SRI MANAKULA VINAYAGAR ENGINEERING COLLEGE

(An Autonomous Institution)

(As per UGC - 2018 Regulations and Affiliated to Pondicherry University)

(Accredited by NAAC with 'A' grade)

PUDUCHERRY – 605107

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

M.TECH.

POWER ELECTRONICS AND DRIVES

(REGULATIONS - 2020)

CURRICULUM AND SYLLABI

COLLEGE VISION AND MISSION

Vision

To be globally recognized for excellence in quality education, innovation and research for the transformation of lives to serve the society.

Mission

M1: Quality Education:

To provide comprehensive academic system that amalgamates the cutting edge technologies with best practices.

M2: Research and Innovation:

To foster value based research and innovation in collaboration with industries and institutions globally for creating intellectuals with new avenues.

M3: Employability and Entrepreneurship:

To inculcate the employability and entrepreneurial skills through value and skill based training.

M4: Ethical Values:

To instill deep sense of human values by blending societal righteousness with academic professionalism for the growth of society.

DEPARTMENT VISION AND MISSION

Vision

To promote proficiency in the field of Electrical and Electronics Engineering by creating a stimulating environment for research, innovation and entrepreneurship

Mission

M1: Quality Education:

To impart high quality technical education with problem solving capabilities by innovative pedagogy in emerging technologies.

M2: Industrial and Societal Needs:

To cater the dynamic needs of the industry and society by strengthening industry-institute interaction.

M3: Research and Innovation:

To nurture the spirit of research attitude by carrying out innovative technologies pragmatically.

M4: Placement and Entrepreneurship:

To inculcate the professionalism in career by advancing synergetic skills to compete in the corporate world.

PROGRAMME OUTCOMES (POs)

PO1: Exploration of Research:

An ability to independently carry out research/investigation and development work to solve practical problems.

PO2: Technical Skill:

An ability to write and present a substantial technical report/document.

PO3: Expertise in Academics:

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.

PO4: Problem solving:

An ability to discriminate, analyze, evaluate and synthesize the technologies to provide solution for multidimensional engineering problems.

PO5: Usage of Modern Tools:

Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities with an understanding of the limitations.

PO6: Ethical Practices and Social Responsibility:

Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Proficiency

To evolve post graduates with a strong foundation in design, analytics and problem solving skills in the field of Power Electronics and Drives.

PEO2: Leadership skills

To attain intellectual leadership skills to cater the changing needs of power industry, academia and society.

PEO 3: Innovation

To design and develop innovative products and services in the field of Power Electronics and Drives.

PEO 4: Lifelong Learning

To enhance the skills by adapting the current trends through continuous learning.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO 1: Analytical Skills

Ability to apply the technical knowledge and solve complex problems in the field of power electronics, controllers and machines using modern tools and technologies.

PSO 2: Societal Needs

Capability to solve real-world Engineering problems in promising fields like Smart Grid, Renewable Energy interfaces and Electric Vehicles.

PSO 3: Competence in Research

Ability to incorporate creative research to address the recent problems in the electrical power industry.

SEMESTER – I										
Sl. No.	Course Code	Course Title	Category	Periods			Credits	Max. Marks		
				L	T	P		CAM	ESM	Total
Theory										
1.	P20BST102	Advanced Mathematics for Electrical Engineers	BS	2	2	0	3	40	60	100
2.	P20PET101	Analysis of Power converters	PC	3	0	0	3	40	60	100
3.	P20PET102	Analysis of Electrical Machines	PC	3	0	0	3	40	60	100
4.	P20PET103	Nano Electronics	PC	3	0	0	3	40	60	100
5.	P20CCT101	Research Methodology and IPR	CC	2	0	0	2	40	60	100
6.	P20PEE1XX	Professional Elective – I*	PE	3	0	0	3	40	60	100
Practical										
7.	P20PEP101	Power Converters simulation Laboratory	PC	0	0	4	2	50	50	100
8.	P20CCP101	Technical Report Writing and Seminar	CC	0	0	4	2	100	-	100
Audit Course										
9.	P20ACT10X	Audit Course – I**	AC	0	0	2	-	100	-	100
Employability Enhancement Course										
10.	P20PEC1XX	Employability Enhancement Course-I#	EEC	0	0	4	-	100	-	100
Total							**21**	590	410	1000

SEMESTER – II										
Sl. No.	Course Code	Course Title	Category	Periods			Credits	Max. Marks		
				L	T	P		CAM	ESM	Total
Theory										
1.	P20PET204	Industrial control Drives	PC	3	0	0	3	40	60	100
2.	P20PET205	Design Techniques for Switch Mode Power Conversion	PC	3	0	0	3	40	60	100
3.	P20PET206	Electric and Hybrid Vehicle	PC	3	0	0	3	40	60	100
4.	P20PET207	Microcontroller and DSP based System Design	PC	3	0	0	3	40	60	100
5.	P20PEE2XX	Professional Elective – II*	PE	3	0	0	3	40	60	100
6.	P20PEE2XX	Professional Elective – III*	PE	3	0	0	3	40	60	100
Practical										
7.	P20PEP202	Power Converters and Drives Laboratory	PC	0	0	4	2	50	50	100
8.	P20CCP202	Seminar on ICT: A hands-on approach	CC	0	0	4	2	100	-	100
Audit Course										
9.	P20ACT20X	Audit Course – II**	AC	0	0	2	-	100	-	100
Employability Enhancement Course										
10.	P20PEC2XX	Employability Enhancement Course-II#	EEC	0	0	4	-	100	-	100
Total							**22**	590	410	1000

**** Professional Elective Courses are to be selected from the list given in Annexure I***
 # Employability Enhancement Courses are to be selected from the list given in Annexure II
***** Audit Courses are to be selected from the list given in Annexure III***

SEMESTER – III											
Sl. No.	Course Code	Course Title	Category	Periods			Credits	Max. Marks		
				L	T	P		CAM	ESM	Total
Theory											
1.	P20PEE3XX	Professional Elective -IV*	PE	3	0	0	3	40	60	100
2.	P20PEE3XX	Professional Elective- V*	PE	3	0	0	3	40	60	100
3.	P20PEE3XX	Professional Elective- VI*	PE	3	0	0	3	40	60	100
Practical											
4.	P20PEW301	Project Phase – I	PW	0	0	12	6	50	50	100
5.	P20PEW302	Internship	PW	0	0	0	2	100	-	100
Employability Enhancement Course											
6.	P20PES301	NPTEL/GIAN/MOOC	EEC	0	0	0	-	100	-	100
Total							**17**	370	230	600

SEMESTER – IV										
Sl. No.	Course Code	Course Title	Category	Periods			Credits	Max. Marks		
				L	T	P		CAM	ESM	Total
Practical										
1.	P20PEW403	Project Phase – II	PW	0	0	24	12	50	50	100
Total							**12**	50	50	100

**** Professional Elective Courses are to be selected from the list given in Annexure I***

BS – Basic Science
PC – Professional Core
PE – Professional Elective
PW – Project Work
CC – Common Course
AC – Audit Course
EEC – Employability Enhancement Course

Credit Distribution

Semester	I	II	III	IV	Total
Credits	21	22	17	12	72

Total number of credits required to complete M.Tech in Power Electronics and Drives : 72 Credits

Annexure – I

PROFESSIONAL ELECTIVE COURSES

Sl. No.	Course Code	Course Title
Professional Elective – I (Offered in Semester I)		
1.	P20PEE101	Optimization techniques
2.	P20PEE102	PWM Techniques for Converters
3.	P20PEE103	Special Electrical Machines
4.	P20PEE104	Electromagnetic Field Computation and Modelling
5.	P20PEE105	Advanced power semiconductor devices
Professional Elective – II (Offered in Semester II)		
1.	P20PEE206	Electrical safety
2.	P20PEE207	Intelligent Controllers
3.	P20PEE208	Smart Grid Technologies
4.	P20PEE209	Electric traction
5.	P20PEE210	High Voltage Direct Current Transmission
Professional Elective – III (Offered in Semester II)		
1.	P20PEE211	Advanced Control Systems
2.	P20PEE212	Solar Photovoltaic system design
3.	P20PEE213	Flexible AC Transmission Systems
4.	P20PEE214	Energy Management and Auditing
5.	P20PEE215	Distributed Generation and Microgrid
Professional Elective – IV (Offered in Semester III)		
1.	P20PEE316	Machine Learning
2.	P20PEE317	Wind Energy Conversion Systems
3.	P20PEE318	MEMS Technology
4.	P20PEE319	Energy Storage Systems
5.	P20PEE320	Principles of VLSI design
Professional Elective – V (Offered in Semester III)		
1.	P20PEE321	Power Electronics Applications to Lighting System
2.	P20PEE322	Automotive Electrical and Electronic Systems
3.	P20PEE323	Virtual Instrumentation
4.	P20PEE324	Analysis and Design of Inverters
5.	P20PEE325	PLC and SCADA system
Professional Elective – VI (Offered in Semester III)		
1.	P20PEE326	Advanced Digital Signal Processing
2.	P20PEE327	Robotics and control
3.	P20PEE328	Power Quality
4.	P20PEE329	Advanced Digital system design
5.	P20PEE330	Control System Design

Annexure – II

EMPLOYABILITY ENHANCEMENT COURSES

Sl.No.	Course Code	Course Title
1	P20PECX01	Android Programming
2	P20PECX02	Ansys -Multiphysics
3	P20PECX03	Artificial Intelligence
4	P20PECX04	Artificial Intelligence And Edge Computing
5	P20PECX05	AutoCad for Electrical
6	P20PECX06	Design & Documentation Using Eplan Electric P8
7	P20PECX07	Digital Marketing
8	P20PECX08	Embedded System Using Arduino
9	P20PECX09	Embedded System Using C
10	P20PECX10	Industry 4.0
11	P20PECX11	Industrial Automation
12	P20PECX12	Java Programming
13	P20PECX13	Machine Learning
14	P20PECX14	PLC
15	P20PECX15	Python Programming
16	P20PECX16	Revit MEP
17	P20PECX17	Robotics
18	P20PECX18	VLSI Design
19	P20PECX19	Web Programming - I (HTML, CSS, JAVA Script)
20	P20PECX20	Web Programming - II

Annexure – III

AUDIT COURSES

Sl. No.	Course Code	Course Title
1.	P20ACTX01	English for Research Paper Writing
2.	P20ACTX02	Disaster Management
3.	P20ACTX03	Sanskrit for Technical Knowledge
4.	P20ACTX04	Value Education
5.	P20ACTX05	Constitution of India
6.	P20ACTX06	Pedagogy Studies
7.	P20ACTX07	Stress Management by Yoga
8.	P20ACTX08	Personality Development Through Life Enlightenment Skills
9.	P20ACTX09	Unnat Bharat Abhiyan

P20BST102	ADVANCED MATHEMATICS FOR ELECTRICAL ENGINEERS	L	T	P	C	Hrs
		2	2	0	3	60

Course Objectives

- To introduce the formulation of LPP.
- To gain knowledge on differentiation and apply to several variables.
- To introduce linear independence and dependence.
- To find the dimension of spaces such as those associated with matrices and linear transformations.
- To understand the axiomatic formulation of Probability Theory and random variables as an intrinsic need for the analysis of random phenomena.

Course Outcomes

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

CO1 - Learn different methods in LPP. **(K2)**
CO2 - Apply the differentiation process in calculus of variation.**(K3)**
CO3 - Compute inner products on a real vector space and orthogonality in inner product spaces.**(K3)**
CO4 - Find the basis for the kernel and range, and determine the nullity and rank.**(K4)**
CO5 - Familiarize with Modern Probability and random variables.**(K2)**

UNIT I LINEAR PROGRAMMING **(12 Hrs)**

Formulation – Graphical solution – simplex method – Big M – Method – Transportation and Assignment models.

UNIT II CALCULUS OF VARIATION **(12 Hrs)**

Concept of variation and its properties – Euler's equation – Functional dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables –Variational problems with moving boundaries – Isoperimetric problems - Direct methods: Ritz and Kantorovich methods.

UNIT III VECTOR SPACES **(12 Hrs)**

Vector spaces, subspaces, span of a set, linear independence and dependence, Dimension and Bases, inner product spaces - Gram-Schmidt orthogonalization

UNIT IV LINEAR TRANSFORMATIONS **(12 Hrs)**

Definition and examples, Range and Kernel of a linear map, rank and nullity, Inverse of a linear transformation, consequences of Rank-Nullity theorem, the space L (U, V), composition of linear maps, Matrix associated with a linear map and linear map associated with a matrix.

UNIT V PROBABILITY AND RANDOM VARIABLES **(12 Hrs)**

Probability – Axioms of probability – Conditional probability – Baye's theorem - Random variables - Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions.

Text Books

1. Hamdy A. Taha, "Operations Research: An Introduction", Pearson publications, 10th Edition, 2016.
2. Isarel M. Gelfand and S. V. Fomin, "Calculus of Variations (Dover Books on Mathematics", Dover Publications Inc, 2012.
3. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, 8th Edition, 2015.
4. Gilbert Strang, "Introduction to Linear Algebra", Wellesley-Cambridge Press, 5th Edition 2016.

Reference Books

1. Andrews L.C. and Phillips R.L., "Mathematical Techniques for Engineers and Scientists",SPIE Press, Illustrated Edition, 2003
2. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley publications, 10th Edition 2015.
3. Dr.G.Balaji, "Probability and Random Processes", G.Balaji Publishers, 16th Edition, 2016.

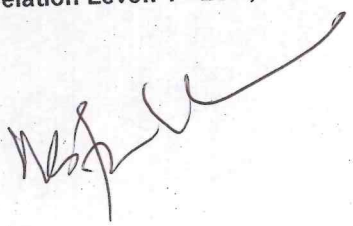
Web References

1. https://nptel.ac.in/courses/111/105/111105100/
2. https://nptel.ac.in/courses/110/106/110106062/
3. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ma23/
4. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ma22/
5. https://www.tutorialspoint.com/statistics/probability_density_function.htm

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	2	2	-	-	2	2	2
2	3	-	2	2	-	-	2	2	2
3	3	-	2	2	-	-	2	2	2
4	3	-	2	2	-	-	2	2	2
5	3	-	2	2	-	-	2	2	2

Correlation Level: 1 - Low, 2 - Medium, 3 - High



P20PET101	ANALYSIS OF POWER CONVERTERS	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To explain the operation and steady state analysis of single phase, three phase controlled rectifiers with R, RL and RLE Load.
- To provide the knowledge about various configurations of resonant DC-DC converters.
- To familiarize the principle of operation, design and synthesis of different power conversion circuits and their applications.
- To study about the operation of AC voltage converters and cycloconverters.
- To provide strong foundation for further study of power electronic circuits and systems.

Course Outcomes

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

CO1- Design and analyze the characteristics of Power electronics devices, single phase and three phase rectifiers. **(K4)**
CO2- Design and describe the circuit and the modes of operation of Choppers. **(K4)**
CO3- Analyze the performance parameters of the inverters and multilevel inverters. **(K4)**
CO4- Design and analysis of single phase and three phase AC Voltage regulators and Cycloconverters **(K4)**
CO5- Analyze the converters, inverters, choppers and ac-ac converters through software simulation. **(K4)**

UNIT I AC-DC CONVERTERS **(09 Hrs)**

Switch Realization: Survey of power semiconductor devices, Power diode, SCR, GTO, LASCR, RCT, SITH, BJT, MOSFET, IGBT etc., Switching losses, driver circuits, protection, cooling, application.

Converters: Single Phase /Three Phase –half wave-half controlled and fully controlled converters with R-L, R-L-E loads and freewheeling diodes – continuous and discontinuous modes of operation - inverter operation – Dual converter – Sequence control of converters – performance parameters: harmonics, ripple, distortion, power factor – effect of source impedance and overlap- reactive power and power balance in converter circuits.

UNIT II DC-DC CONVERTERS **(09 Hrs)**

Choppers: Principle of operation of buck, boost, buck-boost, Cuk, fly back, forward, push-pull, half bridge, full bridge Converters with continuous and discontinuous operation, Input & output filter design, multi-output boost converters, Classification of Choppers – AC chopper.

Resonant Pulse Converters: Switching loss, hard switching, and basic principles of soft switching-classification of resonant converters- load resonant converters – series and parallel – resonant switch converters – operation and analysis of ZVS, ZCS converters, comparison of ZCS/ZVS.

UNIT III DC-AC CONVERTERS **(09 Hrs)**

Inverters: Single and three phase bridge inverters with R, RL and RLE loads, Voltage control, Harmonic reduction, square wave inverters, PWM inverters, modulation techniques, SPWM, Selective Harmonic Elimination PWM and delta modulation. Resonant dc link inverters, Multi level inverters: types, operations, features.

UNIT IV AC-AC CONVERTERS **(09 Hrs)**

AC voltage controllers: Single phase and three phase ac voltage controllers with R, RL and RLE loads, Voltage control, Harmonic analysis, Matrix converters.

Cycloconverters: Single phase and three phase cycloconverters with R, RL and RLE loads – Voltage control,Harmonic analysis, Operation of single phase, Three phase to single phase-three phase to three phase cycloconverter-Input and output performances-Harmonics-output voltage and frequency range-control circuit of cycloconverter.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Design and simulation of zero current and zero voltage switching techniques –simulation of three phase to three phase cyclo converters- Case study- HVDC transmission, static VAR controller.

Text Books

1. Ned Mohan, Undeland and Robbins, "Power Electronics: concepts, applications and design", Wiley publishers, 3rd Edition, 2007.
2. Rashid M.H., "Power Electronics Circuits, Devices and Applications", Prentice Hall India, 4th Edition, 2017.
3. Jai P.Agrawal, "Power Electronics Systems", Pearson Education, 1st Edition, 2002.
4. Bimal K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, 1st Edition, 2015.
5. R W Erickson and D Makgimovic,"Fundamental of Power Electronics" Springer Nature (SIE), 2nd Edition 2005.

Reference Books

1. Shashi B. Dewan and Alan Straughen, "Power Semiconductor Circuits", John Wiley and Sons, 1975.
2. Dubey G.K, " Thyristorised Power Controllers", New Age International Private Limited, 2nd Edition 2012
3. Sen P.C., "Thyristor DC Drives", Krieger Publishing Company, Reprint Edition, 1991
4. Joseph Vithayathil, "Power Electronics - Principles and Applications", McGraw Hill Education, 2017.
5. Vedam Subrahmanyam, "Power Electronics", McGraw-Hill Education, 1994.

