability - Carbon Emissions in Logistics - Energy Efficiency in Transportation - Role of ICT in Greening Transportation Networks - Urban Logistics and Green Infrastructure.

UNIT IV SUSTAINABLE SUPPLY CHAIN DESIGN AND STRATEGY 9

Sustainable Supply Chain Network Design - Supplier Selection and Collaboration for Sustainability. Risk Management - Sustainable Product Design and Eco-innovation. Green Supply Chain Metrics and Performance Indicators - Integration of Environmental and Social Considerations into SCM Strategy - Case Studies.

UNIT V GREEN SUPPLY CHAIN ANALYTICS AND PERFORMANCE MANAGEMENT 9

Data Analytics for Green Supply Chain Management - Tools and Techniques for Evaluating Sustainability in SCM - Environmental and Economic Performance Evaluation in GSCM - Benchmarking and Best Practices in Green SCM - Use of Green Certifications and Standards for Supply Chain Performance - Reporting and Communicating Sustainability in the Supply Chain - Challenges in Monitoring and Managing Green Supply Chains

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Explain Intelligent Systems Concepts.
- CO2: Apply AI Techniques in various applications.
- CO3: Design and Development of Intelligent Controllers.
- CO4: Integration of Intelligent Systems in Practical Applications.
- CO5: Apply Neural Network Techniques in various applications.

TEXT BOOKS

1. Wang, Hsiao-Fan & Gupta, Surendra M. Green Supply Chain Management: Product Life Cycle Approach, McGraw-Hill Professional, 2011.
2. Sarkis, Joseph & Dou, Yijie, Green Supply Chain Management: A Concise Introduction, Routledge, 2017.
3. Khan, Mehmood; Hussain, Matloub; Ajmal, Mian M. Green Supply Chain Management for Sustainable Business Practice, IGI Global, 2017.

REFERENCE BOOKS

1. Johnsen, Thomas E.; Howard, Mickey; Miemczyk, Joe, Purchasing and Supply Chain Management: A Sustainability Perspective, Routledge, 2018.
2. Bouchery, Yann; Corbett, Charles J.; Fransoo, Jan C.; Tan, Sustainable Supply Chains: A Research-Based Textbook on Operations and Strategy Springer, 2017.
3. Khan, Syed Abdul Rehman (Ed.), Green Practices and Strategies in Supply Chain Management, Intech Open, 2019.
4. Esty, Daniel C.; Winston, Andrew S. Yale University Green to Gold: How Smart Companies Use Environmental Strategy to Innovate, Create Value, and Build Competitive Advantage, Press, 2006.
5. Sarkis, Joseph (Ed.), Handbook of Green Supply Chain Management, CRC Press, 2012.

COURSE OBJECTIVES

- To understand the fundamentals and classification of renewable energy sources, their environmental impact, and the current scenario in India.
- To analyze the working principles and characteristics of solar photovoltaic and wind energy systems, including system design and performance factors.
- To explore various alternative renewable energy technologies such as biomass, ocean, hydrogen, fuel cells, and geothermal systems.

UNIT I INTRODUCTION**9**

Classification of energy sources – Co₂ Emission - Features of Renewable energy – Renewable energy scenario in India -Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - CO₂ Emission - importance of renewable energy sources, Potentials – Achievements– Applications..

UNIT II SOLAR PHOTOVOLTAICS**9**

Solar Energy: Sun and Earth-Basic Characteristics of solar radiation- angle of sunrays on solar collector-Estimating Solar Radiation Empirically - Equivalent circuit of PV Cell- Photovoltaic cell characteristics: P-V and I-V curve of cell-Impact of Temperature and Insolation on I-V characteristics-Shading Impacts on I-V characteristics-Bypass diode - Blocking diode.

UNIT III PHOTOVOLTAIC SYSTEM DESIGN**9**

Block diagram of solar photo voltaic system : Line commutated converters (inversion mode) - Boost and buck-boost converters - selection of inverter, battery sizing, array sizing - PV systems classification- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

UNIT IV WIND ENERGY CONVERSION SYSTEMS**9**

Origin of Winds: Global and Local Winds- Aerodynamics of Wind turbine-Derivation of Betz's limit Power available in wind-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine- Aerodynamic Efficiency-Tip Speed-Tip Speed Ratio-Solidity-Blade Count-Power curve of wind turbine - Configurations of wind energy conversion systems: Type A, Type B, Type C and Type D Configurations- Grid connection Issues - Grid integrated SCIG and PMSG based WECS.

UNIT V OTHER RENEWABLE ENERGY SOURCES**9**

Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy, Geothermal Energy Resources.

TOTAL: 45 PERIODS

COURSE OUTCOMES

- CO1: Demonstrate the need for renewable energy sources.
- CO2: Develop a stand alone photo voltaic system and implement a maximum power Point tracking in the PV system.
- CO3: Design a stand alone and Grid connected PV system.
- CO4: Analyze the different configurations of the wind energy conversion systems.
- CO5: Realize the basic of various available renewable energy sources.

TEXT BOOKS

1. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford University Press, 2009.
2. Rai. G.D, “Non conventional energy sources”, Khanna publishes, 1993.
3. Chetan Singh Solanki, “Solar Photovoltaics: Fundamentals, Technologies and Applications”, PHI Learning Private Limited, 2012.

REFERENCE BOOKS

1. John Twideu and Tony Weir, “Renewal Energy Resources” BSP Publications, 2006
2. Gray, L. Johnson, “Wind energy system”, prentice hall of India, 1995.
3. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
4. Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013
5. Rai. G.D,” Solar energy utilization”, Khanna publishes, 1993.

24OEMF03 MEDICAL ROBOTICS

L T P C
3 0 0 3

COURSE OBJECTIVES

- Identify and describe different types of medical robots and their potential applications.
- Know basic concepts in kinematics, Dynamics, and control relevant to Medical Robotics.
- Develop the Analytical and Experimental skills necessary to Design and Implement robotic assistance for both minimally invasive surgery and Image guided interventions.

UNIT I INTRODUCTION

9

Types of medical robots - Navigation - Motion Replication - Imaging - Rehabilitation and Prosthetics – State of art of robotics in the field of healthcare-DICOM.

UNIT II LOCALIZATION AND TRACKING

9

Position sensors requirements - Tracking - Mechanical linkages - Optical – Sound based - Electromagnetic - Impedance-based - In-bore MRI tracking-Video matching - Fiber optic tracking systems - Hybrid systems.

UNIT III DESIGN OF MEDICAL ROBOTS

9

Characterization of gestures to the design of robots - Design methodologies - Technological choices - Security.

UNIT IV SURGICAL ROBOTICS **9**

Minimally invasive surgery and robotic integration - surgical robotic sub systems – synergistic control - Control Modes – Radio surgery - Orthopedic Surgery - Urologic Surgery and Robotic Imaging -Cardiac Surgery – Neurosurgery - case studies.

UNIT V ROBOTS I REHABILITATION AND MEDICAL CARE **9**

Rehabilitation for Limbs - Brain-Machine Interfaces - Steerable Needles - Assistive robots – Robots in Physiotherapy - case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Analyze and design Non-Isolated DC-DC converter.
- CO2: Analyze and design Isolated DC-DC converter.
- CO3: Derive transfer function of different converters.
- CO4: Design controllers for DC-DC converters.
- CO5: Comprehend the concepts of power conditioners, UPS & filters.

TEXT BOOKS

1. Achim Ernst Floris Schweikard, "Medical Robotics", Springer, 2016.
2. Paula Gomes, "Medical robotics Minimally invasive surgery", Woodhead, 2013.
3. Russell H. Taylor, Paolo Dario, Gabor Fichtinger, "Medical Robotics", Springer, 2022.

REFERENCE BOOKS

1. Jaydev P Desai, Rajni V Patel, Antoine Ferreira; Sunil Kumar Agrawal, "The Encyclopedia of Medical Robotics", World Scientific Publishing Co. Pvt. Ltd, 2019.
2. Jocelyne Troccaz , "Medical Robotics", John Wiley & Sons Incorporated, 2013.
3. Vanja Bonzovic , "Medical Robotics", I-tech Education publishing, Austria, 2008.
4. Farid Gharagozloo "Robotic Surgery", Springer, 2022.
5. Vanessa Diaz "Medical Robotics", Elsevier (Woodhead Publishing)

24OEMF04 TEXTILE REINFORCED COMPOSITES

L T P C
3 0 0 3

COURSE OBJECTIVES

- Describe the role and properties of reinforcements in composite materials.
- Explain the difference between thermoset and thermoplastic matrices in composites.
- List and briefly explain two mechanical tests used for evaluating composite materials.

UNIT I REINFORCEMENTS

9

Introduction – composites –classification and application; reinforcements- fibres and its properties; preparation of reinforced materials and quality evaluation; preforms for various composites.power balance in converter circuit.

UNIT II MATRICES**9**

Preparation, chemistry, properties and applications of thermoplastic and thermoset resins; mechanism of interaction of matrices and reinforcements; optimization of matrices.