Web References

1. https://nptel.ac.in/courses/108/105/108105066/
2. https://www.tutorialspoint.com/power_electronics/index.htm
3. https://www.electronics-tutorials.ws/category/power
4. www.power electronics .com
5. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-334-power-electronics-spring-2007/lecture-notes/

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	3	3	2	-	3	3	3
2	3	-	3	3	2	-	3	3	3
3	3	-	3	3	2	-	3	3	3
4	3	-	3	3	2	-	3	3	3
5	3	-	3	3	2	-	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PET102 **ANALYSIS OF ELECTRICAL MACHINES**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To provide knowledge about the fundamentals of magnetic circuits, energy, force and torque of multi-excited systems.
- To understand the basic concepts and characteristics of DC machines.
- To provide the knowledge of theory of transformation of three phase variables to two phase variables.
- To analyze the steady state and dynamic state operation of three-phase induction machines using transformation theory based mathematical modeling and digital computer simulation.
- To understand the simulation model and instructional activity.

Course Outcomes

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

CO1 -.Analyze the energy conversions of different systems.**(K4)**
CO2 - Analyze the steady state and dynamic state operation of DC machines.**(K3)**
CO3 - Construct machine models based on different reference frames. **(K3)**
CO4 - Synthesize equivalent circuit parameters for synchronous and asynchronous machines. **(K3)**
CO5 - Model and simulate the DC and AC machines. **(K3)**

UNIT I PRINCIPLES OF ELECTROMAGNETIC ENERGY CONVERSION **(09 Hrs)**

Magnetic circuits, permanent magnet, stored magnetic energy, co-energy-force and torque in singly and doubly excited systems–machine windings and air gap mmf–determination of winding resistances and inductances of machine windings–determination of friction coefficient and moment of inertia of electrical machines.

UNIT II DC MACHINES **(09 Hrs)**

Elementary 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.

UNIT III REFERENCE FRAME THEORY **(09 Hrs)**

Historical background of Clarke and Park transformations–power invariance and phase transformation and commutator transformation–transformation of variables from stationary to arbitrary reference frame-variables observed from several frames of reference.

UNIT IV AC MACHINES **(09 Hrs)**

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 – modelling of multiphase machines -Three phase synchronous machine and analysis of steady state operation - voltage and torque equations in machine variables and rotor reference frame variables -analysis of dynamic performance for load torque variations.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Mathematical modelling of DC and AC Machines, Digital computer simulation of Electrical Machines.

Text Books

1. Paul C.Krause, Oleg Wasyzczuk, Scott S, Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley,2nd Edition, 2010.
2. P.S Bimbhra, "Generalized Theory of Electrical Machines", Khanna Publishers, 2008.
3. A.E, Fitzgerald, Charles Kingsley, Jr and Stephan D, Umanx, " Electric Machinery", Tata McGraw Hill, 5th Edition,1992.

Reference Books

1. Charles Kingsley,Jr, A.E. Fitzgerald, Stephen D.Umans, "Electric Machinery", Tata McgrawHill, 5th Edition,1992.
2. R. Krishnan, "Electric Motor & Drives: Modeling, Analysis and Control", Prentice Hall of India, 2nd Edition, 2001.
3. Miller, T.J.E, "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press, 1st Edition, 1989.

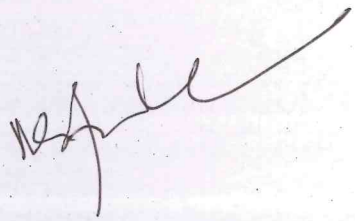
Web References

1.https://ieeexplore.ieee.org/book/5265638
2.https://india.oup.com/product/electrical-machines-9780199472635
3.https://nptel.ac.in/course.html
4. http://www.ee.iitm.ac.in/2016/08/ee5201/
5.https://www.iea.lth.se/publications/Theses/LTH-IEA-1043.pdf

COs/POs/PSOs Mapping

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	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	3	3	2	-	3	3	3
2	3	-	3	3	2	-	3	3	3
3	3	-	3	3	2	-	3	3	3
4	3	-	3	3	2	-	3	3	3
5	3	-	3	3	2	-	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High



P20PET103 **NANO ELECTRONICS**

L	T	P	C	Hours
3	0	0	3	45

Course Objectives

- To introduce the properties of electron and its implication for electronics.
- To understand the importance and the issues of Nano scale CMOS technology.
- To study about the characteristics and applications of Nano electronic devices, methods and techniques.
- To provide the knowledge on circuits and architectural features of Nano memory devices.
- To know about the various fabrication techniques for Nano electronic devices.

Course Outcomes

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

CO1 - Interpret the properties of electron and the significance of nanotechnology. **(K2)**
CO2 - Familiarize with the Concept of nano scale CMOS devices and its various issues. **(K2)**
CO3 - Apply the concept of nanotechnology and understand the significance of nano electronic devices.**(K4)**
CO4 - Analyze the nano configurations of computational processors and memories with improved design strategies.**(K4)**
CO5 - Apply the Nano technology to design analog and digital devices. **(K4)**

UNIT I INTRODUCTION **(09 Hrs)**

Overview of nanotechnology – Implication on science, engineering and technology- Particles-, waves, Wave mechanics, schrodinger equation- Electron transport in semiconductors and nanostructures, Nano materials and its properties- Electrical and Electronics Applications of Nanotechnology.

UNIT II NANOSCALE CMOS **(09 Hrs)**

Survey of modern electronics and trends towards Nano electronics CMOS scaling, challenges and limits, static power, device variability, interconnect - CNT-FET, FinFET, FerroFET - Surround gate FET nanoscale CMOS circuit design and analysis.

UNIT III NANOELECTRONIC DEVICES **(09 Hrs)**

Resonant-tunneling diodes- Resonant Tunneling Transistor-Single-electron transfer devices-Potential effect transistors- Nano Photonic Devices-Molecular electronic devices -Nano-electromechanical system devices-Recent development.

UNIT IV NANOELECTRONIC COMPUTATION AND MEMORIES **(09 Hrs)**

Quantum - dot cellular automata – Spintronics – Memristor - Nano tube for memories- Nano RAM Nanoscale DRAM, SRAM, Tunnel magneto resistance -Giant magneto resistance- design and applications.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Discussions/Practice on Workbench: on modelling of nano /micro analog and digital devices. Case study: Nanotechnology Impact on Environments, Design of 3D nano magnetic logic circuits.

Text Books

1. Hagelstein, Peter L., Stephen D. Senturia, and Terry P. Orlando, "Introduction to Applied Quantum and Statistical Physics", New York, NY: Wiley, 1st Edition, 2004.
2. Rainer Waser, "Nanoelectronics and Information Technology", Wiley, 3rd Edition, 2012.
3. Michael A. Nielsen and Isaac L. Chuang, "Quantum Computation and Quantum Information", Cambridge University Press, 10th Edition, 2010.

Reference Books

1. Adrian Ionesu and Kaustav Banerjee eds. "Emerging Nanoelectronics: Life with and after CMOS",Vol I, II, and III, Kluwer Academic,1st Edition, 2004.
2. Kiyoo Itoh Masashi Horiguchi, Hitoshi Tanaka, "Ultra Low voltage nano scale memories", Spl Indian Edition, Springer, 2007
3. George W. Hanson, "Fundamental of nanoelectronics", Pearson education.1st Edition, 2007.

Web References

1. https://nanohub.org/
2. https://www.nano.gov/
3. https://nptel.ac.in/courses/118/104/118104008/
4. https://www.nanowerk.com/nanoelectronics.php
5. https://nptel.ac.in/courses/117/108/117108047/

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	2	2	2	-	2	2	3
2	3	-	2	2	2	-	2	2	3
3	3	-	2	2	2	-	2	2	3
4	3	-	2	2	2	-	2	2	3
5	3	-	2	2	2	-	2	2	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20CCT101	RESEARCH METHODOLOGY AND IPR (Common to all M.Tech Programme)	L	T	P	C	Hrs
		2	0	0	2	30

Course Objectives

- To impart knowledge and skills required for research and IPR
- Problem formulation, analysis and solutions
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents

Course Outcomes

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

CO1- Formulate research problem.**(K2)**

CO2- Carry out research analysis. **(K2)**

CO3- Follow research ethics. **(K2)**

CO4- Describe today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity. **(K2)**

CO5- Interpret IPR and filing patents in R & D.**(K3)**

UNIT I RESEARCH PROBLEM FORMULATION **(06 Hrs)**

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II LITERATURE REVIEW **(06 Hrs)**

Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III TECHNICALWRITING /PRESENTATION **(06 Hrs)**

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR **(06 Hrs)**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR) **(06 Hrs)**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Text Books

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'" Kenwyn Publisher, 1996
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"2nd edition, Lansdowne publisher, 2001
3. C.R. Kothari, Gaurav Garg , New Age Internationa ,Research Methodology: Methods and Techniques 4th Edition, 2018.

Reference Books

1. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.

2. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners" 2010.
3. C.R. Kothari, Gaurav Garg , New Age Internationa ,Research Methodology: Methods and Techniques 4th Edition, 2018.
4. Trochim, Research Methods: the concise knowledge base, Atomic Dog Publishing 2005.
5. Fink A, Conducting Research Literature Reviews: From the Internet to Paper, Sage Publications,2009.

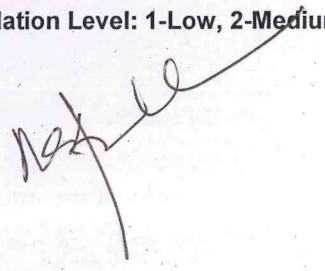
Web References

1. https://www.scribd.com/document/427419672/Research-Methodology-and-Ipr
2. https://www.isical.ac.in/~palash/research-methodology/RM-lec9.pdf
3. https://www.wipo.int/edocs/pubdocs/en/intproperty/958/wipo_pub_958_3.pdf
4. https://lecturenotes.in/m/21513-research-methodology-
5. https://iare.ac.in/sites/default/files/MTECH-CAD.CAM-R18-RM-IP-NOTES.pdf

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	1	1	3
CO2	3	2	1	1	2	1	1	1	3
CO3	3	2	1	1	2	1	1	1	3
CO4	3	2	1	1	2	1	1	1	3
CO5	3	2	1	1	2	1	1	1	3

Correlation Level: 1-Low, 2-Medium, 3- High



P20PEP101	POWER CONVERTERS SIMULATION LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives

- To enable the students to acquire knowledge on the simulation of power electronics using computer simulation package.
- To provide an understanding on the static and dynamic switching characteristic of power electronic.
- To enable the students to design and simulate a power converter circuits at appreciable voltage/power levels with heat sink.
- To determine the operation, characteristics and performance parameters of controlled rectifiers.
- To acquire knowledge about the operation of various power converter circuits namely controlled rectifiers, choppers, AC voltage regulators and inverters.
- To enable the students to do simulation of these circuits and verify the simulation results with mathematical formula based theoretical results

Course Outcomes

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

CO1 - Design and analyze the simulation model and verify power converter circuits.
CO2 - Analyze the operation of power converter circuits.
CO3 - Design circuit specification in power inverter for different load.
CO4 - Choose a power converter circuit for specific application.
CO5 - Design Heat sink for different load by thermal analysis.

List of Experiments

1. Simulation of single phase half and full converter using RLE loads
2. Simulation of single phase AC voltage controller using RLE loads.
3. Simulation of Single phase inverter with PWM control
4. Simulation of Resonant pulse commutation circuit and Buck chopper.
5. Simulation and analysis of Boost converters with RL load
6. Simulation and analysis of Buck-Boost converters with RL load
7. Simulation and analysis of three phase PWM inverter fed Induction Motor.
8. Simulation and analysis of Multi Level inverter fed Induction Motor.
9. Obtain PID controller parameters for DC Motor Speed Control
10. Dynamic behavior of Induction motor using transfer function approach
11. Dynamic behavior of Induction motor using State Space Model approach
12. Modelling and simulation of separately excited DC motor and to study the dynamic behavior of the machine for change in load torque
13. Modelling and simulation of Induction machine and to study the dynamic behavior of the machine for change in load torque
14. Modelling and simulation of three phase synchronous machine and to study the dynamic behavior of the machine for change in load torque
15. Thermal Analysis of Heat Sink with Fins of Different Configuration for MOSFET device Using simulation

Reference Books

1. Narayanaswamy P R Iyer, "Power Electronic Converters: Interactive Modelling Using Simulink", CRC, Taylor& Francis Group, 1st Edition2018.
2. Ned Mohan, Undeland and Robbins, "Power Electronics: concepts, applications and design", Johnwiley and sons, Singapore,1st Edition2000.
3. Rashid M.H., "Power Electronics Circuits, Devices and Applications", Prentice Hall India, 3rd Edition, New Delhi, 2004.
4. Jai P.Agrawal, "Power Electronics Systems", Pearson Education, 2nd Edition,2002.

5. M.B.Patil, "Simulation of power electronics cirscuits", Narosa Publishing House, 1st Edition 2009.
6. Dubey G.K., Doralda S.R., Joshi A., and sinha R.M.K., "Thyristorised power controllers", Wiley Eastern Limited, 1st Edition1986.
7. Sen P.C., "Thyristor DC Drives", John Wiley and Sons, 1st Edition 1991.
8. Bimal K. Bose, "Modern Power Electronics and AC Drives", Pearson, 2nd Edition 2003.

Web References

1. https://www.coursera.org › courses › query=power electronics
2. https://nptel.ac.in/courses/108/105/108105066/
3. https://www.udemy.com/course/designing-of-power-electronic-converters-in-matlabsimulink/
4. https://www.mathworks.com/solutions/power-electronics-control/power-electronics-simulation.html
5. http://ecee.colorado.edu/~ecen5797/course_material/matlab/
6. https://swayam.gov.in › nd1_noc19_ee37
7. https://rhyni.com › simulation-of-power-electronics-converters

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	2	2	3	-	3	3	3
2	3	-	2	2	3	-	3	3	3
3	3	-	2	2	3	-	3	3	3
4	3	-	2	2	3	-	3	3	3
5	3	-	2	2	3	-	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High

		L	T	P	C	Hrs
P20CCP101	**TECHNICAL REPORT WRITING AND SEMINAR**	0	0	4	2	45

(Common to all M.Tech Programme)

Course Objectives

- Selection of topic based on interest
- Formulate the Objective
- To develop their scientific and technical reading and writing skills that they need to understand and construct research articles.
- To obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas.
- Preparation of report

Course Outcomes

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

CO1 - Select a subject, narrowing the subject into a topic.**(K2)**

CO2 - Explain objective and collect the relevant bibliography.**(K2)**

CO3- Describe the papers and understand the author's contributions and critically analyzing each paper. **(K3)**

CO4 -Prepare a working outline and linking the papers and preparing a draft of the paper. **(K2)**

CO5- Prepare conclusions based on the reading of all the papers, Writing the Final Paper, and giving final Presentation.**(K3)**

Activity	Instructions	Submission week	Evaluation
Selection of area of interest and Topic	select an area of interest, topic and state an objective	2nd week	**3 %** Based on clarity of thought, current relevance and clarity in writing
Stating an Objective			
Collecting Information about area & topic	• List 1 Special Interest Groups or professional society • List 2 journals • List 2 conferences, symposia or workshops • List 1 thesis title • List 3 web presences (mailing lists, forums, news sites) • List 3 authors who publish regularly in your area • 7. Attach a call for papers (CFP) from your area.	3rd week	**3%** (the selected information must be area specific and of international and national standard)
Collection of Journal papers in the topic in the context of the objective – collect 20 & then filter	• provide a complete list of references you will be using- Based on your objective - Search various digital libraries and Google Scholar • When picking papers to read - try to: - Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them. - Favour papers from well-known journals and	4th week	**6%** (the list of standard papers and reason for selection)

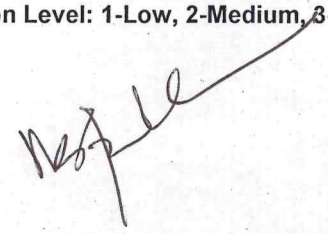
	conferences,in the field (as indicated in other Favour more recent papers, - Pick a recent survey of the field so you can quickly gain an overview,Find relationships with respect to each other and to your topic area(classification scheme/categorization) - Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered		
Reading and notes for first 5 papers	Reading Paper Process For each paper form a Table answering the following questions: • What is the main topic of the article? • What was/were the main issue(s) the author said they want to discuss? • Why did the author claim it was important? • What simplifying assumptions does the author claim to be making? • What did the author do? • How did the author claim they were going to evaluate their work and compare it to others? • What did the author say were the limitations of their research? • What did the author say were the important directions for future research? • Conclude with limitations/issues not addressed by the paper (from the perspective of survey)	6th week	8%(The table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for next 5 papers	Repeat Reading Paper Process	7th week	8%(the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper
Draft outline 1 and Linking papers	Prepare a draft Outline, your survey goals, along with a classification / categorization diagram	8th week	8%(this component willbe evaluated based on the linking and classification among the papers)

Abstract	Prepare a draft abstract and give a presentation	9th week	6%(Clarity, purpose and conclusion) 6% Presentation & Viva Voce
Introduction Background	Write an introduction and background sections	10th week	5% (clarity)
Sections of the paper	Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey	11th week	10%(this component willbe evaluated based on the linking and classification among the papers)
Conclusions	Write your conclusions and future work	12th week	5% (conclusions)
Final Draft	Complete the final draft of your paper	13th week	10% (formatting, English, Clarity and linking) 4% Plagiarism Check Report
Seminar	A brief 15 slides on your paper	14th& 15th week	10% (based on presentation and Vivavoi ce)

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	2	3	3	1	3	3	2	1	2
CO2	2	3	2	1	3	2	2	1	2
CO3	2	3	2	1	3	2	2	1	2
CO4	2	3	2	1	3	2	2	1	2
CO5	2	3	2	1	3	2	2	1	2

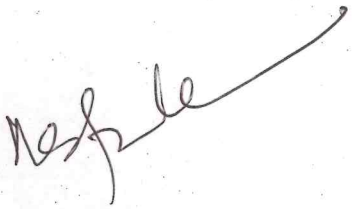
Correlation Level: 1-Low, 2-Medium, 3- High



P20PEC1XX	EMPLOYABILITY ENHANCEMENT COURSE- I	L	T	P	C	Hrs
		0	0	4	-	50

Students shall choose an International certification course offered by the reputed organizations like Google, Microsoft, IBM, Texas Instruments, Bentley, Autodesk, Eplan and CISCO, etc. The duration of the course is 40-50 hours specified in the curriculum, which will be offered through Centre of Excellence.

Pass /Fail will be determined on the basis of participation, attendance, performance and completion of the course. If a candidate fails, he/she has to repeat the course in the subsequent years. Pass in this course is mandatory for the award of degree.



P20PET204 **INDUSTRIAL CONTROL DRIVES**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To provide knowledge on performance characteristics of Electric Drives.
- To equip the students with DC motor drives and to understand its speed control methods.
- To equip the students with AC motor drives and to understand its speed control methods.
- To know the special motor drives and its control methods.
- To familiarize with the simulation and to analysis the performance of various motor drives.

Course Outcomes

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

CO1- Realize the fundamental concepts of electric drive characteristics and section of motor ratings.**(K2)**
CO2- Ability to analyze, comprehend and design DC motor based adjustable speed drives. **(K4)**
CO3- Ability to analyze, comprehend and design AC motor based adjustable speed drives. **(K4)**
CO4- Identify the characteristics of special machines and its applications. **(K3)**
CO5- Design the motor model and its control for various electrical drives using simulation software.**(K3)**

UNIT I INTRODUCTION **(09 Hrs)**

Electric machines, power converter, controllers - Characteristics of mechanical system–dynamic equations, components of torque, types of load; Requirements of drives characteristics-stability of drives – multi-quadrant operation - Drive elements, types of motor duty and selection of motor rating.

UNIT II DC MOTOR DRIVES **(09 Hrs)**

Principle of phase control – Fundamental relations - Analysis of shunt, series and separately excited DC motor with single-phase and three-phase converters – Speed-torque characteristics-. chopper controlled DC motor – performance analysis, multi-quadrant control- Chopper based implementation of braking schemes - PMDC motor - Speed and position control methods.

UNIT III AC MOTOR DRIVES **(09 Hrs)**

Stator and rotor control of Induction motors - Scalar control of induction motor, Principle of vector control, direct and indirect vector control- sensor less control and flux observers, model reference adaptive system (MARS) - Direct torque and flux control of induction motor- Multilevel converter-fed induction motor drive. - Dynamic d-q model of synchronous motor drive - sinusoidal and trapezoidal SPM motor drives - wound field motor drives.

UNIT IV SPECIAL MOTOR DRIVES **(09 Hrs)**

BLDC motor drives - sensors and sensor-less control - switched reluctance motor drives - Block Diagram of Servo Controlled System with velocity and torque feedback- DC and AC Servomotors-Selection of Servomotors - Stepper motor drives - uni-polar and bipolar control.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Case study on Motor drives used in Textile, Paper, Sugar mill, Cement Industry – Simulation of DTC based IM Drives and vector control of synchronous motor drives.

Text Books

1. Ned Mohan , 'Electric Drives: An integrative approach', MNPERE, Minneapolis, USA, 1st Edition, 2003
2. R. Krishnan, "Electric motor drives", Pearson Education India, 1st Edition , 2015
3. N. Mohan, "Power Electronics: Converters, applications and design", John Wiley and Sons, 3rd Edition, 2006.
4. J. M. D. Murphy and F.G. Turnbull, "Power electronic control of AC motor", Pergamon press, 1st Edition 1990.
5. B.K. Bose, "Power electronics and AC drives", Prentice-Hall, 1st Edition, 2002.

Reference Books

1. W. Leonhard, "Control of electrical drives", Springer- Verlag, 3rd Edition, 2001.
2. G.K. Dubey, "Fundamental of Electrical Drives", Narosa, 2nd Edition, 2010.
3. M.A. El-Sharkawi, "Fundamentals of Electric Drives", Cengage Learning, 2nd Edition, 2018.
4. Wach P. "Brushless DC Motor Drives (BLDC). In: Dynamics and Control of Electrical Drives", Springer, 1st Edition, 2011.

Web References

1. https://nptel.ac.in/courses/108/104/108104140/
2. https://nptel.ac.in/courses/108/102/108102046/
3. https://nptel.ac.in/courses/108/108/108108077/
4. https://nptel.ac.in/courses/108/104/108104011/
5. https://www.intechopen.com/books/electric-machines-for-smart-grids-applications-design-simulation-and-control/the-design-of-motor-drive-for-brushless-dc-motor

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	3	3	2	-	3	2	3
2	3	-	3	3	2	-	3	2	3
3	3	-	3	3	2	-	3	2	3
4	3	-	3	3	2	-	3	2	3
5	3	-	3	3	2	-	3	2	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PET205	DESIGN TECHNIQUES FOR SWITCH MODE POWER CONVERSION	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To give a practical step by step approach for design and assembly of Power Supplies and apply the necessary recent technology to comply the standards and certification requirements.
- To understand the design of inductor, transformer and capacitors for power electronic applications.
- To design the state analysis of second and higher order Switched Mode power converters.
- To understand the concepts of soft-switching dc - dc converters.
- To study about pulse width modulated rectifiers.

Course Outcome

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

CO1- Design magnetic components for DC-DC converters. **(K3)**

CO2- Analyze and design Buck, Boost, CUK and SEPIC converters. **(K4)**

CO3- Analyze and design forward, push-pull and bridge converters. **(K4)**

CO4- Derive transfer function of different converters. **(K3)**

CO5- Develop the mathematical model of power converter circuits.**(K3)**

UNIT I DESIGN OF CONVERTER COMPONENTS **(09 Hrs)**

Elements - Active and Passive - Selection of output filter capacitor and energy storage inductor, Design of High Frequency Inductor and High frequency Transformer, Selection of switches – Design of snubber and driver circuits - EMI Filter Components, EMI suppression, Measurement. Protection: Over current, over voltage, Inrush current. Thermal Model: Thermal Resistance, Cooling Considerations, Selection of Heat sinks and calculations.

UNIT II NON-ISOLATEDCONVERTERS **(09 Hrs)**

Buck, Boost, Buck-Boost, CUK Converters, Single Ended Primary Inductance Converter (SEPIC) and Zeta converters – Operation – Concepts of volt-sec balance and charge balance - Analysis and design based on steady- state relationships-Design Examples.

UNIT III ISOLATED CONVERTERS **(09 Hrs)**

Introduction, classification, operation and analysis of fly back, forward, double ended (Two switch) forward converter, push-pull converter-full bridge and half-bridge converters, design considerations, current fed converters, multiple outputs.

UNIT IV CONVERTER DYNAMICS **(09 Hrs)**

AC equivalent circuit analysis – State space averaging – Circuit averaging – Averaged switch modelling – Transfer function model for Buck, Boost, Buck-Boost and CUK converters – Input filters.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Design of controller for Buck, Boost, Buck-Boost and CUK converters- Bode plot based analysis- gain margin and phase margin, State space model of converters.

Text Books

1. Robert W. Erickson and Dragan Maksimovic, "Fundamentals of Power Electronics", Springer, 2nd Edition, 2001.
2. Ned Mohan, Undeland and Robbins, "Power Electronics: Converters, applications and design", John Wiley and sons,1st Edition, 2003.
3. M.H. Rashid, "Power Electronics: Circuits, Devices and Applications", Pearson Education, PHI 4th Edition, New Delhi, 2017.
4. H. W. Whittington, B. W. Flynn and D. E. MacPherson, "Switched Mode Power Supplies, Design and Construction", Universities Press, 1st Edition, 2009.
5. Umanand L and Bhatt S R, "Design of Magnetic Components for Switched Mode Power Converters", Wiley Eastern Publication, 1st Edition, 2009.
6. Daniel W Hart, "Power Electronics", Tata McGraw Hill, 1st Indian Edition, 2017.
7. D M Mitchel, "DC-DC Switching Regulator Analysis" McGraw-Hill Ltd, 1st Edition, 1988.

Reference Books

1. Marian K. Kazimierczuk, "Pulse-width Modulated DC-DC Power Converters", John Wiley & Sons Ltd., 2nd Edition, 2015.
2. Philip T Krein, "Elements of Power Electronics", Oxford University Press, 2nd Edition, 2012.
3. Issa Batarseh, "Power Electronic Circuits", John Wiley, 3rd Edition, 2006.
4. Middlebrook, R.D., and Slobodan Cuk, "Advances in Switched-Mode Power Conversion", Volumes I and II, 2nd Edition, TESLAco, 1983.
5. V. Ramanarayanan, "Course Material on Switched Mode Power Conversion", Department of Electrical Engineering, Indian Institute of Science, Bangalore, 2nd Edition, 2006.

Web References

1. http://minchu.ee.iisc.ernet.in/new/people/faculty/vr/book.pdf
2. https://www.ti.com/power-management/non-isolated-dc-dc-switching-regulators/overview.html
3. https://www.intechopen.com/books/electric-vehicles-modelling-and-simulations/dc-dc-converters-for-electric-vehicles
4. https://www.renesas.com/us/en/products/power-management/dc-dc-converters.html
5. http://web.eecs.utk.edu/~dcostine/ECE482/Spring2018/materials/Ch9notes.pdf
6. https://nptel.ac.in/courses/108/108/108108036/

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
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2	3	-	3	3	2	-	3	3	3
3	3	-	3	3	2	-	3	3	3
4	3	-	3	3	2	-	3	3	3
5	3	-	3	3	2	-	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PET206 **ELECTRIC AND HYBRID VEHICLE**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To understand the concept of electric vehicles and its operations.
- To understand various motor controlling techniques in electric vehicles.
- To understand different configurations of electric vehicle and sizing of components.
- To understand different types of architecture in electric and hybrid vehicle.
- To understand various electric drive system suitable for hybrid electric vehicles.

Course Outcomes

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

CO1- Analyze the mathematical models, performance and characteristics of hybrid and electric vehicles.**(K4)**

CO2- Analyze the characteristics and performance of hybrid and electric drive train using both DC and AC Drives. **(K4)**

CO3- Analyze the various aspects of hybrid electric drive such as their configuration and types of electric Machines. **(K4)**

CO4- Design various control strategies for hybrid electric motor drives. **(K3)**

CO5- Implement energy management techniques for electric and hybrid vehicles. **(K3)**

UNIT I ARCHITECTURE OF ELECTRIC VEHICLES AND VEHICLE MECHANICS **(09 Hrs)**

Electric Vehicles (EV), Hybrid Electric Vehicles (HEV) - Engine ratings-Comparisons of EV with internal combustion Engine vehicles-Fundamentals of vehicle mechanics. Architecture of EV's and HEV's – Plug-n Hybrid Electric Vehicles (PHEV) - Power train components and sizing-Gears-Clutches, Transmission and Brakes.

UNIT II ELECTRIC PROPULSION SYSTEM AND MOTOR CONTROL **(09 Hrs)**

DC Motors, AC Motors, Permanent Magnet Motors, Brushless DC and Reluctance Motors – Characteristics, Regenerative Braking, Control System Principles, Speed and Torque Control.

UNIT III HYBRID VEHICLE SYSTEM **(09 Hrs)**

Matching the electric machine and the internal combustion engine (ICE) - sizing the propulsion motor- sizing the power electronics- selecting the energy storage technology- communications-supporting subsystems

UNIT IV HYBRID ELECTRICAL DRIVE **(09 Hrs)**

Concepts of hybrid electric drive train, architecture of series and parallel hybrid electric drive train, merits and demerit, series and parallel hybrid electric drive train design.

UNIT V INSTRUCTIONAL ACTIVITIES **(09 Hrs)**

Mathematical models to describe electric vehicle performance - Case study on brake system of EVs and HEVs – Case study on different types of energy storage system – case study on implementation issues of energy strategies.

Text Books

1. Mehrdad Ehsani, Yimin Gao, Sebastien E.Gay, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles", CRC Press, 1st Edition, 2010.
2. Tom Denton, "Electric and Hybrid Vehicles" Routledge Publisher, 1st Edition, 2016.
3. Ali Emadi, Mehrdad Ehsani, John M.Miller, "Vehicular Electric Power Systems", Marcel dekker, Inc , Special Indian Edition, 2010.
4. Chris Mi, M. Abul Masrur, David Wenzhong Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", Wiley, 2011.
5. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals," CRC Press,Taylor & Francis Group, 2nd Edition,2010.

Reference Books

1. Thomas J. Bohme, Benjamin Frank, "Hybrid Systems, Optimal Control and Hybrid Vehicles: Theory, Methods and Applications", Springer Publication, 1st Edition, 2017.
2. Sira -Ramirez, R. Silva Ortigoza, "Control Design Techniques in Power Electronics Devices", Springer, 3rdEdition, 2006.
3. Siew-Chong Tan, Yuk-Ming Lai, Chi Kong Tse, "Sliding mode control of switching Power Converters", CRC Press, 2011.
4. Ion Boldea and S.A Nasar, "Electric drives", CRC Press, 2005.

Web References

1. https://nptel.ac.in/courses/108/103/108103009
2. https://www.virta.global/smart-charging
3. https://www.virta.global/blog/effect-of-electric-cars-on-power-grid
4. https://www.taylorfrancis.com/books/9781315731612
5. https://energysavingtrust.org.uk/transport/electric-cars-and-vehicles/electric-vehicles

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	3	3	1	2	3	3	3
2	3	-	3	3	1	2	3	3	3
3	3	-	3	3	1	2	3	3	3
4	3	-	3	3	1	2	3	3	3
5	3	-	3	3	1	2	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PET207	MICROCONTROLLER AND DSP BASED SYSTEM DESIGN	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To develop an in-depth knowledge in operation of microcontrollers, machine language programming & interfacing techniques.
- To understand the architecture and programming of PIC Microcontrollers.
- To provide in depth knowledge about embedded processor, its hardware and software.
- To understand the embedded system design and their operating system.
- To apply knowledge of embedded processor architecture in various applications.

Course Outcomes

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

CO1 - Analyze the architecture and programming of PIC Microcontrollers. **(K4)**

CO2 - Develop embedded C language to program the peripheral devices of PIC Microcontrollers. **(K3)**

CO3- Analyze the architecture, programming and features of Digital Signal Processors.**(K4)**

CO4 - Develop program for triggering and control circuitry employing Micro-controller and DSP. **(K3)**

CO5 - Design a real time embedded application. **(K3)**

UNIT I INTRODUCTION TO PIC 16C7X MICROCONTROLLER (09 Hrs)

Architecture memory organization – Addressing modes – Instruction set – Programming techniques – simple programs.

UNIT II PERIPHERALS OF PIC 16C7X MICROCONTROLLER (09 Hrs)

Timers – interrupts – I/O ports – I2C bus for peripheral chip access – A/D converter –UART, CCP modules – Sensor Interfacing.

UNIT III INTRODUCTION TO DIGITAL SIGNAL PROCESSORS (09 Hrs)

Introduction- Core architecture of 2000 family of Digital Signal Processors, System configuration registers - Memory Addressing modes – Instruction set – Programming techniques – simple programs.

UNIT IV PERIPHERALS OF DIGITAL SIGNAL PROCESSORS (09 Hrs)

General purpose Input / Output (GPIO) Functionality- Interrupts - A/D converter-Event Managers (EVA, EVB)- PWM signal generation.

UNIT V INSTRUCTIONAL ACTIVITIES (09 Hrs)

Interfacing of 7 segment displays, DC and AC motor control with PIC microcontroller - Interface of Wi-Fi module using PIC microcontroller for Transmission and Reception of data.

Text Books

1. John B. Peatman, "Design with PIC Microcontrollers', Pearson Education Publications, 1st Edition,2008.
2. Hamid A.Toliyat, Steven Campbell, "DSP based electromechanical motion control",CRC Press , 2nd Edition,2005.
3. PIC16F87X datasheet, 28/40- pin 8 bit CMOS Flash Microcontrollers, Microchip Technology Inc, 1st Edition, 2001.

Reference Books

1. Myke Predko, "Programming and customizing the PIC Microcontroller", Tata McGraw Hill, 3rd Edition, 2008.
2. Tim Wilmshurst, " An Introduction to the Design of Small Scale Embedded Systems", Pal grave Publisher, 2nd Edition, 2004.
3. Texas instruments Handbook on "Digital Signal Processing Solutions for Motor Control Using the TMS320F240 DSP-Controller", 2nd Edition, 2010.
4. Sen M Kuo, WoonSengGan, "Digital Signal Processors-Architecture, Implementation and Applications", Pearson Education, 1st Edition, 2005.
5. M. D. Singh and K. B. Khanchandani, "Power Electronics", Tata McGraw Hill Publishing Company Limited, 2nd Edition, 2006.

Web References

1. https://nptel.ac.in/courses/108/105/108105102/
2. https://www.youtube.com/watch?v=TO66UN64-os
3. https://www.youtube.com/watch?v=MfhTBeaDpQA
4. https://www.youtube.com/watch?v=6dFnpz_AEyA
5. https://www.pantechsolutions.net/blog/best-dsp-projects-for-engineering-students/

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	2	2	2	-	3	2	3
2	3	-	2	2	2	-	3	2	3
3	3	-	2	2	2	-	3	2	3
4	3	-	2	2	2	-	3	2	3
5	3	-	2	2	2	-	3	2	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PEP202	POWER CONVERTERS AND DRIVES LABORATORY	L	T	P	C	Hrs
		0	0	4	2	45

Course Objectives

- To study the characteristics of the power electronic devices and performance of converter circuits through hardware setup.
- To acquire knowledge on design and analyses of DC and AC drives.
- To generate the firing pulses for converters and inverters using digital processors.
- To determine the operation, characteristics and performance parameters of controlled rectifiers.
- To acquire knowledge about the operation of various power converter circuits namely controlled rectifiers, choppers, AC voltage regulators and inverters.

Course Outcomes

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

CO1 - Measure the performance parameters of power converters in order to find out solutions. **(K2)**
CO2 - Able to design control structure for efficient operation of power converters. **(K3)**
CO3 - Ability to check and compare both hardware result and theoretical result. **(K4)**
CO4 - Realize the hardware prototype for power converters. **(K3)**
CO5 - Analyze and predicts the calculation and performance of Voltage control of SMPS. **(K3)**

List of Experiments

1. PIC microcontroller based digital PWM generation schemes for 1-Φ and 3 Φ -Inverters.
2. Speed control of converter/Chopper fed DC motor.
3. Speed control of VSI fed three phase Induction motor.
4. PIC Microcontroller based speed control of stepper motor.
5. (a) Design and implementation of multilevel inverter using PIC microcontroller.
   (b) Analysis of Odd harmonics and even harmonics for 7 level inverter.
6. Design and implementation of AC chopper.
7. Study of Three phase to single phase cyclo-converter.
8. Four quadrant operation of DC drive using Dual converter.
9. Design and Implementation of switched mode power supplies.
10. Study of UNITRODE ICs for the Voltage control of SMPS.
11. Study of FPGA controller.