UNIT III COMPOSITE MANUFACTURING**9**

Classification; methods of composites manufacturing for both thermoplastics and hermosets Hand layup, Filament Winding, Resin transfer moulding, prepregs and autoclave moulding, pultrusion, vacuum impregnation methods, compression moulding; post rocessing of composites and composite design requirements.

UNIT IV TESTING**9**

Fibre volume and weight fraction, specific gravity of composites, tensile, flexural, impact, compression, inter laminar shear stress and fatigue properties of thermoset and thermoplastic composites.

UNIT V MECHANICS**9**

Multilevel concept – diode clamped – flying capacitor – cascaded type multilevel inverters -Comparison of multi-level inverters-application of multilevel inverters–PWM techniques for MLI–Single phase & Three phase Impedance source inverters–Filters.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

On successful completion of this course, the student will be able to

- CO1: Compare the different types of textile reinforcements.
- CO2: Explain the different types of matrices.
- CO3: Explore the manufacturing of composites.
- CO4: Evaluation of the properties of thermoset and thermoplastic composite.
- CO5: Discuss the mechanics of composites failure.

TEXT BOOKS

1. Bor Z.Jang,“Advanced Polymer composites”,ASM International,USA,1994.
2. Carlsson L.A. and Pipes R.B., “Experimental Characterization of advanced composite Materials”,Second Edition,CRCPress,NewJersey,1996.
3. K. K. Chawla, "Composite Materials: Science and Engineering", Springer, 2012.

REFERENCE BOOKS

1. George Lubinand Stanley T.Peters, “Handbook of Composites”, Springer Publications,1998.
2. Mel. M. Schwartz, “Composite Materials”, Vol. 1 &2, Prentice Hall PTR, New Jersey, 1997.
3. Richard M.Christensen, “Mechanics of composite materials”, Dover Publications, 2005.
4. Sanjay K. Mazumdar, “Composites Manufacturing: Materials, Product, and Process Engineering”, CRC Press,2001.
5. Autar K. Kaw, "Mechanics of Composite Materials", CRC Press, 2005.

COURSE OBJECTIVES

- To explore the difficulties, fabrication technologies and properties of nanocomposite materials.
- To gain knowledge on Nano materials.
- To get familiarize in synthesis of Nano materials.

UNIT I CERAMIC-BASED NANOCOMPOSITES 9

Composites – nomenclature, properties; classification of ceramic nanocomposites; challenges with bulk nanoceramics/Nano ceramic composites; problems associated with synthesis of nanosize powders – chemical /physical methods of synthesis of nanoscaled ceramic powders, challenges posed by the typical properties of nanoscaled powders, Challenges faced during processing/ sintering; various processing techniques, spark plasma sintering; properties of nanoceramics – hardness, tensile; super plasticity – super plastic forming applications; super hard nanocomposites – properties, bottle neck, industrial applications.

UNIT II METAL-BASED NANOCOMPOSITES 9

Processing of metal-matrix nanocomposites – liquid metallurgy processing techniques, thermal spray techniques, cold spray, powder metallurgy (PM) techniques, difficulties, applications of metal matrix nanocomposites – Cu–Ni alloy nanocomposites, magnesium metal–matrix nanocomposites- implants, titanium nanocomposites; fractal-based glass-metal nanocomposites, its designing and fractal dimension analysis; core–shell structured nanocomposites; bio-medical imaging, environmental remediation applications, semiconductor core–shell nanomaterials, hetero junction photo catalyst.

UNIT III POLYMER-BASED NANOCOMPOSITES 9

Block copolymer nanocomposites – features, advantage over homopolymer composites; fundamentals of block copolymer; nanoparticle co-assembly; particle–polymer enthalpic interactions; particle surface chemistry – grafting suitable polymeric ligands, entropic interactions, mechanism of nanoparticle incorporation; applications of block copolymers nanocomposites – Textile fabric, bulk hetero junction (BHJ) organic photovoltaic (solar cell) devices, drug delivery; polymer and carbon nano tube–based composites, their mechanical properties, and industrial possibilities.

UNIT IV BIOMEDICAL NANOCOMPOSITES 9

Natural nanocomposite systems – spider silk, bones, shells; ceramic nanocomposites – biomedical applications; toughening mechanisms; alumina and zirconia ceramics, alumina–zirconia nanocomposites; tooth nanocomposites and dental implants; organic–inorganic nanocomposite formation through self-assembly; biomimetic synthesis of nanocomposites material.

UNIT V NANOCOMPOSITE TECHNOLOGY

9

Nanocomposite membrane structures – preparation and applications; nanotechnology in textiles and cosmetics; nano-fillers embedded polypropylene fibers – soil repellency, lotus effect; nano finishing in textiles (UV resistant, anti-bacterial, hydrophilic, self-cleaning, flame-retardant finishes); sun-screen dispersions for UV protection using titanium oxide – colour cosmetics; nanotechnology in food technology – nanopackaging for enhanced shelf life, smart/intelligent packaging.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Explain the fabrication technologies, properties and drawbacks of ceramic nanocomposites.
- CO2: Explain the fabrication technologies, properties and drawbacks of metal based nanocomposites.
- CO3: Explain the fabrication technologies, properties and drawbacks of block copolymer nanocomposites.
- CO4: Comprehend biomimicry and evaluate them in load bearing arena for bone tissue engineering
- CO5: Design nanocomposite material for engineering applications.

TEXT BOOKS

1. Twardowski T.E., “Introduction to nanocomposite materials: properties, processing, characterization”, DES Tech Publications, USA, 2007.
2. Ajayan P.M., Schadler L.S. and Braun P.V., “Nanocomposites science and technology”, 2006.
3. Tsuji, Nobuo, "Nano Structured Metals and Alloys: Processing, Microstructure, Mechanical Properties and Applications", Woodhead Publishing, 2011.

REFERENCE BOOKS

1. Sadasivuni K.K., Ponnamma D., Rajan M., Ahmed B. and Al-Maadeed M.A.S.A., “Polymer nanocomposites in biomedical engineering”, Springer Nature, Switzerland, 2019.
2. Basu B. and Balani K., “Advanced structural ceramics”, John Wiley & Sons, 2011.
3. Brown P. and Stevens K., “Nanofibers and nanotechnology in textiles”, Woodhead publication, London, 2006.
4. Rakesh K. Gupta, "Polymer and Composite Nanotechnology: Synthesis and Applications", DEStech Publications, 2012.
5. Sabu Thomas, Shaijumon Manayil Jacob, Deepalekshmi Ponnamma, "Nanocomposite Materials: Synthesis, Properties and Applications", Wiley-VCH, 2020.

COURSE OBJECTIVES

- The course aims at providing the basic concepts of product design, product features.
- Architecture so that student can have a basic knowledge in the common features a product has and how to incorporate them suitably in product.
- To gain knowledge for business opportunity.

UNIT I INTRODUCTION**9**

Need for IPPD – Strategic importance of Product development – integration of customer, designer, material supplier and process planner, Competitor and customer – Behaviour analysis. Understanding customer – prompting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specifications.

UNIT II CONCEPT GENERATION AND SELECTION**9**

Task – Structured approaches – clarification – search – externally and internally – explore systematically – reflect on the solutions and processes – concept selection – methodology – benefits.

UNIT III PRODUCT ARCHITECTURE**9**

Implications – Product change – variety – component standardization – product performance – manufacturability – product development management – establishing the architecture – creation – clustering – geometric layout development – fundamental and incidental interactions – related system level design issues – secondary systems – architecture of the chunks – creating detailed interface specifications.

UNIT IV INDUSTRIAL DESIGN**9**

Integrate process design – Managing costs – Robust design – Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically – Need for industrial design – impact – design process – investigation of for industrial design – impact – design process – investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.

UNIT V DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT**9**

Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs – Minimize system complexity – Prototype basics – principles of prototyping – planning for prototypes – Economic Analysis – Understanding and representing tasks – baseline project planning – accelerating the project – project execution.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Explain the strategic significant of product and the integration of customer, designer, supplier and process planner in IPPD.
- CO2: Apply structured methods to generate, explore, and evaluate innovative product concepts effectively
- CO3: Analyze product architecture and its impact on design manufacturability, variety, and system level interaction.
- CO4: Evaluate the role of industrial design in product development, integrating tools and customer needs to enhance usability and performance.
- CO5: Demonstrate principles of design for manufacturing, cost estimation, prototyping, and economic analysis to ensure efficient product development.

TEXT BOOK

1. Kari T.Ulrich and Steven D.Eppinger, "Product Design and Development", McGraw-Hill International Edns. 1999.
2. Kevin Otto, Kristin Wood, "Product Design: Techniques in Reverse Engineering and New Product Development", Pearson Education, 2001.
3. Anil Mital, Anoop Desai, Anand Subramanian, Aashi Mital, "Product Development: A Structured Approach to Design and Manufacture", Elsevier, 2008

REFERENCE BOOKS

1. Kemnneth Crow, "Concurrent Engg./Integrated Product Development", DRM Associates, 26/3, Via Olivera, Palos Verdes, CA 90274(310) 377-569, Workshop Book.
2. Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin, Homewood, 1992, ISBN 1-55623-603-4.
3. Staurt Pugh, "Tool Design –Integrated Methods for Successful Product Engineering", Addison Wesley Publishing, New york, NY.
4. Michael Luchs, Scott Swan, Abbie Griffin, "Design Thinking: New Product Development Essentials from the PDMA", Wiley, 2015.
5. Don Norman, "The Design of Everyday Things", Basic Books, 2013.

240EVL01 VLSI ARCHITECTURE FOR IMAGE PROCESSING

L T P C
3 0 0 3

COURSE OBJECTIVES

- The students will be able to acquire knowledge on image and video processing algorithms.
- The students will be able to acquire knowledge on design of VLSI architectures.
- To enhance the knowledge on the concepts of image processing.

UNIT I IMAGE PROCESSING ALGORITHMS AND ARCHITECTURES

9

Image Processing Tasks - Low Level Image Processing Operations - Intermediate Level Operations Image Processor Architecture: Requirements and Classification - Uni and Multi

Processors - MIMD Systems - SIMD Systems - Pipelines - Design Aspects of Real Time Low Level Image Processors - Design Method for Special Architectures.

UNIT II 3D IMAGE PROCESSING 9

Overview of 3D Image - Types and Characteristics of 3D Image Processing - Examples of 3D Image Processing, Continuous and Digitized Images, Models of Image Operations, Algorithm of Image Operations - Smoothing Filter - Difference Filter - Differential Features of a Curved Surface - Region Growing.

UNIT III 3D BINARY IMAGE PROCESSING 9

Fast convolution – Cook-Toom algorithm, modified Cook-Toom algorithm, Pipelined and parallel recursive filters – Look-Ahead pipelining in first-order IIR filters, Look-Ahead pipelining with powerof-2 decomposition, Clustered look-ahead pipelining, Parallel processing of IIR filters, combined pipelining and parallel processing of IIR filters.

UNIT IV PIPELINED, 2D AND 3D IMAGE PROCESSING ARCHITECTURES 9

Architecture of a Cellular Logic Processing Element - Second Decomposition in Data Path and Control - Real Time Pipeline for Low Level Image Processing - Design Aspects of Image Processing Architectures - Implementation of Low Level 2D and 3D and Intermediate Level Algorithms

UNIT V VLSI SYSTEMS FOR IMAGE PROCESSING 9

Concurrent Systems for Image Analysis- VLSI Wave front Arrays for Image Processing- Curve Detection in VLSI-Design of VLSI Based Multicomputer Architecture for Dynamic Scene Analysis VLSI-Based Image Resampling for Electronic Publishing.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the students will be able to

- CO1: Analyze Various Architectures to Realize Image Processing Algorithms and Explain The 3D Image Processing Algorithms.
- CO2: Explore Various Processing Techniques of Image and Design Different Architectures for Image Processing.
- CO3: Analyze various pipelined hardware architecture for 2D and 3D Image processing
- CO4: Realize binary image processing algorithm in VLSI systems
- CO5: Implement filter techniques in 2D and 3D image.

TEXT BOOKS

1. Pieter Jonker, "Morphological Image Processing: Architecture and VLSI Design", Springer, First Edition, 1992.
2. Junichiro Toriwaki · Hiroyuki Yoshida, "Fundamentals of Three-Dimensional Digital Image Processing", Springer 2009.
3. King-Sun Fu, "VLSI for Pattern Recognition and Image Processing", Springer-Verlag, 1984.

REFERENCE BOOKS

1. U. Meyer – Baese, “Digital Signal Processing with Field Programmable Gate Arrays”, Springer, 2nd Edition, 2004.
2. J.G. Proakis and D.G. Manolakis, Digital Signal Processing, Third Edition, Prentice Hall, 2007.
3. Jose E. France, Yannis Tsividis, Design of Analog Digital VLSI Circuits for Telecommunications and Signal Processing’ Prentice Hall, 1994.
4. Mohammed Ismail, Terri, Fiez, Analog VLSI Signal and Information Processing, McGraw Hill, 1994.
5. Kung. S.Y., H.J. White house T.Kailath, VLSI and Modern signal processing, Prentice Hall, 1985.

24OEVL02 DATA ACQUISITION

L T P C

3 0 0 3

COURSE OBJECTIVES

- To teach Learn to develop Hadoop applications for storing processing and analyzing data stored in Hadoop cluster.
- To Understand the complexity and volume of Big Data and their challenges.
- To comprehend the necessity for pre-processing Big Data and their issues.

UNIT I INTRODUCTION TO BIG DATA ACQUISITION

9

Big data framework – fundamental concepts of Big Data Management and analytics – Current challenges and trends in Big Data Acquisition. Anatomy of File Write and Read, Name Node, Secondary Name Node, and Data Node - Hadoop Configuration – Pig Configuration – Hive Configuration - HBase Configuration.

UNIT II DATA COLLECTION AND TRANSMISSION

9

Big data collection – Strategies – Types of Data Sources – Structured Vs Unstructured data – ELT vs ETL – storage infrastructure requirements – Collection methods – Log files – sensors – Methods for acquiring network data (Libcap-based and zero-copy packet capture technology) – Specialized network monitoring softwares (Wireshark, Smartsniff and Winnetcap) – Mobile equipments, Transmission methods, Issues.

UNIT III PIG FEATURES

9

Introduction - Pig features - Pig Architecture - Pig Execution modes, Pig Grunt shell and Shell commands. Pig Latin Basics: Data model, Data Types, Operators - Pig Latin Commands - Load & Store, Filtering, Sorting, Splitting - Built-In Functions, User define functions. Pig Execution Modes: Batch Mode – Embedded Mode – Pig Execution in Batch Mode – Use cases - Map Reduce programs with Pig – Pig Vs SQL

UNIT IV HIVE FEATURES

9

Introduction - Hive Features - Hive architecture - Hive Meta store - Hive data types - Hive Tables - Table types - Creating database, Altering database, Create table, alter table, Drop table, Built-In Functions - Built-In Operators, User defined functions(UDFs), View, Pig Vs Hive.

UNIT V HBASE FEATURES

9

HBasics, Features of HBase, Concepts, Clients, Example, Hbase Versus RDBMS, Limitations of HBase Big Data Privacy And Applications: Data Masking – Privately identified Information (PII) – Privacy preservation in Big Data – Popular Big Data Techniques and tools –Applications- Social Media Analytics – Fraud Detection.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the students will be able to

CO1: Study the various sources of Big Data

CO2: Collect and store Big Data from various sources.

CO3: Write Pig Scripts- Extract, Transform and Load the data on HDFS.

CO4: Write Hive Scripts- Extract, Transform, Load and Analyse the data present in HDFS.

CO5: Write scripts to extract data from structured and un-structured data for analytics.

TEXT BOOKS

1. Raj. Pethuru “ Handbook of Research on Cloud Infrastructures for Big Data Analytics”, IGI Global..
2. M. Pelgrom, “Analog-to-Digital Conversion”, Springer, 2010.
3. Rudy Van De Plassche, “CMOS Integrated Analog-to-Digital and Digital-to- Analog Converters” Kluwer Academic Publishers, Boston, 2003.

REFERENCE BOOKS

1. Bart Baesens, “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications’, John Wiley & Sons, 2014.
2. Tom White “ Hadoop: The Definitive Guide” Third Edit on, O’reily Media, 2012.
3. Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015.
4. Min Chen. Shiwen Mao, Yin Zhang. Victor CM Leung, Big Data: Related Technologies, Challenges and Future Prospects, Springer, 2014.
5. Michael Minelli, Michele Chambers Ambiga Dhiraj, “Big Data, Big Analytics : Emerging Business Intelligence and Analytic Trends”, John Wiley & Sons, 2013.

240EVL03 ADVANCED VLSI DESIGN

L T P C

3 0 0 3

COURSE OBJECTIVES

- To understand MOS transistor fabrication processes.
- To have an exposure to the design rules to be followed for drawing the layout of circuits.
- To have a knowledge of the testing processes of CMOS circuits.

UNIT I INTRODUCTION**9**

Brief Introduction to IC technology MOS, PMOS, NMOS, CMOS & BiCMOS Technologies.

UNIT II VLSI CIRCUIT DESIGN PROCESSES**9**

VLSI Design Flow, MOS Layers, Stick Diagrams, Design Rules and Layout, Lambda(λ)-based design rules for wires, contacts and Transistors, Layout Diagrams for NMOS and CMOS Inverters and Gates, Scaling of MOS circuits, Limitations of Scaling. (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

UNIT III GATE LEVEL DESIGN**9**

Logic gates and other complex gates, Switch logic, Alternate gate circuits. Sheet Resistance R_s and its concepts to MOS, Area Capacitances calculations, Inverter Delays, Driving large Capacitive Loads, Wiring Capacitances, Fan-in and fan-out.

UNIT IV SUBSYSTEM DESIGN**9**

Shifters, Adders, ALUs, Multipliers, Parity generators, Comparators, Counters. Full-custom, Standard Cells, Gate-arrays, FPGAs, CPLDs and Design Approach for Full-custom and Semi-custom devices, parameters influencing low power design.