Application

12. Study of power quality analyzer.
13. Study on DSP-TMS320F2812 based controller for Power converter.
    a. Creating a PWM signal with fixed & variable duty cycle and frequency .
    b. Creating a Sinusoidal PWM signal.
14. Experiment on speed control of BLDC motor.

Text Books

1. Muhammad H. Rashid, "Power Electronics - Devices, Circuits and Applications", Pearson publication, 4th Edition, 2017.
2. Ned Mohan, Undeland and Robbins, "Power Electronics: concepts, applications and design", John Wiley and sons, Singapore, 1st Edition, 2000.
3. Jai P. Agrawal, "Power Electronics Systems", Pearson Education, 2nd Edition, 2002.
4. John B. Peatman, "Design with PIC Microcontrollers", Pearson Education, 1st Edition, 2004.

Reference Books

1. Hamid A.Toliyat, Steven Campbell, "DSP based electromechanical motion control", CRC Press, 1st Edition, 2019.
2. Dubey G.K., Doralda S.R., Joshi A., and sinha R.M.K., "Thyristorised power controllers", Wiley Eastern Limited, 1st Edition, 1986.
3. Sen P.C., "Thyristor DC Drives", John Wiley and Sons, 1st Edition, 1991.

4. Bimal K. Bose, "Modern Power Electronics and AC Drives", Pearson, 2nd Edition, 2003.

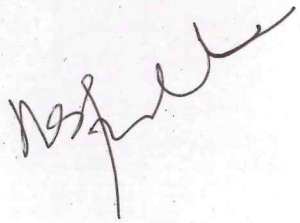
Web References

1. https://www.coursera.org › courses › query=power electronics
2. https://nptel.ac.in/courses/108/105/108105066/
3. https://www.udemy.com/course/designing-of-power-electronic-converters-in-matlabsimulink/
4. https://www.mathworks.com/solutions/power-electronics-control/power-electronics-simulation.html
5. http://ecee.colorado.edu/~ecen5797/course_material/matlab/
6. https://swayam.gov.in › nd1_noc19_ee37
7. https://rhyni.com › simulation-of-power-electronics-converters

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	2	2	3	-	3	3	3
2	3	-	2	2	3	-	3	3	3
3	3	-	2	2	3	-	3	3	3
4	3	-	2	2	3	-	3	3	3
5	3	-	2	2	3	-	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High



P20CCP202	SEMINAR ON ICT: A HANDS-ON APPROACH	L	T	P	C	Hrs
		0	0	4	2	45

Course Objectives

- To develop their technical reading and presentation skills that they need to understand and present using ICT Tools.
- To obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and practice to present.

Course Outcomes

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

CO1 - Select a topic, narrowing the topic into presentation.
CO2 - State an objective and use the relevant ICT tools to make the presentation effective.
CO3 - Study the topic and understanding the contributions and prepare report.
CO4 - Prepare a working demo.
CO5 - Prepare conclusions based on the reading of the topic and giving final Presentation.

The methodology used is "learning by doing", a hands-on approach, enabling the students to follow their own pace. The teacher, after explaining the project, became a tutor, answering questions and helping students on their learning experience.

ICT skills

- Understand ICT workflow in the respective domain choosed.
- Manage multitasking.
- Deal with main issues using tech in class.
- Record, edit and deliver audio and video.
- Automate assessments and results.

Scope

- Perspective in order to design activities in class.
- Understand the process of creating audiovisuals.

Teaching tools

- Different ways to create audiovisual activities.
- Handle audiovisual editors.
- Collaborative working.
- Individualize learning experience.
- Get instant feedback from students.

Each one of the students will be assigned an ICT Topic and the student has to conduct a detailed study on the assigned topic and prepare a report, running to 30 or 40 pages for which a demo to be performed followed by a brief question and answer session. The demo will be evaluated by the internal assessment committee (comprising of the Head of the Department and two faculty members) for a total of 100 marks.

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	-	3	1	1	3	3	3	-	-
CO2	-	3	1	1	3	2	3	-	-
CO3	-	3	1	1	3	2	3	-	-
CO4	-	3	1	1	3	2	3	-	-
CO5	-	3	1	1	3	2	3	-	-

Correlation Level: 1-Low, 2-Medium, 3- High

		L	T	P	C	Hrs
P20PEC2XX	EMPLOYABILITY ENHANCEMENT COURSE- II	0	0	4	-	50

Students shall choose an International certification course offered by the reputed organizations like Google, Microsoft, IBM, Texas Instruments, Bentley, Autodesk, Eplan and CISCO, etc. The duration of the course is 40-50 hours specified in the curriculum, which will be offered through Centre of Excellence.

Pass /Fail will be determined on the basis of participation, attendance, performance and completion of the course. If a candidate fails, he/she has to repeat the course in the subsequent years. Pass in this course is mandatory for the award of degree.

P20PEW301	PROJECT PHASE - I	L	T	P	C
		0	0	12	6

Aim and Objective:

The project work aims to develop the work practice and to apply theoretical and practical tools/techniques for solving real life problems related to industry and current research. The objective of the project work is to improve the professional competency and research attitude by touching the areas which are not covered in theory or laboratory classes.

- The project work shall be a design project/experimental project and/or computer simulation project on any of the topic in manufacturing engineering or related field.
- The project work shall be allotted individually on different topics.
- The students shall be encouraged to do their project work in the parent institute itself. In exceptional cases the students shall be permitted to undertake continue their project outside the parent institute with appropriate permission from Head of the institution through the Project Coordinator.
- Department shall constitute an Evaluation Committee to review the project work.
- The Evaluation committee shall consist of at least three faculty members namely internal guide, project coordinator and another expert in the specified area of the project.

The student is required to undertake the project phase I during the third semester and the same shall be continued in the 4th semester (Phase II). Phase I consist of preliminary thesis work, three reviews of the work and the submission of preliminary report. First review shall highlight the topic, objectives and origin of problem, second review shall highlight, Literature survey, methodology and expected results. Third review shall evaluate the progress of the work, preliminary report and scope of the work which shall be completed in the 4th semester. Also the evaluation of project phase - I shall be done externally.

P20PEW302	INTERNSHIP	L	T	P	C
		0	0	0	2

Students should undergo training or internship during summer / winter vacation at Industry/ Research organization / University (after due approval from the Programme Academic Coordinator and Department Consultative Committee (DCC). In such cases, the internship/training should be undergone continuously (without break) in one organization. Normally no extension of time is allowed. However, DCC may provide relaxation based on the exceptional case. The students are allowed to undergo three to four weeks of internship in established industry / Esteemed institution during vacation period. The student should give presentation and submit report to DCC. The Internship is assessed internally for 100 marks.

P20PES301	NPTEL/GIAN/MOOC	L	T	P	C
		0	0	0	-

Student should register online courses like MOOC / SWAYAM / NPTEL etc. approved by the Department committee comprising of HoD, Programme Academic Coordinator and Subject Experts. Students have to complete relevant online courses successfully. The list of online courses is to be approved by Academic Council on the recommendation of HoD at the beginning of the semester if necessary, subject to ratification in the next Academic council meeting. The Committee will monitor the progress of the student and recommend the grade (100% Continuous Assessment pattern) based on the marks secured in online examinations. The marks attained for this course is not considered for CGPA calculation.

P20PEW403	PROJECT PHASE - II	L	T	P	C
		0	0	24	12

Aim and Objective:

The project work aims to develop the work practice and to apply theoretical and practical tools/techniques for solving real life problems related to industry and current research. The objective of the project work is to improve the professional competency and research attitude by touching the areas which are not covered in theory or laboratory classes.

- The project work shall be a design project/experimental project and/or computer simulation project on any of the topic in manufacturing engineering or related field.
- The project work shall be allotted individually on different topics.
- The students shall be encouraged to do their project work in the parent institute itself. In exceptional cases the students shall be permitted to undertake continue their project outside the parent institute with appropriate permission from Head of the institution through the Project Coordinator.
- Department shall constitute an Evaluation Committee to review the project work.
- The Evaluation committee shall consist of at least three faculty members namely internal guide, project coordinator and another expert in the specified area of the project.

Project phase II is a continuation of project phase I which started in the third semester. There shall be three reviews in the fourth semester, first in the beginning of the semester, second in the middle of the semester and the Third at the end of the semester. First review is to evaluate the progress of the work and planned activity; second review shall be presentation and discussion. Third review shall be a pre-submission presentation before the evaluation committee to assess the quality and quantity of the work done. This would be a pre qualifying exercise for the students for getting approval for the submission of the thesis. At least one technical paper shall be prepared for possible publication in journals or conferences. The technical paper shall be submitted along with the thesis. The final evaluation of the project shall be done externally.

PROFESSIONAL ELECTIVE COURSES

		L	T	P	C	Hrs
P20PEE101	OPTIMIZATION TECHNIQUES	3	0	0	3	45

Course Objectives

- To get knowledge in various optimization techniques.
- To learn about linear and nonlinear programming.
- To know about geometric, integer programming.
- To understand about dynamic programming.
- To acquire knowledge on the applications of optimization techniques.

Course Outcomes

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

CO1- Interpret the optimization techniques and classification. **(K2)**
CO2- Familiarize with learn the different types of linear programming. **(K2)**
CO3- Understand the concept of non-linear programming. **(K3)**
CO4- Analyze the various geometric, integer and dynamic programming methods. **(K4)**
CO5- Apply the optimization algorithms for various applications. **(K3)**

UNIT I INTRODUCTION TO OPTIMIZATION **(09 Hrs)**

Engineering Applications - Classification of optimization problems - Classical optimization techniques - Single and multivariable optimization with and without constraints - Lagrange model - Kuhn - tucker conditions.

UNIT II LINEAR PROGRAMMING **(09 Hrs)**

Standard form of LPP - definitions and Theorem - Solution of Linear simultaneous equations - Pivoted reduction - Simplex algorithm - Revised simplex methods - Gauss Jordan Elimination process - Duality in linear programming-Decomposition principle – Transportation problem - Northwest corner rule - Least cost method.

UNIT III NON LINEAR PROGRAMMING **(09 Hrs)**

Nonlinear programming - one dimensional minimization methods - unrestricted search Exhaustive search - Interpolation and Quadratic interpolation method - Cubic method-unconstrained optimization techniques -Direct search methods - simplex method – Descent methods - Gradient function – Steepest Descent method - Constrained optimization techniques - Transformation techniques - sequential unconstrained minimization techniques Interior and exterior penalty function method.

UNIT IV INTEGER AND DYNAMIC PROGRAMMING **(09 Hrs)**

Geometric programming - Polynomial – Unconstrained and Constrained minimization problem – Primal and Dual programmes – Integer linear programming Mixed integer programming – Sequential linear discrete programming-Dynamic programming: Multistage decision processes – Concept of sub-optimization – Principle of optimality – Continuous dynamic programming- Stochastic Programming, Separable programming.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Determination of Optimal Switching angle for Active Filter design using optimization techniques - Application of Dynamic programming in Unit commitment problem.

Text Books

1. Rao, S.S., "Optimization Theory and Applications", Wiley Eastern Ltd., 2nd Edition,2009.
2. Donald A. Pierre.,"Optimization Theory with Applications", Courier Corporation, 2nd Edition, 2012.
3. Stephen G Nash and ArielaSofer, "Linear and Nonlinear Programming", McGraw Hill College Div., 1st Edition , 2009.

Reference Books

1. David G. Luenberger, Yinyu Ye.,"Linear and Nonlinear Programming",Springer Science & Business Media, 2nd Edition, 2008.
2. Rao, S.S., "Engineering Optimization Theory and Practice", New Age International, 1st Edition, 2009.

3. Hamdy A. Taha., "Integer Programming: Theory, Applications, and Computations", Academic Press, 2nd Edition,2014.

Web References

1. https://nptel.ac.in/courses/111/105/111105039/
2. https://www.kdd.org/kdd2016/topics/view/optimization-techniques
3. https://nptel.ac.in/content/storage2/courses/105108127/pdf/Module_1/M1L1slides.pdf
4. https://mech.iitm.ac.in/nspch52.pdf
5. https://onlinelibrary.wiley.com/doi/abs/10.1002/9780470686652.eae495

COs/POs/PSOs Mapping

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1	3	-	2	2	2	-	3	2	3
2	3	-	2	2	2	-	3	2	3
3	3	-	2	2	2	-	3	2	3
4	3	-	2	2	2	-	3	2	3
5	3	-	2	2	2	-	3	2	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PEE102	PWM TECHNIQUES FOR CONVERTERS	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To understand PWM techniques and its characteristics for converter circuits
- To provide the SPACE VECTOR BASED PWM control techniques.
- To be familiar with the calculation of torque and current ripple in converters employing PWM techniques.
- To get knowledge on converter losses due to switching, conduction and dead-time.
- To make the students in implementation of converter circuits.

Course Outcomes

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

CO1 - Explain the basic concepts of PWM control techniques. **(K2)**
CO2 - Analysis the SVPWM techniques for inverters. **(K4)**
CO3 - Analyze the torque and current ripple in converters employing PWM techniques. **(K4)**
CO4 - Determine the losses due to switching, conduction and dead-time for different converter circuits. **(K3)**
CO5 - Design and analyze the different control techniques for converter configurations using simulation. **(K3)**

UNIT I INTRODUCTION TO PULSE WIDTH MODULATION (PWM) **(09 Hrs)**

Review of Fourier series, Harmonic voltages and their undesirable effects - Pulse width modulation at low switching frequency - Low switching frequency operation of a VSI - square wave operation, one switching angle per quarter- Two switching angles per quarter - Selective harmonic elimination and THD optimized PWM.

UNIT II SPACE VECTOR BASED PWM **(09 Hrs)**

SPWM- modified SPWM and phase displacement techniques- Third harmonic injection PWM (THIPWM)- Bus-clamping PWM - Space vector PWM: Concept of space vector- Conventional space vector PWM and bus-clamping PWM- Advanced bus-clamping PWM.

UNIT III PERFORMANCE ANALYSIS OF INVERTER **(09 Hrs)**

Transformation from stationary reference frame to synchronously revolving dq reference frame- Volt-second balance and instantaneous error voltage-Calculation of RMS line current ripple - Space vector hybrid PWM for reduced line current ripple - Average and RMS values of dc link current - Analysis of torque ripple: Calculation of harmonic torques and RMS torque ripple- Hybrid PWM techniques to reduce ripple torque.

UNIT IV LOSS CALCULATIONS AND OVER MODULATION **(09 Hrs)**

Calculation of switching and conduction losses- compensation for dead time and DC voltage regulation- Effect of inverter dead-time with continuous and discontinuous modulation - Per-phase approach to over modulation, Space vector approach to over modulation - A perspective from the synchronously revolving d-q reference frame - low-frequency harmonic distortion.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Comparative analysis of various PWM and SVPWM techniques for converter circuits - Calculation of switching and conduction losses for converter circuits.

Text Books

1. Mohammed H.Rashid, "Power Electronics – Circuits, Devices and Applications", Eastern Economy Edition, 3rd Edition, 2004.
2. Bimal K Bose, "Modern Power Electronics and AC Drives", Pearson Education Asia, 2003.
3. Iss Batarseh, "Power Electronic Circuits", John Wiley &Sons Inc, 2004.

Reference Books

1. Mohan, Undeland and Robbins, "Power Electronics: Converter, Applications and Design", Wiley India, 2011 Edition, ISBN-13: 9781848003170.
2. Erickson R W, "Fundamentals of Power Electronics", Chapman Hall, 1997 Edition, ISBN 0-412-08541-0.
3. JosephVithyahil, "Power electronics-Principles and Applications", TMH, 2011 Edition, ISBN

9780070702394.

Web References

1. https://nptel.ac.in/courses/108/108/108108035/
2. https://nptel.ac.in/courses/108/102/108102145/
3. https://www.digimat.in/nptel/courses/video/108108035/L01.html
4. https://nptel.ac.in/content/storage2/courses/108105066/PDF/L-38(DP)(PE)%20((EE)NPTEL).pdf
5. https://www.youtube.com/watch?v=_gJPYgQQ01c&list=PLbMVogVj5nJQoZqyLxx-cg_dYE-Dt2UMH

COs/POs/PSOs Mapping

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2	3	-	3	3	2	-	3	3	3
3	3	-	3	3	2	-	3	3	3
4	3	-	3	3	2	-	3	3	3
5	3	-	3	3	2	-	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PEE103	SPECIAL ELECTRICAL MACHINES	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To review the fundamental concepts of permanent magnets and the operation of permanent magnet brushless DC motors.
- To introduce the concepts of permanent magnet brushless synchronous motors and synchronous reluctance motors.
- To develop the control methods and operating principles of switched reluctance motors.
- To introduce the concepts of stepper motors and its applications.
- To Know about the applications and case study of special machines.

Course Outcomes

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

CO1- Design and control the Brushless DC motors. **(K3)**
CO2- Construct the controller of Permanent magnet synchronous machines. **(K3)**
CO3- Analyze the control aspects of switched reluctance motors. **(K4)**
CO4- Analyze the principle of operation and power converter for stepper motor. **(K4)**
CO5- Model and simulate PMSM and SSRM machines. **(K3)**

UNIT I PERMANENT MAGNET BRUSHLESS DC MOTORS **(09 Hrs)**

Fundamentals of Permanent Magnets- Types- Principle of operation- Magnetic circuit analysis- EMF and Torque equations- Characteristics and control.

UNIT II PERMANENT MAGNET SYNCHROUNOUS MOTORS **(09 Hrs)**

Principle of operation – EMF and Torque equations - Phasor diagram - Power controllers – Torque speed characteristics–Digital controllers – Constructional features, operating principle and characteristics of synchronous reluctance motor.

UNIT III SWITCHED RELUCTANCE MOTORS **(09 Hrs)**

Constructional features –Principle of operation- Torque prediction–Characteristics- Power controllers – Control of SRM drive - Sensor less operation of SRM – Applications.