UNIT CMOS TESTING**9**

CMOS Testing, Need for Testing, Test Principles, Design Strategies for Test, Chip Level and Board Level Test Techniques.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

On successful completion of this course, the students will be able to

- CO1: Use various VLSI design MOS transistor fabrication methodologies.
- CO2: Understand the basic circuit concepts.
- CO3: Develop algorithms for partitioning and placement.
- CO4: Design of building blocks using different approaches.
- CO5: Design and testing processes of CMOS circuits.

TEXT BOOKS

1. Sabih H. Gerez, “Algorithms for VLSI Design Automation”, Second Edition, Wiley-India, 2017.
2. Naveed a. Sherwani, “Algorithms for VLSI Physical Design Automation”, 3rd Edition, Springer, 2017.
3. Essentials of VLSI Circuits and Systems, Kamran Eshraghian, Eshraghian Douglas, A. Pucknell, 2005, PHI..

REFERENCE BOOKS

1. Charles J. Alpert, Dinesh P. Mehta and Sachin S Sapatnekar, “Handbook of Algorithms for Physical Design Automation, CRC Press, 1st Edition,
2. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, 2002.

3. Ramachandran, "Digital VLSI systems design", Springer, 2007.
4. M. Sarrafzadeh and C.K. Wong, An introduction to physical design, McGraw Hill, 1996.
5. J. Bhasker, Verilog VHDL synthesis: a practical primer, B S Publications, 1998.

240EVL04 EMBEDDED SYSTEM DESIGN

L T P C
3 0 0 3

COURSE OBJECTIVES

- To understand the design challenges in embedded systems.
- To understand the bus structures and protocols.
- To design a real time embedded system.

UNIT I EMBEDDED SYSTEM OVERVIEW

9

Embedded System Overview, Design Challenges – Optimizing Design Metrics, Design Methodology, RT-Level Combinational and Sequential Components, Optimizing Custom Components, Optimizing Custom Single-Purpose Processors.

UNIT II GENERAL AND SINGLE PURPOSE PROCESSOR

9

Basic Architecture, Pipelining, Superscalar and VLIW Architectures, Programmer's View, Development Environment, Application-Specific Instruction-Set Processors (ASIPs) Microcontrollers, Timers, Counters and Watchdog Timer, UART, LCD Controllers and Analog-to- Digital Converters, Memory Concepts.

UNIT III BUS STRUCTURES

9

Basic Protocol Concepts, Microprocessor Interfacing – I/O Addressing, Port and Bus - based I/O, Arbitration, Serial Protocols, I2C, CAN and USB, Parallel Protocols – PCI and ARM bus, Wireless Protocols – IRDA, Bluetooth, IEEE 802.11.

UNIT IV STATE MACHINE AND CONCURRENT PROCESS MODELS

9

Basic State Machine Model, Finite-State Machine with Data path Model, Capturing State Machine in Sequential Programming Language, Program-State Machine Model, Concurrent Process Model, Communication among Processes, Synchronization among processes, RTOS – System design using RTOS.

UNIT V SYSTEM DESIGN

9

Burglar alarm system-Design goals -Development strategy-Software development-Relevance to more complex designs- Need for emulation -Digital echo unit-Creating echo and reverb-Design requirements-Designing the codecs -The overall system design

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the students will be able to

- CO1: Use different protocols.
- CO2: Apply state machine techniques and design process models.

CO3: Apply knowledge of embedded software development tools and RTOS.

CO4: Apply networking principles in embedded devices.

CO5: Design suitable embedded systems for real world applications.

TEXT BOOKS

1. Mohammed Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, The 8051 Microcontroller and Embedded Systems Using Assembly and C, Second Edition, Pearson Education, 2008.
2. Marilyn Wolf, Computers as Components – Principles of Embedded Computing System Design, Third Edition, Morgan Kaufmann, 2012.
3. Arshdeep Bahga, Vijay Madisetti, Internet – of- Things – A Hands on Approach, Universities Press, 2015.

REFERENCES BOOKS

1. Frank Vahid and Tony Gwargie, “Embedded System Design”, John Wiley & Sons, 2009.
2. Steve Heath, “Embedded System Design”, Elsevier, Second Edition, 2004.
3. Bruce Powel Douglas, “Real Time UML, Second Edition: Developing Efficient Objects for Embedded Systems”, 3rd Edition 2004, Pearson Education.
4. Daniel W. Lewis, “Fundamentals of Embedded Software where C and Assembly Meet”, Pearson Education, 2004.
5. Bruce Powel Douglas, “Real Time UML; Second Edition: Developing Efficient Objects for Embedded Systems”, 3rd Edition 1999, Pearson Education.

2240EVL05 SYSTEM ON CHIP

L T P C
3 0 0 3

COURSE OBJECTIVES

- To introduce architecture and design concepts underlying system on chips.
- Students can gain knowledge of designing SoCs.
- To impart knowledge about the hardware-software design of a modest complexity chip all the way from specifications, modeling, synthesis and physical design.

UNIT I SYSTEM ARCHITECTURE OVERVIEW

9

Components of the system – Processor architectures – Memory and addressing – system level interconnection – SoC design requirements and specifications – design integration – design complexity – cycle time, die area and cost, ideal and practical scaling, area-time-power tradeoff in processor design, Configurability.

UNIT II PROCESSOR SELECTION FOR SOC

9

Overview – soft processors, processor core selection. Basic concepts – instruction set, branches, interrupts and exceptions. Basic elements in instruction handling – Minimizing pipeline delays – reducing the cost of branches – Robust processors – Vector processors, VLIW processors, Superscalar processors.

UNIT III MEMORY DESIGN

9

SoC external memory, SoC internal memory, Scratch pads and cache memory – cache organization and write policies – strategies for line replacement at miss time – split I- and Dcaches – multilevel caches – SoC memory systems – board-based memory systems – simple processor/memory interaction.

UNIT IV INTERCONNECT ARCHITECTURES AND SOC CUSTOMIZATION

9

Bus architectures – SoC standard buses – AMBA, Core Connect – Processor customization approaches – Reconfigurable technologies – mapping designs onto reconfigurable devices - FPGA based design – Architecture of FPGA, FPGA interconnect technology, FPGA memory, Floor plan and routing.

UNIT V FPGA BASED EMBEDDED PROCESSOR

9

Hardware software task partitioning – FPGA fabric Immersed Processors – Soft Processors and Hard Processors – Tool flow for Hardware/Software Co-design –Interfacing Processor with memory and peripherals – Types of On-chip interfaces – Wishbone interface, Avalon Switch Matrix, OPB Bus Interface, Creating a Customized Microcontroller - FPGA-based Signal Interfacing and Conditioning.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the students will be able to

- CO1: Explain all important components of a System-on-Chip and an embedded system.
- CO2: Digital hardware and embedded software.
- CO3: Outline the major design flows for digital hardware and embedded software.
- CO4: Discuss the major architectures and trade-offs concerning performance.
- CO5: Consumption of single chip and embedded systems.

TEXT BOOKS

1. Chrysostomos Nicopoulos, Vijaykrishnan Narayanan, and Chita R. Das, System-on-Chip Architectures: Holistic Design Exploration, Springer.
2. Wayne Wolf, —Modern VLSI Design – System – on – Chip Design, Prentice Hall, 3rd Edition, 2008.
3. Sudeep Pasricha and NikilDutt, On-Chip Communication Architectures System on Chip Interconnect, Elsevier, 2008.

REFERENCE BOOKS

1. F Wayne Wolf, “Modern VLSI Design – System – on – Chip Design”, Prentice Hall, 3rd Edition, 2008.
2. Wayne Wolf , “Modern VLSI Design – IP based Design”, Prentice Hall, 4th Edition, 2008
3. Konstantinos Tatas and Kostas Siozios "Designing 2D and 3D Network-On-Chip, Architectures" 2013

4. Palesi, Maurizio, Daneshtalab, Masoud “Routing Algorithms in System-On-Chip” 2014
5. Fayezgebali, Haythamelmiligi, Hqhahedwathaq E1-Kharashi “On-Chips Theory and Practice CRC Press.

24OEVL06 WIRELESS SENSOR NETWORKS

L T P C
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COURSE OBJECTIVES

- To study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high-performance computing for Smart Grid application.

UNIT I OVERVIEW OF WIRELESS SENSOR NETWORKS 9

Challenges for wireless sensor networks-characteristics requirements-required mechanisms, difference between mobile ad-hoc and sensor networks, applications of sensor networks- case study, enabling technologies for wireless sensor networks.

UNIT II ARCHITECTURES 9

Single-node architecture - hardware components, energy consumption of sensor nodes, operating systems and execution environments, network architecture - sensor network scenarios, optimization goals and figures of merit, gateway concepts. Physical layer and transceiver design considerations.

UNIT III MAC AND ROUTING 9

MAC protocols for wireless sensor networks, IEEE 802.15.4, Zigbee, low duty cycle protocols and wakeup concepts - s-MAC , the mediation device protocol, wakeup radio concepts, address and name management, assignment of MAC addresses, routing protocols-energy- efficient routing, geographic routing.