UNIT IV STEPPER MOTORS AND OTHER SPECIAL MACHINES **(09 Hrs)**

Constructional features – Principle of operation –Types – Torque predictions – Linear and Non-linear analysis – Characteristics – Drive circuits – Closed loop control – Principle of operation and characteristics of Hysteresis motor – AC series motors – Linear induction motor- Servo motors – Applications.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Modelling and Simulation of PMSM and SRM Machines- Performance analysis – Case study on applications of other special machines.

Text books

1. Ramu Krishnan, "Permanent Magnet Synchronous and Brushless DC Motor Drives", 2nd Edition CRC press, 2017.
2. Jacek F. Gieras, Rong-Jie Wang, Maarten J. Kamper, "Axial Flux Permanent Magnet Brushless Machines", 2nd Edition, Springer, 2008.
3. Ramu Krishnan, "Switched Reluctance Motor Drives: Modeling, Simulation, Analysis, Design and Applications" , CRC press,2nd Edition, 2017.
4. Paul Acarnley, "Stepping Motors: A Guide to Theory and Practice", Institution of Engineering and Technology, United Kingdom, 4th Edition, 2007.
5. T.Kenjo, "Stepping motors and their microprocessor controls", Oxford University press, New Delhi, 2nd Edition, 2000.

References Books

1. R.Krishnan, "Electric Motor Drives: Modelling Analysis and Control", Prentice-Hall of India Pvt. Limited, 2nd Edition , 2008
2. D.P.Kothari and I.J.Nagrath, "Electric machines",Tata Mc Graw hill publishing company, New Delhi,3rd Edition,2004.

3. Irving L.Kosow, "Electric Machinery and Transformers" Pearson Education, 2nd Edition,2007.

Web References

1. https://nptel.ac.in/courses/108/102/108102156/
2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-685-electric-machines-fall-2013/
3. https://www.ktuassist.in/2020/03/ktu-ee402-special-electrical-machines.html
4. https://vidwan.inflibnet.ac.in/profile/103958
5. https://shodhganga.inflibnet.ac.in/bitstream/10603/141569/9/09_chapter%201.pdf

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	2	2	2	-	3	2	3
2	3	-	2	2	2	-	3	2	3
3	3	-	2	2	2	-	3	2	3
4	3	-	2	2	2	-	3	2	3
5	3	-	2	2	2	-	3	2	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PEE104	ELECTROMAGNETIC FIELD COMPUTATION AND MODELLING	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To refresh the fundamentals of Electromagnetic Field Theory.
- To provide foundation in formulation and computation of Electromagnetic Fields using analytical and numerical methods.
- To impart in-depth knowledge on Finite Element Method in solving Electromagnetic field problems.
- To introduce the concept of mathematical modeling and design of electrical apparatus.
- To familiarize concepts in design of rotating machines.

Course Outcomes

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

CO1- Formulate and compute Electromagnetic Fields from Maxwell's equations, FEM problems from the fundamental concepts. **(K3)**

CO2- Compute the respective field using FEM, check and optimize the design of electrical power equipment. **(K3)**

CO3- Understand the concepts of electromagnetic computations. **(K2)**

CO4- Formulate the FEM method and use of the package. **(K3)**

CO5- Apply the concepts in the design of rotating machines. **(K3)**

UNIT I INTRODUCTION **(09 Hrs)**

Review of basic field theory – electric and magnetic fields – Maxwell's equations – Laplace, Poisson and Helmoltz equations – principle of energy conversion – force/torque calculation – Electro thermal formulation.

UNIT II SOLUTION OF FIELD EQUATIONS- I **(09 Hrs)**

Limitations of the conventional design procedure need for the field analysis based design, problem definition, and solution by analytical methods-direct integration method – variable separable method – method of images, solution by numerical methods- Finite Difference Method.

UNIT III SOLUTION OF FIELD EQUATIONS- II **(09 Hrs)**

Finite element method (FEM) – Differential/ integral functions – Variational method – Energy minimization – Discretisation – Shape functions –Stiffness matrix –1D and 2D planar and axial symmetry problem.

UNIT IV FIELD COMPUTATION **(09 Hrs)**

Computation of electric and magnetic field intensities– Capacitance and Inductance – Force, Torque, Skin effect – Resistance- Energy for basic configurations.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Case study: Insulators - Bushings – Cylindrical magnetic actuators – Transformers – Rotating machines. Electric and Magnetic field intensity comparison for Iron core with composite materials.

Text Books

1. Stephan Russenschuck, "Field Computation for Accelerator Magnets: Analytical and Numerical Methods for Electromagnetic Design and Optimisation", Wiley Publications, 2nd Edition, 2011.
2. Andrzej Krawczyk, S. Wiak," Electromagnetic Fields in Electrical Engineering", IOS Press, 2002.
3. J. Sykulski," Computational Magnetics, Springer , 1st Edition, 1995.
4. Nicola Biyanchi, "Electrical Machine analysis using Finite Elements", Taylor and Francis Group, CRC Publishers, 2005.
5. Binns.K.J, Lawrenson.P.J, Trowbridge.C.W, "The analytical and numerical solution of Electric and magnetic fields", John Wiley & Sons, 1993.

Reference Books

1. Nathan Ida, Joao P.A.Bastos , "Electromagnetics and calculation of fields", Springer- Verlage, 2nd Edition, 2013.
2. Singiresu S. Rao, The Finite Element Method in Engineering,Elsevier, 5th Edition, 2011.
3. Daryl L. Logan," First Course in the Finite Element Method, Cencage Learning, 4th Edition, 2007.
4. D.A.Lowther and P.P Silvester, "Computer Aided Design in Magnetics", Springer verlag- New York, 1986.

Web References

1. https://nptel.ac.in/courses/115/101/115101007/
2. https://www.youtube.com/watch?v=7YbLDlbv17w
3. https://www.slideshare.net/ASHOKKUMAR27088700/me6603-finite-element-analysis-unit-ii-notes-and-question-bank
4. https://nptel.ac.in/content/storage2/courses/112104030/pdf/lecture1.pdf
5. https://nptel.ac.in/courses/112/104/112104193/

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
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2	3	-	2	2	2	-	3	2	3
3	3	-	2	2	2	-	3	2	3
4	3	-	2	2	2	-	3	2	3
5	3	-	2	2	2	-	3	2	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PEE105	ADVANCED POWER SEMICONDUCTOR DEVICES	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To impart knowledge on power switching devices and its switching characteristics.
- To identify the performance of the static and dynamic characteristics of current controlled power semiconductor devices.
- To investigate the static and dynamic characteristics of voltage controlled power semiconductor devices.
- To identify the control and firing circuit for different devices and gain the knowledge on thermal protection of power semiconductor devices.
- To develop the design and simulation model of power electronic switches and electrical machines.

Course Outcomes

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

CO1- Analyze the semiconductor device and its characteristics and losses. **(K4)**
CO2- Determine the suitable current controlled device and its switching characteristics. **(K3)**
CO3- Design and analyze a voltage controlled devices for the required application. **(K3)**
CO4- Design of protection and control circuits for power semiconductor devices. **(K3)**
CO5- Develop capability to design and simulate power semiconductor devices using Software package. **(K3)**

UNIT I INTRODUCTION **(09 Hrs)**

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

UNIT II CURRENT CONTROLLED DEVICES **(09 Hrs)**

BJTs - Construction, static characteristics, switching characteristics- Negative temperature coefficient and secondary breakdown - Power Darlington - Thyristors - Physical and electrical principle underlying operating mode - Two transistor analogy - Effect of α and ico on ia - concept of latching - Gate and switching characteristics - Converter grade and inverter grade and other types; series and parallel operation- Comparison of BJT and Thyristor- Steady state and dynamic models of BJT and Thyristor.

UNIT III VOLTAGE CONTROLLED DEVICES **(09 Hrs)**

Power MOSFETs and IGBTs - Principle of voltage controlled devices, construction, types, static and switching characteristics - Steady state and dynamic models of MOSFET and IGBTs; GTO, MCT, FCT, RCT, IGCT , COOL MOS, SIT, SITH, Power Modules, Intelligent Power Modules (IPM), silicon carbide, gallium nitride and GaAs devices.

UNIT IV FIRING AND PROTECTING CIRCUITS **(09 Hrs)**

Necessity of isolation - pulse transformer - opto-coupler; Gate drive circuit for SCR, MOSFET, IGBTs and base driving for power BJT - overvoltage, over current and gate protections- Snubber Requirements -Design of snubbers.-Thermal protection :Heat transfer - conduction, convection and radiation - Cooling - liquid cooling, vapour - phase cooling; Guidance for heat sink selection - Thermal resistance and impedance - Electrical analogy of thermal components, heat sink types and design - Mounting types.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Case study – Calculation of Power Loss, Switching Loss, Conduction Loss and analysis of electromagnetic interference in power converters.

Text Books

1. Fang Lin Luo, Hong Ye," Power Electronics: Advanced Conversion Technologies", CRC press, 2010.
2. Jayanth Baliga, "Fundamentals of Power Semiconductor Devices", Springer Science and Business Media, 1st Edition,2008.
3. Muhammad H. Rashid, "SPICE for Power Electronics and Electric Power", CRC press, 2nd Edition, 2006.
4. V. R. Moorthi, "Power Electronics: Devices, Circuits and Industrial Applications, Oxford University Press, 1st Edition, 2005.

Reference Books

1. M.D. Singh and K.B.Khanchandani, "Power Electronics", Tata McGraw Hill, 2nd Edition, 2008.
2. Mohan, Undeland and Robins, "Power Electronics - Concepts, applications and design", John Wiley and sons, Singapore, 2000.
3. K Sundareswaran, "Elementary Concepts of Power Electronic Drive", CRC press, 1st Edition, 2019.

Web References

1. https://nptel.ac.in/courses/108/107/108107128/
2. https://www.allaboutcircuits.com/technical-articles/a-review-on-power-semiconductor-devices/
3. https://digital-library.theiet.org/content/books/10.1049/pbpo057e_cha3
4. http://www.egr.unlv.edu/~eebag/EE-442-642-Power%20switching%20devices%20fall14.pdf
5. https://cusp.umn.edu/advance-power-electronics-ii-videos

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	2	2	2	-	3	2	3
2	3	-	2	2	2	-	3	2	3
3	3	-	2	2	2	-	3	2	3
4	3	-	2	2	2	-	3	2	3
5	3	-	2	2	2	-	3	2	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PEE206	ELECTRICAL SAFETY	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To understand the concept of first aid and International standards on electrical safety.
- To enable the students to understand about electrical hazards.
- To expose the ideas of overload and short circuit protection.
- To provide adequate knowledge about operation and maintenance of protection system.
- To apply the obtained knowledge of safety in domestic, commercial and Industrial buildings.

Course Outcomes

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

CO1 - List the norms to follow on IE rules and its significance. **(K2)**
CO2 - Avoid the shock by handling the equipments properly. **(K2)**
CO3 - Carry out electrical safety methods during installation, testing, commissioning, operation and maintenance. **(K3)**
CO4 - Describe the various hazardous area and application of electrical safety in various places. **(K3)**
CO5 - Propose the safety measures to be carried out in Domestic, Commercial and Industrial buildings. **(K3)**

UNIT I CONCEPTS AND STATUTORY REQUIREMENTS **(09 Hrs)**

Objective and scope of electrical safety – National electrical Safety code – Indian electricity acts and rules – The Electricity Act 2003 – Statutory requirements – International standards on electrical safety safe limits of current, voltage – Earthing of system neutral – Rules regarding first aid and firefighting facility – Electrical safety laws.

UNIT II ELECTRICAL SHOCKS AND PREVENTIVE MEASURES **(09 Hrs)**

Primary and secondary electrical shocks-Possibilities of getting electrical shocks and severity - medical analysis of electric shocks and effects - shocks due to flash/ Spark over's-Prevention of shocks - Safety precautions against contact shocks - Flash shocks – Burns -Residential buildings and shops - Do's and Don'ts for safety in the use of domestic electrical appliances

UNIT III INSTALLATIONS AND COMMISSIONING **(09 Hrs)**

Need for inspection and maintenance - Preliminary preparations – Safety documentation –Field quality and safety - Personal protective equipment – Safe guards for operators – Techniques of explosion protection - Safety aspects, Risks during installation of electrical plant, equipment's and rotating machines - Drying out and insulation resistance measurement - Temporary installations. Agricultural pump installation

UNIT IV HAZARDOUS ZONES AND SAFETY MANAGEMENT **(09 Hrs)**

Hazardous– classification of Hazardous Zones and electrical equipment's (IS, NFPA, API and OSHA standards) -Explosive gas area classifications: Class I (Division 1) - Zone 0, Zone 1 , Zone 2 locations, Design Philosophy for Equipment and installations - equipment's enclosure for various hazardous gases and vapours - Equipment certifying agencies - Electrical safety risks at construction site, lab and office. Principles of Safety Management - safety policy - Safety organization- Safety auditing- Motivation to managers, supervisors, employees.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Case study - installations and commissioning procedure for the domestic, commercial and industrial buildings - Agricultural pump installation

Text Books

1. Fordham Cooper. W., "Electrical Safety Engineering", Newnes,1st Edition, 2002.
2. John Cadick, Mary Capelli-Schellpfeffer, Dennis Neitzel, Al Winfield, "Electrical Safety Handbook", McGraw-Hill Education, 4th Edition, 2018.
3. Madden, John M, "Electrical Safety and the Law: A Guide to Compliance", Wiley publications, 4th Edition, 2002.
4. Mohamed A. El-Sharkawi , "Electric Safety: Practice and Standards", CRC Press, 1st Edition, 2013.

5. Dennis Neitzel and Al Winfield, "Electrical Safety Handbook", McGraw - Hill Education, 4th Edition, 2012.

Reference Books

1. S. Rao, R. K. Jain, H.L. Saluja, "Electrical Safety, Fire Safety Engineering and Safety Management", Khanna Publishers, New Delhi, 2nd Edition, 1997.
2. Martha J. Boss, Gayle Nicoll, "Electrical Safety: Systems, Sustainability and Stewardship", CRC Press, 1st Edition, 2014.
3. Indian Electricity Act and Rules, Government of India.
4. Power Engineers – Handbook of TNEB, Chennai, 1989.
5. Rob Zachariason, "Electrical Safety", Delmar Cengage Learning, 1st Edition, 2011.
6. Peter E. Sutherland, "Principles of Electrical Safety", Wiley-IEEE Press, 1st Edition, 2014.

Web References

1. https://www.apeasternpower.com/downloads/elecact2003.pdf
2. https://safetyculture.com/topics/electrical-hazards/
3. https://www.jove.com/science-education/10114/electrical-safety-precautions-and-basic-equipment
4. https://electrical-engineering-portal.com/21-safety-rules-for-working-with-electrical-equipment
5. https://www.electrical4u.com/safety-precautions-for-electrical-system/
6. https://www.constellation.com/energy-101/electrical-safety-tips.html

COs/POs/PSOs Mapping

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	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	2	2	-	2	2	2	2
2	3	-	2	2	-	2	2	2	2
3	3	-	2	2	-	2	2	2	2
4	3	-	2	2	-	2	2	2	2
5	3	-	2	2	-	2	2	2	2

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PEE207	INTELLIGENT CONTROLLERS	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To get expertise about the design of ANN and fuzzy set theory.
- To familiarize with the analysis and implementation of ANN and Fuzzy logic for modeling and control of Non-linear system
- To get familiarize with the Matlab toolbox.
- To impart the knowledge of various optimization techniques and hybrid schemes with the ANFIS tool box.
- To apply the soft computing techniques for various real time applications.

Course Outcomes

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

CO1- Understand the basic architectures of NN and Fuzzy sets.
CO2- Design and implement ANN architectures, algorithms and know their limitations.
CO3- Identify and work with different operations on the fuzzy sets.
CO4- Develop ANN and fuzzy logic based models and control schemes for non-linear systems.
CO5- Explore hybrid control schemes and apply intelligent control for real time applications.

UNIT I OVERVIEW OF ARTIFICIAL NEURAL NETWORK (ANN) AND FUZZY LOGIC (09 Hrs)

Review of fundamentals - Biological neuron, Artificial neuron, Activation function, Single Layer Perceptron – Limitations – Multi Layer Perceptron – Back propagation algorithm (BPA); Fuzzy set theory – Fuzzy sets – Operation on Fuzzy sets - Scalar cardinality, fuzzy cardinality, union and intersection, complement (yager and sugeno), equilibrium points, aggregation, projection, composition, fuzzy relation – Fuzzy membership functions.

UNIT II NEURAL NETWORKS FOR MODELLING AND CONTROL (09 Hrs)

Generation of training data - optimal architecture – Model validation- Control of non linear system using ANN- Direct and Indirect neuro control schemes- Adaptive neuro controller–Case study - Familiarization of Neural Network Control Tool Box.

UNIT III FUZZY LOGIC FOR MODELLING AND CONTROL (09 Hrs)

Modeling of nonlinear systems using fuzzy models (Mamdani and Sugeno) –TSK model – Fuzzy Logic controller – Fuzzification – Knowledge base – Decision making logic – Defuzzification-Adaptive fuzz y systems-Case study-Familiarization of Fuzzy Logic Tool Box- Fuzzification and rule base using ANN–Neuro fuzzy systems- ANFIS- Case study–Familiarization of ANFIS Tool Box.

UNIT IV GENETIC ALGORITHM (09 Hrs)

Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm. Concept on some other search techniques like Tabu search,Ant-colony search and Particle Swarm Optimization-Optimization of membership function and rule base using Genetic Algorithm and Particle Swarm Optimization

UNIT V INSTRUCTIONAL ACTIVITY (09 Hrs)

Neuro fuzzy controller design for DC/AC motor-Minimization of Harmonics using optimization techniques.

Text Books

1. Lawrence Fausatt, "Fundamentals of neural networks", Prentice Hall of India, New Delhi, 1994.
2. Timothy J.Ross, "Fuzzy Logic with Engineering Applications", Wiley, 3rd Edition,2010.
3. Astrom .K, "Adaptive Control", Pearson Education Asia Pvt. Ltd, 2nd Edition,2002.
4. David E.Goldberg, "Genetic Algorithms in Search, Optimization, and Machine Learning", Pearson Education, 2009.