UNIT IV INFRASTRUCTURE ESTABLISHMENT 9

Topology control, clustering, time synchronization, localization and positioning, sensor tasking and control.

UNIT V DATA MANAGEMENT AND SECURITY 9

Data management in WSN, storage and indexing in sensor networks, query processing in sensor, data aggregation, directed diffusion, tiny aggregation, greedy aggregation, security in WSN, security protocols for sensor networks, secure charging and rewarding scheme, secure event and event boundary detection.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Design and implement simple wireless network concepts.
- CO2: Design, analyze and implement different network architectures.

- CO3: Implement MAC layer and routing protocols.
 CO4: Deal with timing and control issues in wireless sensor networks.
 CO5: Analyze and design secured wireless sensor networks.

TEXT BOOKS

1. C. Siva Ram Murthy and B. S. Manoj, —Ad Hoc Wireless Networks Architectures and Protocols, Prentice Hall, PTR, 2004.
2. Feng Zhao, Leonidas Guibas, —Wireless Sensor Networks: an information processing approach, Elsevier publication, 2004.
3. Charles E. Perkins, —Ad Hoc Networking, Addison Wesley, 2000.

REFERENCE BOOKS

1. Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley, 2005.
2. Erdal Çayirci , Chunming Rong, “Security in Wireless Ad Hoc and Sensor Networks”, John Wiley and Sons, 2009.
3. Kazem Sohraby, Daniel Minoli, & Taieb Znati, “Wireless Sensor Networks-S Technology, Protocols, and Applications”, John Wiley, 2007.
4. Yingshu Li, My T. Thai, Weili Wu, “Wireless Sensor Networks and Applications”, Springer, 2008.
5. I.F. Akyildiz, W. Su, Sankarasubramaniam, E. Cayirci, —Wireless sensor networks: a survey, computer networks, Elsevier, 2002, 394 - 422.

24OECS01 SPEECH SIGNAL PROCESSING

**L T P C
3 0 0 3**

COURSE OBJECTIVES

- To understand the fundamentals of the speech processing.
- Gather knowledge about the phonetics and pronunciation processing.
- To understand the concepts of speech recognition.

UNIT I INTRODUCTION

9

Introduction Knowledge in Speech and Language Processing-Ambiguity-Models and Algorithms-Language-Thought-Understanding-RegularExpressionandAutomata-Words & Transducers— N grams.

UNIT II SPEECH MODELING

9

Word Classes and Part of Speech Tagging – Hidden Markov Model– Computing Likelihood: The Forward Algorithm – Training Hidden Markov Model – Maximum Entropy Model – Transformation - Based Tagging – Evaluation and Error Analysis – Issues in Part of Speech Tagging – Noisy Channel Model for Spelling.

UNIT III SPEECH PRONUNCIATION AND SIGNAL PROCESSING 9

Phonetics - Speech Sounds and Phonetic Transcription - Articulatory Phonetics – Phonological Categories and Pronunciation Variation - Acoustic Phonetics and Signals - Phonetic Resources - Articulatory and Gestural Phonology.

UNIT IV SPEECH IDENTIFICATION 9

Speech Synthesis –Text Normalization- Phonetic Analysis –Prosodic Analysis – Diphone Wave Form Synthesis Unit Selection Waveform Synthesis–Evaluation.

UNIT V SPEECH RECOGNITION 9

Automatic Speech Recognition - Architecture - Applying Hidden Markov Model - Feature Extraction: MFCC Vectors - Computing Acoustic Likelihoods - Search and Decoding - Embedded Training – Multi-pass Decoding: N-Best Lists and Lattices- a* (_stack) Decoding - Context-Dependent Acoustic Models: Triphones - Discriminative Training - Speech Recognition by Humans..

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Create new algorithms with speech processing.
- CO2: Derive new speech models.
- CO3: Perform various language phonetic analysis.
- CO4: Create a new speech identification system.
- CO5: Generate a new speech recognition system.

TEXT BOOKS

1. Daniel Jurafsky and James H.Martin,—Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognitionl, Person education,2013.
2. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition 2/e Paperback – 1 January 2013 by Jurafsky / Martin (Author).
3. Thomas F. Quatieri, Discrete-Time Speech Signal Processing: Principles and Practice (Prentice-Hall Signal Processing Series) 2001.

REFERENCE BOOKS

1. Kai-FuLee,—Automatic Speech Recognitionl ,The Springer International Series in Engineering and Computer Science, 1999.
2. Himanshu Chaurasiya,— Soft Computing Implementation of Automatic Speech Recognitionl, LAP Lambert Academic Publishing, 2010.

3. Claudio Becchetti, Klucio Prina Ricotti ,—Speech Recognition: Theory and C++ implementation, Wiley publications 2008.
4. Discrete-Time Speech Signal Processing: Principles And Practice Paperback – 1 January 2003 By Quatieri.
5. Ikrami Eldiraway and wesam Ashour, Vishual speech Recognition, Wiley Pubication

24OECS02 DIGITAL FORENSICS

L T P C
3 0 0 3

COURSE OBJECTIVES

- Understand the basics of wireless technologies and security.
- Learn the methods of investigation using digital forensic techniques.
- Identify and explain at least three current issues in the practice of digital forensic investigations.

UNIT I INTRODUCTION

9

Overview of wireless technologies and security: Personal Area Networks, Wireless Local Area Networks, Metropolitan Area Networks, Wide Area Networks. Wireless Threats, Vulnerabilities and Security: Wireless LANs, War Driving, Warchalking, War Flying, Common Wi-fi Security Recommendations, PDA Security, Cell Phones and Security, Wireless DoS attacks, GPS Jamming, Identity Theft.

UNIT II CONFIDENTIALITY, INTEGRITY, AVAILABILITY TRIAD IN MOBILE

9

Confidentiality, Integrity, Availability (CIA) TRIAD in Mobile Phones-Voice, SMS and Identification Data Interception in GSM: Introduction, Practical Setup and Tools, Implementation- Software and Hardware Mobile Phone Tricks: Net Monitor, GSM Network Service Codes, Mobile Phone Codes, Catalog Tricks and AT Command Set- SMS Security Issues.

UNIT III MOBILE PHONE FORENSICS

9

Mobile Phone Forensics: Crime And Mobile Phones, Evidences, Forensic Procedures, Files Present in Sim Card, Device Data, External Memory Dump, Evidences in Memory Card, Operator Systems- Android Forensics: Procedures for Handling an Android Device, Imaging Android USB Mass Storage Devices, Logical and Physical Techniques.

UNIT IV DIGITAL FORENSICS

9

Digital Forensics: Introduction – Evidential Potential of Digital Devices: Closed vs. Open Systems, Evaluating Digital Evidence Potential- Device Handling: Seizure issues, Device Identification, Networked Devices and Contamination.

UNIT V DIGITAL FORENSICS EXAMINATION PRINCIPLES

9

Digital Forensics Examination Principles: Previewing, Imaging, Continuity, Hashing and Evidence Locations- Seven Element Security Model- Developmental Model of Digital Systems- Audit and Logs Evidence Interpretation: Data Content and Context.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Explore the basics of mobile and digital security.
- CO2: Explain mobile phone forensics and android forensics.
- CO3: Analyze issues in Digital forensics.
- CO4: Understand the common data privacy techniques.
- CO5: Examine and analyze Digital forensics techniques.

TEXT BOOKS

1. Gregory Kipper, “Wireless Crime and Forensic Investigation”, Auerbach Publications, 2007.
2. Iosif I. And Roulidakis, “Mobile Phone Security and Forensics: A Practical Approach”, Springer publications, Second Edition, 2016.
3. Andrew Hoog, “Android Forensics: Investigation, Analysis and Mobile Security for Google Android”, Elsevier publications, 2011.

REFERENCE BOOKS

1. Digital Forensics, Andre Arnes, John Wiley and Sons U.S.A. 2017.
2. The Basics of Digital Forensics: The Primer for Getting Started in Digital Forensics Paperback – Import, April 2012 by John Sammons (Author).
3. Cyber Forensics Paperback – 1 June 2018 by Deje (Author), Murugan (Author).
4. Hand book of Digital Forensics and Investigation Book, 2010.
5. Digital Forensics Dr. Jeetendra Pande, Dr. Ajay Prasad, Uttarakhand Open University, 2016.

24OECS03 IT AND AGRICULTURAL SYSTEM

L T P C
3 0 0 3

COURSE OBJECTIVES

- To introduce the students to areas of agricultural systems in which IT and computers play a major role.
- To also expose the students to IT applications in precision farming, environmental control systems, agricultural systems management and weather prediction models.
- To enable students with the intense knowledge of sustainable production system without damaging environment.

UNIT I PRECISION FARMING

9

Precision Agriculture and Agricultural Management–Ground Based Sensors, Remote Sensing, GPS, GIS and Mapping Software, Yield Mapping Systems, Crop Production Modeling.

UNIT II ENVIRONMENT CONTROL SYSTEMS

9

Artificial Light Systems, Management of Crop Grow thin Green houses, Simulation of CO₂ Consumption in Green houses, On-Line Measurement of Plant Grow thin the Green house, Models of Plant Production and Expert Systems in Horticulture.