Reference Books

1. Jacek.M.Zurada, "Introduction to Artificial Neural Systems", Jaico Publishing House, 1999.
2. Yung C. Shin and Chengying Xu, "Intelligent System - Modeling, Optimization and Control", CRC Press, 2009.
3. Driankov, Hellendroon, "Introduction to Fuzzy Control", Springer-Verlag Berlin, 2nd Edition,1996

4. S.N.Sivanandam, S.Sumathi and S.N.Deepa, "Introduction to Neural Networks using MATLAB 6.0", Mc Graw Hill Publishing companies Limited, 3rd Edition, 2008.
5. S.Rajasekaran, G.A.Vijayalakashmi Pai, "Neural Networks, Fuzzy Logic & Genetic Algorithms: Synthesis & Applications", PHI, 3rd Edition, 2007.

Web References

1. https://nptel.ac.in/courses/117/105/117105084/
2. https://nptel.ac.in/courses/108/104/108104157/
3. https://nptel.ac.in/courses/112/105/112105235/
4. shodhganga.inflibnet.ac.in/bitstream/10603/10161/.../11_chapter%203.pdf
5. https://www.ncbi.nlm.nih.gov/pubmed/23529114

COs/POs/PSOs Mapping

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1	3	-	2	2	2	-	2	2	2
2	3	-	2	2	2	-	2	2	2
3	3	-	2	2	2	-	2	2	2
4	3	-	2	2	2	-	2	2	2
5	3	-	2	2	2	-	2	2	2

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PEE208	SMART GRID TECHNOLOGIES	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To understand various aspects of smart grid.
- To study various Integration of Renewable energy sources technologies.
- To expose the ideas about Advanced Metering Infrastructure.
- To know the concept of smart sensors and communication & cyber security networks.
- To acquire knowledge about overview of smart grid.

Course Outcomes

After completion of the course, the students are able to

CO1- Understand smart grid architecture for smart grid. **(K2)**
CO2- Study the concepts of Micro grid, need & applications of Micro grid. **(K2)**
CO3- Know about smart metering and distribution management system for smart grid. **(K2)**
CO4- Familiarize about smart sensors and communication systems. **(K2)**
CO5- Understand the entire activities of smart grid. **(K2)**

UNIT I SMART GRID ARCHITECTURE AND COMPONENTS **(09 Hrs)**

Introduction to Smart Grid- Evolution of Electric Grid-Concept of Smart Grid- Need of Smart Grid- Concept of Robust and Self-Healing Grid- Present development and International policies in Smart Grid- Smart Grid Architecture Models- Components of Smart Grid: Smart Generation systems-Smart Transmission Grid : Geographic Information System (GIS)-Intelligent Electronic Devices (IED) and their application for Monitoring and Protection-Wide Area Monitoring Protection and Control (WAMPAC)- Phasor Measurement Unit (PMU).

UNIT II MICROGRIDS AND DISTRIBUTED ENERGY RESOURCES **(09 Hrs)**

Micro grid: Concept of Micro grid, Need and Applications of Micro grid. Micro grid Architecture-Issues of interconnection- Protection and Control of Micro-grid- Distributed Energy Resources: Plastic and Organic Solar cells- Thin Film Solar cells- Variable Speed Wind Generators- Fuel cells-Micro turbines- Captive Power plants-Integration of Renewable energy sources- Power Quality issues of Grid connected Renewable Energy Sources- Power Quality Conditioners for Smart Grid.

UNIT III SMART METERING AND DISTRIBUTION MANAGEMENT SYSTEM **(09 Hrs)**

Smart Distribution Systems: Smart Meters, Automatic Meter Reading (AMR)-Advanced Metering Infrastructure (AMI)-Real Time Pricing, Smart Appliances- Smart Substations: Substation Automation, Feeder Automation-Outage Management System (OMS) - Introduction to Internet of things (IOT)- Demand-side integration- Outage Management System - Applications of IOT in Smart Grid- Smart net metering models for smart grid in India.

UNIT IV SMART SENSORS AND COMMUNICATION NETWORKS **(09 Hrs)**

Home and Building Automation- Plug in Hybrid Electric Vehicles (PHEV)- Algorithms for Vehicle to Grid and Grid to Vehicle Management-Smart Charging Stations- Energy Storage for Smart Grids: Battery Energy Storage Systems (BESS)- Communication Architecture for Smart Grids-Home Area Network (HAN): IEEE 802.11, IEEE 802.15.4, 6LoWPAN, Neighborhood Area Network (NAN)/Field Area Network (FAN): Radio over Power-Lines (BPL/PLC), IEEE P1901, Wide Area Network (WAN): Optical Fiber Communication-Cellular Networks, Wi-Max and Wireless Sensor Networks.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Case study - Smart grid technology implementation around the world - Smart metering infrastructure for smart grid in India - Design of Cost Effective Wide Area Measurement Systems for Smart Power Network-Review on vehicle to grid and renewable sources integration – Challenges in the smart grid applications.

Text Books

1. Janaka Ekanayake, Kith siri Liyanage, Jianzhong Wu, Akihiko Yokoyama, Nick Jenkins, "Smart Grid Technology and Applications" John Wiley &Sons Publication, 2015.
2. Stuart Borlase "Smart Grids: Infra structure, Technology and Solutions" CRC Press Publication, 1st Edition, 2013.
3. James A. Momoh, "Smart Grid: Fundamentals of Design and Analysis" Wiley-IEEE Press; 1st Edition,2015.

Reference Books

1. Ali Keyhani, "Design of Smart Power Grid Renewable Energy Systems", Wiley,3rd Edition 2019.
2. Fereidoon. P. sioshansi "Smart grid – integrating renewable, distributed and efficient energy", Academic Press, 1st Edition, 2011.
3. Tony Flick, Justin Morehouse, "Securing the Smart Grid: Next Generation Power Grid Security", Academic Press, Boston, 2011.
4. "Smart Grid Primer", Published by Power Grid Corporation of India Limited, September 2013.
5. James Momoh, "Smart Grid: Fundamentals of design and analysis", John Wiley & sons Inc, 2012.
6. Krzysztof Iniewski, "Smart Grid Infrastructure & Networking", Tata McGraw Hill, 1st Edition, 2012.
7. Stuart Borlase,"Smart Grids: Infrastructure, Technology, and Solutions", CRC press, 2013.
8. SawanSen,SamarjitSengupta, AbhijitChakrabarti, "Electricity pricing- regulated, deregulated and smart grid systems", CRC press, 2015.
9. Mini S.Thomas and John Douglas McDonald, "Power system SCADA and smart grids", CRC press, 2015.

Web References

1. https://ieeexplore.ieee.org/document/5620576doi:10.1109/iccasm.2010.5620576
2. https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ee42/
3. bbcr.uwaterloo.ca/~xshen/journal_ieee_magazine_papers.htm
4. www.mdpi.com › htm
5. https://www.researchgate.net/.../312450409_Experimental_investigation_of_ a_new_smart_Grid

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5	3	-	2	2	2	-	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PEE209	ELECTRIC TRACTION	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To understand Traction systems and its mechanics.
- To identify the power supply equipment suited for traction systems.
- To analyze various types of motors used in traction and differentiate AC and DC traction drives.
- To familiarize about various systems of track electrification and power supply system.
- To understand the working of modern electrical traction system utilized in our country.

Course Outcomes

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

CO1 - Recall the history behind the traction system and the basics of Electric Traction System. **(K2)**
CO2 - Outline different Traction Drives and controlling techniques. **(K2)**
CO3 - Differentiate the best suited protection system for Electric Locomotive. **(K2)**
CO4 - Design the Electric Traction Sub-Systems and Signalling system. **(K3)**
CO5 - Apply the new concepts on driving the locomotives with lowering fuel cost. **(K3)**

UNIT I INTRODUCTION OF ELECTRIC TRACTION **(09 Hrs)**

The Indian Scenario of Electric traction, Advantages of Electric Traction over other systems of traction, selection of traction system - Diesel-Electric or Electric. Mechanics of train movement- Speed - time curve for train movement- Requirement of tractive effort and T-N curve of a typical train load, Specific energy consumption and Coefficient of adhesion- Suspension and mechanism of torque transmission Concept of Weight Transfer & Effect of un-sprung mass and wheel diameter.

UNIT II TRACTION MOTOR DRIVES, PRINCIPLES AND GEAR **(09 Hrs)**

Type of traction motor- Available motor characteristics- Optimization of design and construction features- Tractive Effort and Drive Ratings- Important Features of Traction Drives- conventional DC and AC Traction drives-Semiconductor Converter Controlled Drives- DC Traction using Chopper Controlled Drives- Poly phase AC motors for Traction Motors- DC /AC Traction employing Poly-phase motors, Traction control of DC locomotives and EMU's- Traction control system of AC locomotives- Control gear.

UNIT III PROTECTION OF LOCOMOTIVE EQUIPMENT AND CIRCUITS **(09 Hrs)**

Broad strategy for protection, Surge protection, Overload protection of main power circuits, Earth fault protection of power of auxiliary circuits- Protection from over-voltage and under-voltage, Differential protection of traction circuits- Protection against high and low air pressure in the compressed air circuit- Temperature monitoring, Protection of transformer by Bucholz relay- Protection against accidental contact with HT equipment Protection against fires.

UNIT IV ELECTRIC TRACTION SUB-SYSTEMS (OVERHEAD EQUIPMENT) AND RAILWAY SIGNALLING **(09 Hrs)**

Overhead Equipment (OHE), Sectionalizing, Bonding of Rails and Masts, Materials Employed in OHE Electric Traction Sub-Systems (Power Supply Installations): Lay out design of 137/25 KV Traction Substation/ Protection, Booster Transformers and Return Conductor- Salient 2x25 KV AC System/ SCADA. Railway signalling: Block Section Concept-Track Circuits, Interlocking Principle- Train speed and signaling- Solid state Interlocking- Automatic Warning Systems.

UNIT- V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Case studies on local traction industry. Case studies on AC-AC traction. Case studies on application of traction drives as servo mechanisms. Case studies on complete layout of Delhi metro, Chennai metro, Monorail networks and magnetic Levitation Vehicle.

Text Books

1. Upadhayay J, Mahindra S.N, "Electric Traction", Allied Publishers Ltd., 1st Edition, 2000.
2. Andreas Steimel, "Electric Traction-Motive Power and Energy Supply, Deutscher Industrieverlag publishers, 2nd Edition, 2014.
3. A.T. D over, "Electric Traction", Pitman Publishing, 4th Edition, 1965.

Reference Books

1. P.S. Rao, "Principle of 25 KV Overhead Equipments", Printpack Pvt. Ltd., 1st Edition.
2. Gopal K Dubey, "Fundamentals of Electric Drives", Narosa Publishing, 2nd Edition, 2010.
3. H. Partab, "Modern Electric Traction", Dhanpat Rai & Sons, 2017.
4. C. L. Wadhwa, "Generation, Distribution and Utilization of Electrical Energy", New Age International, 3rd Edition, 2015.
5. J.B. Gupta, "Utilization of Electrical Power and Electric Traction", S. K. Kataria & Sons publications, 10th Edition, 2019.
6. R. B. Brooks, "Electric Traction Hand Book", Sir Isaac Pitman and sons Ltd, London, 1st Edition, 1954.

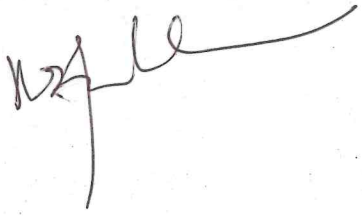
Web References

1. https://epd.wisc.edu/courses/fundamentals-of-traction-power-systems-and-overhead-contact-systems/
2. http://www.railsystem.net/electric-traction-systems/
3. http://hellowbookeas.cf/0271002417-electric-traction-on-the-pennsylvania-railroad-1895-1968.htm
4. http://www.vssut.ac.in/lecture_notes/lecture1424084684.pdf
5. https://Electric-Traction-Upadhyay-S-N-Mahendra/dp/8177640054

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	2	2	2	-	3	2	3
2	3	-	2	2	2	-	3	2	3
3	3	-	2	2	2	-	3	2	3
4	3	-	2	2	2	-	3	2	3
5	3	-	2	2	2	-	3	2	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High



P20PEE210	HIGH VOLTAGE DIRECT CURRENT TRANSMISSION	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To provide in depth understanding about various HVDC transmission systems, reactive power control and protection of HVDC system.
- To understand about the importance of HVDC transmission and analysis of HVDC converters.
- To impart knowledge on operation, modelling and control of HVDC link and Converter control. characteristics.
- To learn about the Multiterminal DC systems.
- To expose various filters used in HVDC.

Course Outcomes

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

CO1 - Illustrate different faults in HVDC systems and the recent trends in HVDC transmission. **(K2)**
CO2 - Analyse different modes of operation for six pulse and twelve pulse converter unit in HVDC system. **(K3)**
CO3 - Describe about MTDC system and its operation under different physical conditions. **(K2)**
CO4 - Examine operational effects of multi terminal DC system. **(K2)**
CO5 - Define HVDC transmission based on Voltage Source Converter (VSC). **(K2)**

UNIT I DC POWER TRANSMISSION TECHNOLOGY **(09 Hrs)**

Introduction - Comparison of AC and DC transmission - Application of DC transmission - Description of DC transmission system - Transients in DC line - Planning for HVDC transmission – Modern trends in DC transmission, DC breakers.

UNIT II ANALYSIS OF HVDC CONVERTERS **(09 Hrs)**

Choice of Converter configuration - Simplified analysis of Graetz Circuit- Converter bridge characteristics - Line Commutated Converter (LCC) and Voltage Source Converter (VSC), 6 pulse and 12 pulse Converter Control - Current and Extinction Angle Control in LCC- Control of VSC - Converter Faults - Harmonic analysis- HVDC Breakers.

UNIT III MULTI TERMINAL DC SYSTEM **(09 Hrs)**

Introduction - Potential application of MTDC systems - Types of MTDC systems - Control and protection of MTDC systems - Operation of HVDC breaker- Generation of harmonics - Types of DC and AC filters- Converter model - Continuous time model - Discrete time converter model - Detailed model of the converter.

UNIT IV CONVERTER AND HVDC SYSTEM CONTROL **(09 Hrs)**

General principles of DC link control - Converter control characteristics- Monopolar operation, converter with and without overlap - System control hierarchy - Firing angle control - Current and extinction angle control - Starting and stopping of DC link - Power control - Higher level controllers - Telecommunication requirements.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Applications of HVDC to interconnect two points in a power grid, Case study of embedded HVDC in power system transmission-impact of integrated HVDC transmission on the rotor angle stability of a power system network.

Text Books

1. Padiyar, K.R., "HVDC Power Transmission System", New Age Publishers, 3rd Edition, 2017.
2. Edward Wilson Kimbark, "Direct Current Transmission Vol. I", John Wiley and sons, 1st Edition, 1971.

Reference Books

1. Rakosh Das Begamudre, "Extra high voltage AC transmission Engineering", New Academic Science Limited, 4th Edition, 2013.
2. Arillaga, J., "High Voltage Direct Current Transmission", Institution of Engineering and Technology, 2nd Edition, 2008.
3. Vlijay K. Sood, "HVDC & FACTS Controllers - Application of static converters in power system", Springer, 1st Edition, 2004.
4. Jos Arillaga, Y.H.Liu, N.R. Watson, "Flexible Power Transmission: The HVDC Options", John Wiley and Sons Ltd, 1st Edition, 2007.

Web References

1. https://www.powermag.com/benefits-of-high-voltage-direct-current-transmission-systems/
2. https://www.electrical4u.com/high-voltage-direct-current-transmission/
3. https://circuitglobe.com/hvdc-high-voltage-direct-current.html
4. http://large.stanford.edu/courses/2010/ph240/hamerly1/
5. https://nptel.ac.in/courses/108/104/108104013/

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
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2	3	-	2	2	1	-	3	2	2
3	3	-	2	2	1	-	3	2	2
4	3	-	2	2	1	-	3	2	2
5	3	-	2	2	1	-	3	2	2

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PEE211 **ADVANCED CONTROL SYSTEMS**

L	T	P	C	Hours
3	0	0	3	45

Course Objectives

- To understand basic concepts of various controller and state space design.
- To impart the knowledge on nonlinear control methods.
- To know about stability analysis of systems using optimal control.
- To expose the ideas on representing systems in digital control system.
- To design and simulate the controller and various methods of control.

Course Outcome

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

CO1-Analyze and design the controller for different methods and design the state space model. **(K2)**
CO2- Design and analyze the techniques such as describing function, Lyapunov Stability. **(K3)**
CO3- Design the optimal control problems by taking into consideration the physical constraints on practical control systems. **(K3)**
CO4- Analyse the digital control systems in the state space domain. **(K3)**
CO5- Design and simulate the controller using MATLAB. **(K3)**

UNIT I CLASSICAL CONTROLLER AND STATE SPACE DESIGN **(09 Hrs)**

Proportional(P)-Integral(I)-Derivative(D)-PI-PD-PID Controllers-Characteristics-Design- Controller Tuning-Ziegler-Nichol's method and cohen coon method – Damped oscillation method -Review of state model for systems-state transition matrix –controllability-observability- Kalman decomposition-state feedback-output feedback-design methods-pole placement controller - full order and reduced order observers-dead beat control.

UNIT II NON LINEAR CONTROL **(09 Hrs)**

Types of non-linearity-typical examples-describing function method-phase plane analysis stability analysis of non linear systems- Lyapunov function – Construction of Lyapunov function- Lyapunov's direct method-Lyapunov's indirect method.

UNIT III OPTIMAL CONTROL **(09 Hrs)**

Statement of optimal control problem – Problem formulation and forms of optimal control – Performance measures for optimal control – Selection of performance measure – Various methods of optimization-Necessary conditions for optimal control – Linear Quadratic regulator problem- Algebraic Riccati Equation – Solving ARE using Eigen vector method.

UNIT IV DIGITAL CONTROL SYSTEMS **(09 Hrs)**

Pulse transfer function-State equation – Solutions – Realization – Controllability–Observability – Stability – Jury's test-Digital Controller Design-Direct design method –Pole Placement controller-Dead beat Control-Discrete-Linear Quadratic regulator.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Transform design of Digital Controllers: Design specifications, direct and indirect design methods, design in w-plane, digital PID controller- Case study examples for state space, Non-linear systems, Optimal control, Digital system control using MATLAB.

Text Books

1. J.Nagrath , M.Gopal, "Control System Engineering", New age international publishers, 5th Edition,2009.
2. M. Gopal, "Control System Principles & Design", Tata McGraw Hill, New Delhi Publishers, 4th Edition, 2012
3. Ogata K., "Modern Control Engineering", Pearson Education, 5th Edition, 2010.