UNIT III AGRICULTURAL SYSTEMS MANAGEMENT

9

Agricultural Systems - Managerial Overview, Reliability of Agricultural Systems, Simulation of Crop Growth and Field Operations, Optimizing the Use of Resources, Linear Programming, Project Scheduling, Artificial Intelligence and Decision Support Systems.

UNIT IV WEATHER PREDICTION MODELS

9

Importance of climate variability and seasonal forecasting, Understanding and Predicting World's Climate System, Global Climatic Models and Their Potential for Seasonal Climate Forecasting, General Systems Approach to Applying Seasonal Climate Forecasts.

UNIT V E-GOVERNANCE IN AGRICULTURAL SYSTEMS

9

Expert Systems, Decision Support Systems, Agricultural and Biological Databases, E-Commerce, E-Business Systems & Applications, Technology Enhanced Learning Systems and Solutions, E-Learning, Rural Development and Information Society.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Apply IT in remote sensing applications such as Drones etc.
- CO2: Explore the green house animation and its advantages.
- CO3: Apply IT principles and concept for management of field.
- CO4: Explore about weather models, their inputs and applications.
- CO5: Apply IT in e-governance in agriculture.

TEXT BOOKS

1. National Research Council, "Precision Agriculture in the 21st Century", National Academies Press, Canada, 1997.
2. H. Krug, Liebig, H.P. "International Symposium on Models for Plant Growth, Environmental Control and Farm Management in Protected Cultivation", 1989.
3. Peart, R.M., and Shoup, W. D., "Agricultural Systems Management", Marcel Dekker, New York, 2004.

REFERENCE BOOKS

1. Hammer, G.L., Nicholls, N., and Mitchell, C., "Applications of Seasonal Climate", Springer, Germany, 2000.
2. Agricultural Systems, Agroecology and Rural Innovation for Development Book - Second Edition - 2017.
3. IT in Agricultural Systems" by Dr. C. R. Balamurugan, N. Ramadevi, and Dr. S. Sathya.
4. An Introduction to Agricultural Systems Springer; 2nd ed. 1988. Softcover reprint of the original 2nd ed. 1988 edition (12 February 2012); 01149344934.
5. IT in Agricultural System by Pranjali S. Bahalkar (Author), Dr. Mithra Venkatesan (Author), Dr. Shubhangi Suryavanshi (Author).

COURSE OBJECTIVES

- Understand fundamental concepts of machine learning and its applications.
- Learn various supervised and unsupervised learning algorithms.
- Explore emerging trends and ethical considerations in machine learning.

UNIT I INTRODUCTION TO MACHINE LEARNING**9**

Definition and Types of Learning – Supervised, Unsupervised, Semi-supervised and Reinforcement Learning – Applications of Machine Learning – Steps in Developing ML Models – Hypothesis Space and Inductive Bias – Performance Evaluation Metrics: Confusion Matrix, Accuracy, Precision, Recall, F1 Score, ROC-AUC.

UNIT II SUPERVISED LEARNING ALGORITHMS**9**

Linear Regression – Gradient Descent – Logistic Regression – k-Nearest Neighbors – Decision Trees – Random Forest – Support Vector Machines – Bias-Variance Tradeoff – Over fitting and Under fitting – Cross-validation.

UNIT III UNSUPERVISED LEARNING**9**

Clustering: k-Means, Hierarchical Clustering, DBSCAN – Dimensionality Reduction: PCA, t-SNE – Association Rule Mining: Apriori, FP-Growth – Evaluation of clustering: Silhouette Score, Davies–Bouldin index.

UNIT IV NEURAL NETWORKS AND DEEP LEARNING BASICS**9**

Perceptron – Multilayer Perceptron (MLP) – Activation functions – Backpropagation – Basics of Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) – Applications in image and sequence data.

UNIT V ADVANCED TOPICS AND APPLICATIONS**9**

Ensemble Learning: Bagging, Boosting, AdaBoost, Gradient Boosting – Introduction to Reinforcement Learning – Basics of Natural Language Processing (NLP) – Model Deployment concepts – Introduction to MLOps – Ethics and fairness in ML.

TOTAL: 45 PERIODS**COURSE OUTCOMES**

On successful completion of this course, the student will be able to

- CO1: Evaluate ML models and demonstrate ethical awareness in deploying AI systems
- CO2: Explain the basic concepts, types and applications of machine learning.
- CO3: Apply appropriate supervised learning techniques to solve Classification/regression problems.
- CO4: Implement and interpret unsupervised algorithms for clustering and pattern discovery.
- CO5: Design simple neural network models and understand their applications.

TEXT BOOKS

1. Tom M. Mitchell, Machine Learning, McGraw-Hill Education.
2. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and Tensor Flow, O'Reilly, 2nd Edition.
3. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer.

REFERENCE BOOKS

1. Ian Good fellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press.
2. Ethem Alpaydin, Introduction to Machine Learning, MIT Press.
3. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press.
4. Shai Shalev-Shwartz and Shai Ben-David, Understanding Machine Learning: From Theory to Algorithms, Publisher: Cambridge University Press.
5. Andriy Burkov, The Hundred-Page Machine Learning Book, Publisher: Andriy Burkov Publications / Amazon Kindle Direct Publishing.

24OECS05 IoT FOR SMART SYSTEMS

L T P C
3 0 0 3

COURSE OBJECTIVES

- To study about Internet of Things technologies and its role in real time applications.
- To familiarize the accessories and communication techniques for IoT.
- To provide insight about the embedded processor and sensors required for IoT.

UNIT I INTRODUCTION TO INTERNET OF THINGS

9

Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.

UNIT II IOT ARCHITECTURE

9

IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture, IoT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy Beacons.

UNIT III PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT PROTOCOLS

9

NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell. Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth / Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary Systems-Recent trends.

UNIT IV IOT PROCESSORS

9

Services/Attributes: Big-Data Analytics for IOT, Dependability, Interoperability, Security, Maintainability. Embedded processors for IOT: Introduction to Python programming - Building IOT with RASPERY PI and Arduino.

UNIT V CASE STUDIES

9

IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Analyze the concepts of IoT and its present developments.
- CO2: Compare and contrast different platforms and infrastructures available for IoT.
- CO3: Explain different protocols and communication technologies used in IoT.
- CO4: Analyze the big data analytic and programming of IoT.
- CO5: Implement IoT solutions for smart applications.

TEXT BOOKS

1. Oliver Hersent, David Boswarthick and Omar Elloumi "The Internet of Things", Wiley, 2016.
2. Samuel Greengard, "The Internet of Things", The MIT Press, 2015.
3. Adrian McEwen and Hakim Cassimally "Designing the Internet of Things", Wiley, 2014.

REFERENCE BOOKS

1. Arshdeep Bahga and Vijai Madisetti: A Hands-on Approach "Internet of Things", Universities Press 2015.
2. Adrian McEwen and Hakim Cassimally "Designing the Internet of Things", Wiley, 2014.
3. Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", John Wiley and sons, 2014.
4. Ling yang Song/Dusit Niyato/Zhu Han/Ekram Hossain, "Wireless Device-to-Device Communications and Networks", CAMBRIDGE UNIVERSITY PRESS, 2015.
5. Jean-Philippe Vasseur, Adam Dunkels, "Interconnecting Smart Objects with IP: The Next Internet" Morgan Kaufmann Publishers, 2010.

24OECS06 SOFTWARE TESTING AND AUTOMATION

L T P C

3 0 0 3

COURSE OBJECTIVES

- To understand the basics of software testing.
- To focus on wide aspects of testing and understanding multiple facets of testing.
- To get an insight about test automation and the tools used for test automation.

UNIT I FOUNDATIONS OF SOFTWARE TESTING

9

Why do we test Software?, Black-Box Testing and White-Box Testing, Software Testing Life Cycle, V-model of Software Testing, Program Correctness and Verification, Reliability versus

Safety, Failures, Errors and Faults (Defects), Software Testing Principles, Program Inspections, Stages of Testing: Unit Testing, Integration Testing, System Testing.

UNIT II TEST PLANNING

9

The Goal of Test Planning, High Level Expectations, Intergroup Responsibilities, Test Phases, Test Strategy, Resource Requirements, Tester Assignments, Test Schedule, Test Cases, Bug Reporting, Metrics and Statistics.

UNIT III TEST DESIGN AND EXECUTION

9

Test Objective Identification, Test Design Factors, Requirement identification, Testable Requirements, Modeling a Test Design Process, Modeling Test Results, Boundary Value Testing, Equivalence Class Testing, Path Testing, Data Flow Testing, Test Design Preparedness Metrics, Test Case Design Effectiveness, Model-Driven Test Design, Test Procedures, Test Case Organization and Tracking, Bug Reporting, Bug Life Cycle.

UNIT IV ADVANCED TESTING CONCEPTS

9

Performance Testing: Load Testing, Stress Testing, Volume Testing, Fail-Over Testing, Recovery Testing, Configuration Testing, Compatibility Testing, Usability Testing, Testing the Documentation, Security testing, Testing in the Agile Environment, Testing Web and Mobile Applications.

UNIT V TEST AUTOMATION AND TOOLS

9

Automated Software Testing, Automate Testing of Web Applications, Selenium: Introducing Web Driver and Web Elements, Locating Web Elements, Actions on Web Elements, Different Web Drivers, Understanding Web Driver Events, Testing: Understanding Testing.xml, Adding Classes, Packages, Methods to Test, Test Reports.

Since 1984

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Explain the basic concepts of software testing and the need for software testing.
- CO2: Design Test planning and different activities involved in test planning.
- CO3: Design effective test cases that can uncover critical defects in the application.
- CO4: Carry out advanced types of testing.
- CO5: Automate the software testing using Selenium and Testing.

TEXT BOOKS

1. Yogesh Singh, "Software Testing", Cambridge University Press, 2012.
2. Unmesh Gundecha, Satya Avasarala, "Selenium Web Driver 3 Practical Guide" - Second Edition 2018.
3. Glenford J. Myers, Corey Sandler, Tom Badgett, The Art of Software Testing, 3rd Edition, 2012, John Wiley & Sons, Inc.

REFERENCE BOOKS

1. Ron Patton, Software testing, 2nd Edition, 2006, Sams Publishing.
2. Paul C. Jorgensen, Software Testing: A Craftsman's Approach, Fourth Edition, 2014, Taylor & Francis Group.
3. Carl Cocchiaro, Selenium Framework Design in Data-Driven Testing, 2018, Packt Publishing.
4. Elfriede Dustin, Thom Garrett, Bernie Gaurf, Implementing Automated Software Testing, 2009, Pearson Education, Inc.
5. Satya Avasarala, Selenium Web Driver Practical Guide, 2014, Packt Publishing.

24OEST01 INTEGRATED WATER RESOURCES MANAGEMENT

L T P C

3 0 0 3

COURSE OBJECTIVES

- To understand the principles, key elements, and global challenges of Integrated Water Resources Management.
- To examine the economic, legal, health, and agricultural dimensions of water management within the IWRM framework.
- To learn global practices, case studies, and policy instruments for effective implementation of IWRM.

UNIT I CONTEXT FOR IWRM

9

Water as a global issue: key challenges – Definition of IWRM within the broader context of development – Key elements of IWRM - Principles – Paradigm shift in water management - Complexity of the IWRM process – UN World Water Assessment - SDGs.

UNIT II WATER ECONOMICS

9

Economic view of water issues: economic characteristics of water good and services – Nonmarket monetary valuation methods – Water economic instruments – Private sector involvement in water resources management: PPP objectives, PPP models, PPP processes, PPP experiences through case studies.

UNIT III LEGAL AND REGULATORY SETTINGS

9

Basic notion of law and governance: principles of international and national law in the area of water management - Understanding UN law on non-navigable uses of international water courses – International law for groundwater management – World Water Forums – Global Water Partnerships - Development of IWRM in line with legal and regulatory framework.

UNIT IV WATER AND HEALTH WITHIN THE IWRM CONTEXT

9

Literature Review, Research Design, Methods of Data Collection - Tools and Procedures - Data Analysis - Interpretation - Findings –Limitations -Recommendations – Conclusion – Bibliography.

UNIT V AGRICULTURE IN THE CONCEPT OF IWRM

9

Proof reading a report – Avoiding Typographical Errors – Bibliography in required Format – Font – Spacing – Checking Tables and Illustrations – Presenting a Report Orally – Techniques.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Identify and explain the global challenges related to water resources and the need for Integrated Water Resources Management (IWRM).
- CO2: Apply economic principles and valuation methods to assess water as an economic good and evaluate water pricing and PPP models.
- CO3: Interpret and analyze legal and regulatory frameworks, including international water laws, for sustainable water governance.
- CO4: Evaluate the interconnections between water and health, and apply health impact assessment tools in water-related projects.
- CO5: Assess the role of water in agriculture, including concepts like virtual water, water footprint, and irrigation efficiency within the IWRM context.

TEXT BOOKS

1. Gupta, R.S., Hydrology and Hydraulic Systems, 4th Edition, Standard Publishers, 2021.
2. Biswas, A.K., Integrated Water Resources Management: A Reassessment, Routledge, 2004.
3. Subramanya, K., Engineering Hydrology, 5th Edition, McGraw Hill, 2020.

REFERENCE BOOKS

1. Batchelor, C., Water Governance and IWRM, Stockholm Environment Institute, 2007.
2. David Keith Todd and Larry W. Mays, "Groundwater Hydrology", 3rd Third Edition, John Wiley & Sons, 2004.
3. Molden, D. (Ed.), Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture, Earthscan, 2007.
4. UN-Water, The United Nations World Water Development Report 2023: Partnerships and Cooperation for Water, UNESCO, 2023.
5. Chatterjee, R. and Ray, P., Groundwater Governance and Management in India, CRC Press, 2020.

24OEST02 WATER, SANITATION AND HEALTH

L T P C

3 0 0 3

COURSE OBJECTIVES

- To understand the fundamentals of WASH, including the links between water, sanitation, health, hygiene, equity, and sustainability.
- To examine the challenges, impacts, and management issues related to WASH, with focus on social, economic, environmental, and political factors.

- To explore governance strategies, development initiatives, and case studies, highlighting policies, community participation, and sustainable solutions at local and global levels.

UNIT I FUNDAMENTALS WASH

9

Meanings and Definition: Safe Water- Health, Nexus: Water- Sanitation - Health and Hygiene – Equity issues - Water security - Food Security. Sanitation And Hygiene (WASH) and Integrated Water Resources Management (IWRM) - Need and Importance of WASH.

UNIT II MANAGERIAL IMPLICATIONS AND IMPACT

9

Third World Scenario – Poor and Multidimensional Deprivation--Health Burden in Developing Scenario -Factors contribute to water, sanitation and hygiene related diseases- Social: Social Stratification and Literacy Demography: Population and Migration- Fertility - Mortality- Environment: Water Borne-Water Washed and Water Based Diseases - Economic: Wage - Water and Health Budgeting -Psychological: Non-compliance - Disease Relapse - Political: Political Will.

UNIT III CHALLENGES IN MANAGEMENT AND DEVELOPMENT

9

Common Challenges in WASH - Bureaucracy and Users- Water Utilities -Sectoral Allocation: - Infrastructure- Service Delivery: Health services: Macro and Micro- level: Community and Gender Issues- Equity Issues - Paradigm Shift: Democratization of Reforms and Initiatives.

UNIT IV GOVERNANCE

9

Public health -Community Health Assessment and Improvement Planning (CHA/CHIP) Infrastructure and Investments on Water, (WASH) - Cost Benefit Analysis – Institutional Intervention-Public Private Partnership - Policy Directives - Social Insurance -Political Will vs Participatory Governance.

UNIT V INITIATIVES

9

Management vs Development -Accelerating Development- Development Indicators Inclusive Development-Global and Local- Millennium Development Goal (MDG) and Targets – Five Year Plans - Implementation - Capacity Building - Case studies on WASH.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Describe the basic concepts of water, sanitation, health, hygiene, and their importance in sustainable development.
- CO2: Identify the social, economic, environmental, and political factors affecting WASH in developing contexts.
- CO3: Recognize common challenges in WASH management and suggest possible solutions considering community and equity aspects.

CO4: Analyze governance frameworks, policies, and institutional approaches related to WASH implementation.

CO5: Analyze global and national WASH initiatives, development plans, and case studies to propose sustainable strategies.

TEXT BOOKS

1. Bonitha R., Beaglehole R., Kjellstrom T. (2006), Basic Epidemiology, 2nd Edition, World Health Organization.
2. National Research Council (2009), Global Issues in Water, Sanitation, and Health: Workshop Summary, The National Academies Press, Washington, DC.
3. Howard, G. and Bartram, J. (2003), Domestic Water Quantity, Service Level and Health, World Health Organization.

REFERENCE BOOKS

1. Van Note Chism, N. and Bickford, D. J. (2002), Improving the Environment for Learning: An Expanded Agenda, New Directions for Teaching and Learning, 2002:
2. Sen, Amartya. (1997), On Economic Inequality, Enlarged Edition, with annex by James Foster and Amartya Sen, Oxford: Clarendon Press.
3. World Bank (2000), Intersectoral Water Allocation Planning and Management, World Bank Publishers.
4. UNICEF/WHO Joint Monitoring Programme (JMP) – Progress Reports on Drinking Water, Sanitation and Hygiene, Multiple Editions.
5. Third World Network, Policy Briefs and Research Articles.

24OEST03 PRINCIPLES OF SUSTAINABLE DEVELOPMENT

L T P C
3 0 0 3

COURSE OBJECTIVES

- To understand the meaning of sustainability and major development challenges.
- To learn about international frameworks, goals, and actions for sustainable development.
- To explore sustainable living methods, resource protection, and progress measurement tools.

UNIT I SUSTAINABILITY AND DEVELOPMENT CHALLENGES

9

Definition of sustainability – environmental, economical and social dimensions of sustainability - sustainable development models – strong and weak sustainability – defining development- millennium development goals – mindsets for sustainability: earthly, analytical, precautionary, action and collaborative– syndromes of global change: utilisation syndromes, development syndromes, and sink syndromes – core problems and cross cutting Issues of the 21 century - global, regional and local environmental issues – social insecurity - resource degradation - climate change – desertification.