Reference Books

1. Donald P.Eckman, "Automatic Process Control",Wiley Eastern Ltd.,New Delhi,2011.
2. Benjamin C. Kuo , Digital Control Systems Second Edition, Oxford University Press,2017.
3. B. N. Sarkar, Advanced Control Systems, PHI Learning Private Limited, 1st Edition, 2013.

Web References

1. https://nptel.ac.in/courses/108/103/108103007/
2. https://www.cranfield.ac.uk/courses/short/energy-and-power/advanced-control-systems
3. https://freevideolectures.com/course/3488/advanced-control-systems
4. https://nptel.ac.in/courses/101/108/101108047/
5. http://www.nptelvideos.in/2012/11/advanced-control-system-design_27.html

COs/POs/PSOs Mapping

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3	3	-	3	2	2	-	3	3	2
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5	3	-	3	2	2	-	3	3	2

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PEE212	SOLAR PHOTOVOLTAIC SYSTEM DESIGN	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To learn about fundamentals of solar cells with their characteristics and parameters.
- To understand the formation of PV modules, various power conditioning units and tracking techniques.
- To learn about the various components and design of grid connected PV systems.
- To understand the various storage technologies available with respect to PV systems.
- To know about the site considerations, estimation and costing of a practical PV erected system.

Course Outcome

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

CO1- Discuss about the various solar photovoltaic techniques and factors affecting PV cell. **(K2)**
CO2- Design and erect a standalone PV system for any type of loads. **(K3)**
CO3- Design and erect various grid connected PV systems for any type of loads. **(K3)**
CO4- Examine accurate energy storage technology suitable for any loads in designing PV system. **(K3)**
CO5- Setup a practical rooftop and water pumping PV system. **(K3)**

UNIT I INTRODUCTION TO PV SYSTEM **(09 Hrs)**

History of Solar cells - Structure and working of Solar Cells - Types, Electrical properties and Behaviour of Solar Cells - Cell properties and design - PV Cell Interconnection and Module Fabrication - PV Modules and arrays - effect of shading - use of bypass and blocking diodes - influence of temperature - equivalent circuit – characteristics - Cell efficiency - Limitations.

UNIT II STANDALONE PV SYSTEM **(09 Hrs)**

Design of system components - PV modules, batteries, charge controllers, inverters, auxiliaries - Performance analysis of a standalone photovoltaic system - Voltage regulation, Maximum tracking, Quick sizing method, Array protection –Testing.

UNIT III GRID CONNECTED PV SYSTEM **(09 Hrs)**

Introduction – Configurations - Schematics, Components, Charge Conditioners, Interface Components - Balance of system Components - Grid connected PV system design for low power applications – Design for PV power plants – Estimation of energy output – costing.

UNIT IV ENERGY STORAGE **(09 Hrs)**

Necessity of storage for solar energy- Electrical energy storage - Fundamental concept of batteries – Types of batteries- Measuring of battery performance, charging and discharging, storage and energy density - safety issues–Alternate storage technologies - Thermal energy storage - Flywheels - Compressed air - Super Capacitors.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Energy Scenario - Case study of PV rooftop system – Water pumping application - Standard Penetration Test – Measurement of water table – Risks Management in Solar Projects commissioning.

Text Books

1. Chetan Singh Solanki,"Solar Photovoltaics: Fundamental, Technologies and Applications", PHI Learning Pvt. Ltd, New Delhi, 3rd Edition, 2015.
2. Martin A. Green,"Solar Cells Operating Principles, Technology, and System Applications", Prentice-Hall, 2008.
3. Rik DeGunther,"Solar Power Your Home for Dummies", Wiley Publishing Inc, 2nd Edition, 2010.

Reference Books

1. Suneel Deambi,"Photovoltaic System Design: Procedures, Tools and Applications", CNC press, 2016
2. A.K. Mukerjee," Photovoltaic Systems Analysis and Design", PHI Learning Private Limited, New Delhi, 1st Edition 2016.
3. John Balfour, Michael Shaw and Nicole Bremer," Introduction to Photovoltaic System Design", Jones and Bartlett Learning, 1st Edition, 2013.

4. Ru-shiliu, Leizhang and Xueliang sun, "Electrochemical technologies for energy storage and conversion", Wiley publications, 1st Edition, 2012.

Web References

1. https://www.cesa.org/wp-content/uploads/Standards-and-Requirements-for Solar.pdf
2. https://ieeexplore.ieee.org/document/7974067
3. https://nptel.ac.in/courses/117/108/117108141/
4. http://www.digimat.in/nptel/courses/video/117108141/117108141.html
5. https://freevideolectures.com/course/4659/nptel-design-photovoltaic-systems

COs/POs/PSOs Mapping

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4	3	-	2	2	3	-	3	3	3
5	3	-	2	2	3	-	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PEE213 **FLEXIBLE AC TRANSMISSION SYSTEMS**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To provide in depth understanding of the concept of reactive power compensation and operation of shunt and series compensator.
- To emphasise the need for FACTS controllers.
- To learn the characteristics, applications and modelling of series and shunt FACTS controllers.
- To analyze the interaction of different FACTS controller and perform control coordination machines and ASM charts.
- To analyse different application of FACTS devices in power system.

Course Outcomes

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

CO 1- Identify the conditions and installation of FACTS Devices. **(K3)**
CO 2- Inspect comparison characteristics of different FACTs controllers. **(K3)**
CO 3- Analyze the performance of a conventional series compensator. **(K3)**
CO 4- Illustrate the modes of operation of STATCOM and can evaluate different FACTS controller. **(K3)**
CO 5- Apply different FACTS controller to enhance stability in power system. **(K3)**

UNIT I FACTS CONCEPTS **(09 Hrs)**

Concepts of reactive power – Different compensation - Concept of FACTS devices - 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- FACTS devices in India and Abroad.

UNIT II SHUNT COMPENSATION **(09 Hrs)**

Tyristor Controlled Reactor (TCR) - Thyristor Switched Reactor (TSR) - Thyristor Switched Capacitor (TSC) - Fixed Capacitor - Thyristor Controlled Reactor (FC-TCR) - Thyristor Switched Capacitor - Thyristor Controlled Reactor (TSC -TCR) - VI Characteristics -Basic operating principle-Control approaches and characteristics - Voltage control by SVC - Increase in power transfer capacity - Improvement of transient stability, power oscillation damping.

UNIT III SERIES COMPENSATOR **(09 Hrs)**

Concept of series compensation - Thyristor Controlled Series Capacitor (TCSC) -Thyristor Switched Series Capacitor (TSSC)- TCPAR, UPFC -- Capability Characteristics - Operating principles and control schemes, SSSC - Power Angle characteristics- Open loop and closed loop control - Improvement of the system stability limit - Enhancement of system damping.

UNIT IV EMERGING FACTS CONTROLLER **(09 Hrs)**

Static Synchronous Compensator (STATCOM): Principle of Operation - V-I Characteristic - Steady state model - SSR mitigation, SSSC- Principles of operation and characteristics - Independent active and reactive power flow control- comparison of UPFC with the controlled series compensators and phase shifters - Injection model, Interline Power Flow Controller (IPFC): Principle of Operation - Control structure.

UNIT V INSTRUCTIONAL ACTIVITY **(09Hrs)**

Case studies of practical power system applications of various FACTS devices on power system problem. Voltage stability analysis using STATCOM - Improve the performance of transmission Line- Reactive and Real power compensation in Transmission Lines- Advance new generation FACTS devices- Locations of FACTS Devices.

Text Books

1. Hingorani ,L.Gyugyi, "Concepts and Technology of Flexible AC Transmission System", IEEE Press New York, 2000.
2. Padiyar K.R., "FACTS controllers for Transmission and Distribution systems" New Age International

Publishers, 1st Edition, 2007.

Reference Books

1. Mohan Mathur R. and Rajiv K.Varma , "Thyristor - based FACTS controllers for Electrical transmission systems", IEEE press, Wiley Inter science , 2002.
2. Enrique Acha, Claudio R.Fuerte-Esqivel, Hugo Ambriz-Perez, Cesar Angeles-Camacho "FACTS Modeling and simulation in Power Networks" John Wiley & Sons, 2002
3. Kalyan K. Sen & Mey Ling Sen, "Introduction to FACTS controllers: Theory, Modeling, and Applications", Wiley-IEEE, 2009

Web References

1. https://onlinecourses.nptel.ac.in/noc18_ee44
2. https://www.tandfonline.com/doi/abs
3. https://www.pewresearch.org/internet/fact-sheet/
4. https://www.electrical4u.com/facts-on-facts-theory-and-applications/
5. https://www.elprocus.com/flexible-ac-transmission-system-need-definition-types/

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
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3	3	-	3	3	2	-	3	3	3
4	3	-	3	3	2	-	3	3	3
5	3	-	3	3	2	-	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High

		L	T	P	C	Hrs
P20PEE214	ENERGY MANAGEMENT AND AUDITING	3	0	0	3	45

Course Objectives

- To study the concepts behind economic analysis and Load management.
- To understand about energy monitoring.
- To emphasize the energy management on various electrical equipment's and metering.
- To illustrate the concept of lighting systems and cogeneration.
- To know about home energy audit energy action planning.

Course Outcomes

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

CO1- Develop the ability to learn about the need for energy management and auditing process. **(K3)**
CO2- Learn about basic concepts of economic analysis and load management. **(K3)**
CO3- Understand the energy management on various electrical machines, concepts of metering and factors influencing cost function. **(K2)**
CO4- Learn about the concept of lighting systems, light sources and various forms of cogeneration. **(K2)**
CO5- Understand the concept of energy audit process. **(K2)**

UNIT I INTRODUCTION **(09 Hrs)**

Need for energy management - energy basics- designing and starting an energy management program – energy accounting -energy monitoring, targeting and reporting energy audit process.

UNIT II ENERGY COST AND LOAD MANAGEMENT **(09 Hrs)**

Important concepts in an economic analysis - Economic models-Time value of money-Utility rate structures-cost of electricity-Loss evaluation- Load management: Demand control techniques-Utility monitoring and control system-HVAC and energy management-Economic justification.

UNIT III METERING AND ENERGY MANAGEMENT FOR MACHINES **(09 Hrs)**

Systems and equipment- Electric Motors-Transformers and reactors-Capacitors and synchronous machines - Relationships between parameters-Units of measure-Typical cost factors- Utility meters -Timing of meter disc for kilowatt measurement - Demand meters - Paralleling of current transformers - Instrument transformer burdens-Multitasking solid-state meters – Metering location vs. requirements- Metering techniques and practical examples.

UNIT IV LIGHTING SYSTEMS & COGENERATION **(09 Hrs)**

Concept of lighting systems - The task and the working space -Light sources - Ballasts -Luminaries - Lighting Controls-Optimizing lighting energy - Power factor and effect of harmonics on power quality - Cost analysis techniques-Lighting and energy standards Cogeneration: Forms of cogeneration - feasibility of cogeneration-Electrical interconnection.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Review on Energy policy-Roles of energy manager and Energy committee- Requirements of energy action planning- Case studies on Global Energy Management System Implementation - worksheets for home energy audit.

Text Books

1. Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, "Guide to Energy Management", The Fairmont Press, Inc., 5th Edition 2007.
2. Eastop T.D & Croft D.R, "Energy Efficiency for Engineers and Technologists", Logman Scientific & Technical, 1990.

Reference Books

1. Reay D.A, "Industrial Energy Conservation", Pergamon Press, 1st Edition, 1979.
2. "IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities", IEEE,1996.
3. Amit K. Tyagi, "Handbook on Energy Audits and Management", TERI, 2003.PS5073.

Web References

1. www.energy.gov/energysave
2. www.cleenet.org/.../online.../126-energy-auditing
3. https://ec.europa.eu/energy/sites/ener/file
4. https://beeindia.gov.in/sites/default/files/1Ch3.pdf
5. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3165967

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
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3	3	-	3	1	1	-	2	2	2
4	3	-	3	1	1	-	2	2	2
5	3	-	3	1	1	-	2	2	2

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PEE215	DISTRIBUTED GENERATION AND MICROGRID	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To study the concepts behind Distributed Generation and Microgrid.
- To illustrate the concept of distributed generation.
- To analyze the impact of grid integration.
- To study concept of Microgrid and its configuration.
- To learn about renewable energy scenario.

Course Outcomes

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

CO1- Attain knowledge on the various schemes of conventional and nonconventional power generation. **(K2)**
CO2- Have the knowledge on the topologies and energy sources of distributed generation. **(K2)**
CO3- Learn about the requirements for Microgrid and grid interconnection and its impact with NCEsources. **(K2)**
CO4- Familiarize with the techniques of control and operation of microgrid. **(K2)**
CO5- Understand the standards and regulations of distributed generation, microgrid and grid integration. **(K2)**

UNIT I INTRODUCTION **(09 Hrs)**

Introduction, Comparative study between conventional and non-conventional methods of power generation: energy crisis due to scarcity of fossil fuel, distributed generation (DG) overview and technology trends. Working principle, architecture and application of renewable DG technologies: Solar PV, bioenergy, wind energy, hydroelectricity, tidal power, wave energy, geothermal energy etc. Non-conventional technology based DGs: Fuel cells, CHP based micro turbine, IC engines, etc. Storage based DGs: Storage technology: Battery, super capacitor, flywheel etc- Distributed Generation Resources in India

UNIT II DISTRIBUTED GENERATIONS (DG) **(09 Hrs)**

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

UNIT III BASICS OF A MICROGRID & IMPACT OF GRID INTEGRATION **(09 Hrs)**

Concept and definition of microgrid- microgrid drivers and benefits- review of sources of microgrids- typical structure and configuration of a microgrid- AC and DC microgrids- Power Electronics interfaces in DC and AC microgrids- Requirements for grid interconnection, limits on operational parameters,: voltage, frequency- THD-response to grid abnormal operating conditions, islanding issues- Impact of grid integration with NCE sources on existing power system: reliability-stability and power quality issues.

UNIT IV CONTROL AND OPERATION OF MICROGRID **(09 Hrs)**

Modes of operation and control of microgrid: grid connected and islanded mode- Active and reactive power control- protection issues, anti-islanding schemes: passive, active and communication based techniques-microgrid communication infrastructure- Power quality issues in microgrids- regulatory standards- Microgrid economics- Introduction to smart microgrids.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Distributed generation in the Indian scenario - Review current energy scenario for microgrids-Study the current standards and regulations of distributed generation, microgrid integration- review the contribution and development of renewable distributed generation and microgrids.

Text Books

1. Nick Jenkins, Janaka Ekanayake, GoranStrbac , "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.

Reference Books

1. AmirnaserYezdani, and Reza Iravani, "Voltage Source Converters in Power Systems: Modeling, Control and Applications", IEEE John Wiley Publications, 2009.
2. DorinNeacsu, "Power Switching Converters: Medium and High Power", CRC Press, Taylor & Francis, 2006.
3. Chetan Singh Solanki, "Solar Photo Voltaics", PHI learning Pvt. Ltd., New Delhi, 2009.
4. J.F. Manwell, "Wind Energy Explained, theory design and applications," J.G. McGowan Wiley publication, 2002.
5. D. D. Hall and R. P. Grover, "Biomass Regenerable Energy", John Wiley, New York, 1987.
6. John Twidell and Tony Weir, "Renewable Energy Resources" Tyalor and Francis Publications, 2005.
7. Technical literatures-research papers published in power system and power electronics related reputed journals and IEEE standards.
8. Renewable Energy-Power for a sustainable future, third Edition, Edited by Godfrey Boyle, Oxford University Press, 2013.
9. Microgrids: Architectures and Control, Nikos Hatziargyriou(Editor), Wiley-IEEE Press ISBN: 978-1-118-72068-4, 340 pages, December 2013.

Web References

1. www.electrical-installation.org/
2. https://nptel.ac.in/courses/108/108/108108034/
3. www.ese.iitb.ac.in/~suryad/Micro-Grid.pdf
4. e2rg.com/microgrid-2012/IIT_Shahidehpour.pdf
5. www.digimat.in/nptel/courses/video/108107113/108107113.html

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	2	2	2	-	3	2	3
2	3	-	2	2	2	-	3	2	3
3	3	-	2	2	2	-	3	2	3
4	3	-	2	2	2	-	3	2	3
5	3	-	2	2	2	-	3	2	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PEE316	MACHINE LEARNING	L	T	P	C	Hrs
		3	0	0	3	45

Course objectives

- To provide an introduction to several fundamental concepts and methods for machine learning.
- To illustrate the typical applications of various clustering based learning algorithms.
- To provide the knowledge related to processing, analyzing and handling data sets.
- To teach machine learning algorithms and their applications.
- To impart knowledge on the applications of Machine learning to power Electronic converters.

Course Outcomes

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

CO1- Understand a range of machine learning algorithms along with their strengths, weaknesses and able to select appropriate ML algorithm. **(K2)**
CO2 - Formulate machine learning problems corresponding to different applications. **(K3)**
CO3 - Apply machine learning algorithms to solve problems of moderate complexity. **(K3)**
CO4 - Recognize and understand the unsupervised learning using various algorithms. **(K2)**
CO5 -Develop codes for machine learning algorithms to solve moderately complex problems. **(K3)**

UNIT I INTRODUCTION TO MACHINE LEARNING **(09 Hrs)**

Objectives of machine learning – Human learning/ Machine learning – Types of Machine learning:- Supervised Learning, Unsupervised learning, Reinforcement Learning and Evolutionary Learning. Application:- Regression and Classification – The Machine Learning Process:- Data Collection and Preparation – Feature Selection – Algorithm Choice – Parameter and Model Selection – Training – Validation.

UNIT II DATA PREPROCESSING **(09 Hrs)**

Data preprocessing: Data Cleaning:– Handling missing data and noisy data – Data integration:- Redundancy and correlation analysis - Data Reduction:- Dimensionality reduction:- Linear Discriminant Analysis, Principal Components Analysis, Factor Analysis , Independent Components Analysis and Numerosity Reduction - Data Compression - Data Normalization and Data Discretization.

UNIT III SUPERVISED LEARNING **(09 Hrs)**

Linearly separable and nonlinearly separable populations – Multi Layer Perceptron – Backpropagation Learning Algorithm – Radial Basis Function Network – Support Vector Machines: - Kernels – Risk and Loss Functions - Support Vector Machine Algorithm – Multi Class Classification – Support Vector Regression-Deep learning.