UNIT II PRINCIPLES AND FRAME WORK 9

History and emergence of the concept of sustainable development - our common future - Stockholm to Rio plus 20– Rio Principles of sustainable development – Agenda 21 natural step- peoples earth charter – business charter for sustainable development –UN Global Compact - Role of civil society, business and government – United Nations’ 2030 Agenda for sustainable development – 17 sustainable development goals and targets, indicators and intervention areas.

UNIT III SUSTAINABLE DEVELOPMENT AND WELLBEING 9

The Unjust World and inequities - Quality of Life - Poverty, Population and Pollution - Combating Poverty - - Demographic dynamics of sustainability - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution, Preservation and Public participation.

UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS 9

Sustainable Development Goals and Linkage to Sustainable Consumption and Production – Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation - Biodiversity conservation and Ecosystem integrity Ecotourism - Sustainable Cities – Sustainable Habitats- Green Buildings - Sustainable Transportation — Sustainable Mining - Sustainable Energy– Climate Change – Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms.

UNIT V ASSESSING PROGRESS AND WAY FORWARD 9

Nature of sustainable development strategies and current practice- Sustainability in global, regional and national context –Approaches to measuring and analysing sustainability– limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development - Hurdles to Sustainability - Science and Technology for sustainable development –Performance indicators of sustainability and Assessment mechanism – Inclusive Green Growth and Green Economy – National Sustainable Development Strategy Planning and National Status of Sustainable Development Goals.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Explain the concept of sustainability and recognize major global issues such as pollution, climate change, and resource degradation.
- CO2: Explain global goals and agreements like the UN Sustainable Development Goals and related principles.
- CO3: Describe the importance of health, education, and poverty reduction in sustainable development.

CO4: Discuss sustainable practices in agriculture, energy, water, cities, and environmental protection.

CO5: Identify tools and indicators used to measure sustainability and suggest steps for future improvement.

TEXT BOOKS

1. Karel Mulder, Sustainable Development for Engineers - A Handbook and Resource Guide, Roulledge Taylor and Francis, 2017.
2. Tom Theis and Jonathan Tomkin, Sustainability: A Comprehensive Foundation, Rice University, Houston, Texas, 2012.
3. Barry Dalal Clayton and Stephen Bass, Sustainable Development Strategies- a resource book”, Earthscan Publications Ltd, London, 2002.

REFERENCE BOOKS

1. The New Global Frontier - Urbanization, Poverty and Environment in the 21st Century George Martine, Gordon McGranahan, Mark Montgomery and Rogelio Fernández-Castilla, IIED and UNFPA, Earthscan, UK, 2008.
2. Nolberto Munier, Introduction to Sustainability: Road to a Better Future, Springer, 2006.
3. A guide to SDG interactions: from science to implementation, International Council for Science, Paris,2017.
4. Jeffrey D. Sachs, The Age of Sustainable Development, Columbia University Press, 2015.
5. K. Mather, Environmental Management, New Age International Publishers, India, Reprint 2012.

24OEST04 ENVIRONMENTAL IMPACT ASSESSMENT

L T P C

3 0 0 3

COURSE OBJECTIVES

- To make the students to understand environmental clearance.
- To provide knowledge on overall methodology of EIA, prediction tools and models.
- To Understand environmental management plan and case studies.

UNIT I INTRODUCTION

9

Historical development of Environmental Impact Assessment (EIA). Environmental Clearance- EIA in project cycle. legal and regulatory aspects in India – types and limitations of EIA –EIA process- screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral issues –public hearing in EIA- EIA consultant accreditation.

UNIT II IMPACT IDENTIFICATION AND PREDICTION

9

Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert systems in EIA. prediction tools for EIA – mathematical modeling for impact prediction – assessment of impacts – air – water – soil – noise – biological — cumulative impact assessment.

UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT 9

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation.

UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN 9

Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment.

UNIT V CASE STUDIES 9

Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Explain need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles.
- CO2: Explore various impact identification methodologies, prediction techniques and model of impacts on various environments.
- CO3: Relate social impacts between social impacts and change in community due to development activities and rehabilitation methods.
- CO4: Document the EIA findings and prepare environmental management and monitoring plan.
- CO5: Identify, predict and assess impacts of similar projects based on case studies.

TEXT BOOKS

1. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996.
2. Van Note Chism, N. and Bickford, D. J., Improving the environment for learning, 2002.
3. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey. 2003.

REFERENCE BOOKS

1. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India.
2. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India.
3. Lee N. and George C. 2000. Environmental Assessment in Developing and Transitional Countries. Chichester: Willey.

4. World Bank –Source book on EIA ,1999.
5. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

24OEST05 ENVIRONMENTAL SUSTAINABILITY

L T P C
3 0 0 3

COURSE OBJECTIVES

- To understand the concept of environmental sustainability.
- To understand the significance of biodiversity.
- To understand environmental economics.

UNIT I INTRODUCTION

9

Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems.

UNIT II CONCEPT OF SUSTAINABILITY

9

Sustainable Development: Defining the Concept, the Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture.

UNIT III SIGNIFICANCE OF BIODIVERSITY

9

Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary - Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation.

UNIT IV POLLUTION IMPACTS

9

Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.

UNIT V ENVIRONMENTAL ECONOMICS

9

Development, Poverty, and the Environment, Visions of the Future, Environmental economics and policy by Tom Tietenberg, Environmental Economics

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- CO1: Explain the concept of environmental problems.
- CO2: Enumerate the sustainability concept.
- CO3: Explain the Significance of biodiversity.
- CO4: Explain the impacts of population.
- CO5: Assess impacts of Environmental economics.

TEXT BOOKS

1. Robert Brinkmann., Introduction to Sustainability, Wiley-Blackwell., 2016.

2. Niko Roorda., Fundamentals of Sustainable Development, 3rd Edn, Routledge, 2020.
3. Bhavik R Bakshi., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019.

REFERENCE BOOKS

1. Andrew Hoffman, Competitive Environmental Strategy - A Guide for the Changing Business Landscape, Island Press.
2. Stephen Doven, Environment and Sustainability Policy: Creation, Implementation, Evaluation, the Federation Press.
3. George C. Environmental Assessment in Developing and Transitional Countries. Chichester: Willey, 2000.
4. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India, 2005.
5. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India.

24OEST06 GREEN BUILDING DESIGN

L T P C
3 0 0 3

COURSE OBJECTIVES

- To learn the fundamentals of sustainable and energy-efficient building design.
- To familiarize students with building envelopes, operational energy reduction and net zero building concepts.
- To expose the students to passive house standards and building rating systems.

UNIT I INTRODUCTION 9

Embodied energy, Operational energy in Building and Life cycle energy. Ecological footprint, Bio-capacity and calculation of planet equivalent.

UNIT II ROLE OF MATERIAL 9

Carbon from Cement, alternative cements and cementitious material - Sustainability issues for concrete – Green steel.

UNIT III OPERATIONAL ENERGY IN BUILDING 9

Role of materials and thermal conductivity - Building envelopes - Building systems and operations (HVAC, lighting, water supply, sewage, garbage disposal, recycling and composting) Clean & renewable energy in buildings - Rainwater harvesting - Effects of trees and microclimatic modification through greening.

UNIT IV RECYCLE AND REUSE METHODS OF BUILDING DESIGN 9

Recycling of industrial and other waste for concrete production – reuse of steel members for new buildings – case studies.

UNIT V SMART BUILDINGS

9

Smart buildings -Sensing and control systems.Net Zero buildings, Passive house standards and Building Rating systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On successful completion of this course, the student will be able to

CO1: Discuss the embodied energy and operational energy in buildings.

CO2: Explain the role of building materials in sustainable design.

CO3: Enumerate the operational energy in building design.

CO4: Evaluate recycling and reuse strategies in sustainable building design.

CO5: Identify the building rating systems.

TEXT BOOKS

1. J Newman, B S Choo, Advanced Concrete Technology-Processes, 1st Edition, Elsevier, 2003.
2. S Kubba, LEED Practices, Certification, and Accreditation Hand book, 1st ed. Elsevier, 2010.
3. Energy Conservation Building Code, Revised Version, Ministry of Power, Bureau of Energy Efficiency, 2018.

REFERENCE BOOKS

1. Building Envelope Stringency Analysis, Architectural Energy Corporation, International Institute for Energy Conservation, 2004.
2. Practical Handbook on Energy Conservation in Buildings, Indian Building Congress, 1st edition, Nabhi Publication, 2008.
3. F C McQuiston, J D Parker, Heating, Ventilating, and Air Conditioning, Analysis and Design, Fourth Ed. John Wiley & Sons, 1994.
4. A H Buchanan, G Brian, Energy and carbon dioxide implications of building construction, Energy and Buildings, 1994.
5. C J Kibert, Sustainable Construction: Green Building Design and Delivery, 3rd edition, Wiley, 2022.