UNIT IV UNSUPERVISED LEARNING **(09 Hrs)**

Introduction – Clustering:- Partitioning Methods:- K-means algorithm - Hierarchical clustering – Fuzzy Clustering–Clustering High-Dimensional Data:- Problems – Challenges – Subspace Clustering – Biclustering - Probability based clustering – The Expectation Maximization Algorithm – Bayesian Classification – Bayesian Networks – Learning Bayesian Networks – Hidden Markov Models.

UNIT-V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Machine Learning based Modeling of Power Electronic Converters-Recent advances and applications of machine learning.

Text Books

1. Stephen Marsland, " Machine Learning: An Algorithmic Perspective", Chapman and Hall/CRC; 2nd Edition, 2014.
2. Ian H. Witten, Eibe Frank, Mark A. Hall, "Data Mining: Practical Machine Learning Tools and Techniques", Elsevier, 3rd Edition, 2011.
3. Jiawei Han, Micheline Kamber, Jian Pei, Data Mining: Concepts and Techniques: Concepts and Techniques, Elsevier, 2011.

Reference Books

1. Ferdinand van der Heijden, Robert Duin, Dick de Ridder, David M. J. Tax, "Classification, Parameter

Estimation and State Estimation: An Engineering Approach Using MATLAB", John Wiley & Sons, 2005.
2. Aurelien Geron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems", O'Reilly Media Publications, 2nd Edition, 2019.

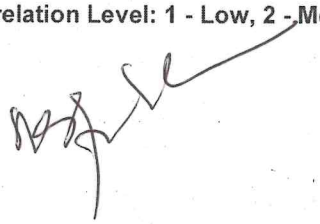
Web References

1. https://elitedatascience.com/machine-learning-projects-for-beginners
2. https://www.sas.com/en_us/insights/analytics/machine-learning.html
3. http://web.cs.iastate.edu/~cs573x/texts.html
4. https://docs.microsoft.com/en-us/azure/machine-learning/concept-automated-ml
5. https://www.deeplearning.ai/blog/breaking-into-ai-marrying-web-performance-with-machine-learning/
6. https://ieeexplore.ieee.org/document/8912608

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	1	1	1	-	1	2	1
2	3	-	1	1	1	-	1	2	1
3	3	-	1	1	1	-	1	2	1
4	3	-	1	1	1	-	1	2	1
5	3	-	1	1	1	-	1	2	1

Correlation Level: 1 - Low, 2 - Medium, 3 - High



P20PEE317	WIND ENERGY CONVERSION SYSTEMS	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To learn the design and control principles of Wind turbine.
- To understand the concepts of fixed speed and variable speed, wind energy conversion systems.
- To analyze the grid integration issues.
- To identify faults in circuits using various design methods.
- To gain knowledge in SCADA, Other database and Monitoring systems.

Course Outcomes

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

CO1 - Acquire knowledge on the basic concepts of Wind energy conversion system. **(K2)**

CO2 - Understand the mathematical modelling and control of the Wind turbine. **(K2)**

CO3 - Identify ideal wind site for wind farm and design of fixed speed system. **(K2)**

CO4 - Study about the need of Variable speed system and its modelling. **(K2)**

CO5 - Learn about Grid integration issues and current practices of wind interconnections with power system. **(K2)**

UNIT I INTRODUCTION AND WIND TURBINES **(09Hrs)**

Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory-Power coefficient- Sabinin's theory-Aerodynamics of Wind turbine. HAWT-VAWT-Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations-Tip speed ratio-Number of Blades- Blade profile-Power Regulation-yaw control-Pitch angle control stall control-Schemes for maximum power extraction.

UNIT II FIXED SPEED SYSTEMS **(09Hrs)**

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 III VARIABLE SPEED SYSTEMS **(09Hrs)**

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 IV GRID CONNECTED SYSTEMS **(09Hrs)**

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

UNIT V INSTRUCTIONAL ACTIVITY **(09Hrs)**

Case study: Modeling and Simulation of Wind generator with Fixed Speed Wind Turbine using software. Dynamic modelling of a wind turbine with doubly fed induction generator using software.

Text Books

1. L.L.Freris, "Wind Energy conversion Systems", Prentice Hall, 1990.
2. S.N.Bhadra, D.Kastha,S.Banerjee, "Wind Electrical Sytems",Oxford University Press,2010.
3. Ion Boldea, "Variable speed generators", Taylor & Francis group, 2006.

Reference Books

1. E.W.Golding , "The generation of Electricity by wind power", Redwood burn Ltd.,Trowbridge,1976.
2. N. Jenkins , " Wind Energy Technology", John Wiley & Sons,1997.
3. S.Heir , "Grid Integration of WECS", Wiley, 1998.
4. Alireza Khaligh and Omer C. Onar, "Energy Harvesting: Solar, Wind, and Ocean Energy Conversion Systems", CRC Press, 2017.

Web References

1. https://nptel.ac.in/courses/108/105/108105058/
2. http://web.mit.edu/windenergy/windweek/Presentations/Wind%20Energy%20101.pdf
3. https://nptel.ac.in/courses/108/108/108108078/
4. https://www.ee.iitb.ac.in/~npsc2008/NPSC_CD/ Data/Tutorial%202/ Wind%20Energy%20Conversion %20Systems%20-%20Prof.%20S.B.%20Kedare.pdf
5. https://www.sciencedirect.com/topics/engineering/wind-energy-conversion-system

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	2	2	2	-	3	3	2
2	3	-	2	2	2	-	3	3	2
3	3	-	2	2	2	-	3	3	2
4	3	-	2	2	2	-	3	3	2
5	3	-	2	2	2	-	3	3	2

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PEE318	MEMS TECHNOLOGY	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To understand properties of materials, microstructure and fabrication methods.
- To know about the design and modeling of Electrostatic sensors, thermal sensors and actuators.
- To understand the fundamentals of piezoelectric sensors and actuators.
- To impart the knowledge of various types of etching process using micromachining technology.
- To formulate, solve, analyze and optimize the design of electrical mechanical components.

Course Outcomes

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

CO1 - Familiarize the basics of micro fabrication models and various MEMS material properties. **(K2)**
CO2 - Analyze the electrostatic sensors, thermal sensors and actuators through MEMS and NEMS devices. **(K3)**
CO3 - Familiarize with the design of piezoelectric sensors, embedded sensors & actuators. **(K2)**
CO4 - Indentify and apply the appropriate etching process for various industrial applications. **(K2)**
CO5 - Apply and design MEMS devices to disciplines beyond Electrical and Mechanical engineering. **(K3)**

UNIT I MICRO-FABRICATION,MATERIALS AND ELECTRO-MECHANICALCONCEPTS (09 Hrs)

Overview of micro fabrication – Silicon and other material based fabrication processes – Concepts: Conductivity of semiconductors-Crystal planes and orientation-stress and strain-flexural beam bending analysis-torsional deflections-Intrinsic stress- resonant frequency and quality factor.

UNIT II ELECTROSTATIC, THERMAL SENSORS AND ACTUATION (09 Hrs)

Electrostatic Sensors: Principle- material- design and fabrication of parallel plate capacitors as electrostatic sensors and actuators- Interdigitated Finger capacitor – Comb drive devices – Micro Grippers -Applications. Thermal Sensors: Principle, material, design and fabrication of thermal couples- thermal resistors - thermal bimorph sensors-thermal resistor sensors-Applications.

UNIT III PIEZOELECTRIC SENSING AND ACTUATION (09 Hrs)

Piezoelectric effect-piezoelectric materials -cantilever piezoelectric actuator model-properties of piezoelectric materials-Applications to inertia, Acoustic, Tactile and Flow sensors - Magnetic Actuators – Micromagnetic components - Case studies of MEMS in magnetic actuators- Actuation using Shape Memory Alloys.

UNIT IV MICROMACHINING (09 Hrs)

Silicon Anisotropic Etching – Anisotrophic Wet Etching – Dry Etching of Silicon – Plasma Etching – Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants - Basic surface micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Striction and Antistriction methods – LIGA Process - Assembly of 3D MEMS – Foundry process.

UNIT V INSTRUCTIONAL ACTIVITY (09 Hrs)

Electro-mechanical integration techniques – Simulation of electrostatic gaps, circuit elements, car tire pressure sensors, disposable blood pressure sensors – RF- MEMS technology - Displacement Stress and Dynamic analysis - Micro fluidics applications -Optical MEMS - NEMS Devices.

Text Books

1. Chang Liu, "Foundations of MEMS", Pearson Education, 1st Edition, 2012.
2. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi, 1st Edition, 2017.
3. Thomas M.Adams and Richard A.Layton, "Introduction MEMS, Fabrication and Application," Springer, 1st Edition, 2010.

Reference Books

1. Marc Madou , "Fundamentals of Microfabrication", CRC Press, 2nd Edition,2002.

2. M.H.Bao, "Micromechanical transducers: Pressure sensors, accelerometers and gyroscopes", Elsevier, Newyork,1st Edition, 2000.
3. Tai Ran Hsu, "MEMS and Microsystems: Design, Manufacture, and Nanoscale Engineering", John Wiley & Sons, 2nd Edition, 2008.
4. Reza Ghodssi, Pinyen Lin, MEMS Materials and Processes Handbook, springer,1st Edition,2011.

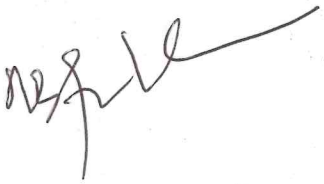
Web References

1. https://nptel.ac.in/courses/117/105/117105082/
2. http://www.nptelvideos.in/2012/12/mems-microsystems.html
3. https://ndl.iitkgp.ac.in/
4. https://www.youtube.com/user/cecedusat
5. http://cec.nic.in/

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	2	-	1	1	-	-	2	2	2
2	2	-	1	1	-	-	2	2	2
3	2	-	1	1	-	-	2	2	2
4	2	-	1	1	-	-	2	2	2
5	2	-	1	1	-	-	2	2	2

Correlation Level: 1 - Low, 2 - Medium, 3 - High



P20PEE319	ENERGY STORAGE SYSTEMS	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives:

- To emphasize basic energy storage concept, technical details and understand the basics of thermodynamics in energy storage.
- To understand the concepts of thermal and thermo mechnical energy storage techniques.
- To study different electrochemical energy storage techniques.
- To know about the various energy storage technologies and super capacitors currently in practice.
- To understand the modeling of various energy storage systems and design.

Course Outcomes:

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

CO1- Recognize various energy storage working principles. **(K2)**

CO2- Analyze the performance of various thermal energy storage systems. **(K3)**

CO3- Employ different thermoelectric measurement techniques. **(K3)**

CO4- Interpret energy storage systems and applications of super capacitors for appropriate storage systems. **(K2)**

CO5- Design, model and control recent energy storage systems and to adopt them with renewable based systems. **(K3)**

UNIT I INTRODUCTION **(09 Hrs)**

A brief history of Energy – Various energy Storage components – Technical Definitions – Capacity – Depth of Discharge – State of charge - Energy and Power for Transportation – Efficiency and propagation of Efficiency losses – Problems – Internal energy – Second Law and Entropy – Gibbs Free Energy and Chemical Potential.

UNIT II THERMAL ENERGY STORAGE **(09 Hrs)**

Heat Vs Thermal Energy – Sensible Heat – Latent Heat – Reduction heat – Eutectic and Noneutectic Heat – Thermo mechanical Energy storage – Heat, Work and States – Compressed Air Energy Storage – Cryogenic Energy Storage – Solar Power Towers – Problems.

UNIT III ELECTROCHEMICAL ENERGY STORAGE **(09 Hrs)**

Nernst equation and the electromotive force – Components and Species – EMF - concentration –Polarization Over potentials – Liquid Junction potential – Electrode Reaction Kinetics – Equilibrium reaction rate and Constant - butler - Volmer Over potentials – Tafel Over potential. procedures for domestic and industrial applications – Role of EMS in power systems.

UNIT IV STORAGE TECHNOLOGIES AND SUPERCAPACITORS **(09 Hrs)**

Pumped Hydroelectric Storage – Compressed Air Energy Storage-Conventional Batteries and Flow Batteries – Hydrogen based Energy storage system – Flywheel Energy Storage System – Superconducting Magnetic Energy Storage – Battery Management Systems - Types of electrodes Electrode materials – Electrolyte - comparison to battery systems – applications.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Modeling of Storage systems – Modeling and Control of the Grid side and storage side Converter – case study – Installations.

Text books

1. Francisco Diaz, Andreas Sumper and Oriol Gomis-Bellmunt, "Energy Storage in Power Systems", John Wiley & Sons Ltd, I st Edition, 2016.
2. Odne Stokke Burhem, " Engineering Energy Storage", Elsevier Acedemic Press, 2017

Reference books

1. Tetsuya Osaka, Madhav Datta, "Energy Storage Systems in Electronics",Gordon and Breach Science Publishers, 2000.
2. R. M. Dell, D.A.J. Rand, "Understanding Batteries",RSC Publications, 2001.
3. James Larminie, Andrew Dick, "Fuel Cell System Explained",J. Wiley, 2003.
4. D.M. Rowe, "Thermoelectrics Handbook: Macro to Nano",CRC Press, 2006.

Web References

1. https://netl.doe.gov/
2. https://www.nyserda.ny.gov/All-Programs/Programs/Energy-Storage/
3. https://indiaesa.inf /
4. https://www.maxwell.com/products/ultracapacitors/grid-energy-storage-system
5. https://batteryuniversity.com/learn/article/whats_the_role_of_the_supercapacitor

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	2	2	1	-	2	2	1
2	3	-	2	2	1	-	2	2	1
3	3	-	2	2	1	-	2	2	1
4	3	-	2	2	1	-	2	2	1
5	3	-	2	2	1	-	2	2	1

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PEE320	PRINCIPLES OF VLSI DESIGN	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To learn the performance of MOS transistors.
- To study the static and dynamic behavior of CMOS design.
- To understand about impact of passive components in circuits.
- To implement CMOS logic in designing combinational and sequential circuits.
- To learn verilog HDL programming language.

Course Outcomes

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

CO1 - Analyze the characteristics of MOS transistors with its small signal parameters. **(K3)**
CO2 - Draw stick diagram and design circuits in static and dynamic CMOS logic. **(K2)**
CO3 - Estimate the VLSI circuit performance based on resistors, inductors and capacitors. **(K2)**
CO4 - Design combinational and sequential circuits in VLSI and understand its clock distribution. **(K2)**
CO5 - Code the combinational and sequential circuits in verilog HDL language. **(K3)**

UNIT I MOS TRANSISTOR THEORY AND PROCESS TECHNOLOGY **(09 Hrs)**

NMOS and PMOS transistors, Threshold voltage- Body effect- Design equations- Second order effects. MOS models and small signal AC characteristics. Basic CMOS technology.

UNIT II INVERTERS AND LOGIC GATES **(09 Hrs)**

NMOS and CMOS Inverters, Stick diagram, Inverter ratio, DC and transient characteristics , switching times, Super buffers, Driving large capacitance loads, CMOS logic structures , Transmission gates, Static CMOS design, dynamic CMOS design.

UNIT III CIRCUIT CHARACTERISATION AND PERFORMANCE ESTIMATION **(09 Hrs)**

Resistance estimation, Capacitance estimation, Inductance, switching characteristics, transistor sizing, power dissipation and design margining. Charge sharing .Scaling.

UNIT IV VLSI SYSTEM COMPONENTS, CIRCUITS AND DESIGN **(09 Hrs)**

Multiplexers, Decoders, comparators, priority encoders, Shift registers. Arithmetic circuits – Ripple carry adders, Carry look ahead adders, High-speed adders, Multipliers. Physical design – Delay modelling ,cross talk, floor planning, power distribution. Clock distribution. Basics of CMOS testing.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Case study on Overview of digital design with Verilog HDL for Structural, Data flow, Behavioral Styles of Hardware Description

Text Books

1. Neil H.E. Weste and Kamran Eshraghian, Principles of CMOS VLSI Design, Pearson Education ASIA, 4th Edition, 2011.
2. John P.Uyemura "Introduction to VLSI Circuits and Systems", John Wiley &Sons, Inc., 2012.
3. Samir Palnitkar, "Verilog HDL", Pearson Education, 2nd Edition, 2008.

Reference Books

1. Eugene D.Fabricius, Introduction to VLSI Design McGraw Hill International Editions, 1999.
2. J.Bhasker, B.S.Publications, "A Verilog HDL Primer", 2nd Edition, 2001.
3. Pucknell, "Basic VLSI Design", Prentice Hall of India Publication, 1995.
4. Wayne Wolf "Modern VLSI Design System on chip. Pearson Education.3rd Edition ,2007.

Web References

1. https://nptel.ac.in/courses/117/101/117101058/
2. https://nptel.ac.in/courses/108/107/108107129/
3. https://nptel.ac.in/courses/117/101/117101105/

4. https://nptel.ac.in/courses/117/103/117103125/
5. https://nptel.ac.in/courses/117/106/117106093/
6. http://nptel.iitm.ac.in

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	1	1	1	-	2	1	1
2	3	-	1	1	1	-	2	1	1
3	3	-	1	1	1	-	2	1	1
4	3	-	1	1	1	-	2	1	1
5	3	-	1	1	1	-	2	1	1

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PEE321	POWER ELECTRONICS APPLICATIONS TO LIGHTING SYSTEM	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To illustrate the factors to increase the efficiency of lighting equipment.
- To study the different design techniques for lighting.
- To illustrate the concepts of solid state lighting sources.
- To learn about the environmental impact and measures for sustainable and energy efficient design.
- To impart the knowledge on the lighting monitoring and control techniques in various applications.

Course Outcomes

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

CO1 – Apply the various factors and parameters necessary for efficient lighting.**(K3)**
CO2 – Design lighting system for Interior and exterior of hotels, Malls, Memorial House, etc. **(K3)**
CO3 – Predict the performance behavior of the various types of solid state light sources. **(K2)**
CO4 – Analyze and apply appropriate power conditioning, monitoring and controlling techniques to lighting systems. **(K3)**
CO5 – Design of various types of lighting applications with efficient energy management and control system. **(K3)**

UNIT I INTRODUCTION **(09 Hrs)**

Illuminance calculation- Derivation of luminous flux from luminous intensity- flux transfer and inter-reflection luminance calculations- Discomfort glare- Optical design reflector system- refractor system - Principle of lighting design- Indoor lighting design by lumen method, by point method, Exterior lighting system- Road and highway lighting system.

UNIT II ARCHITECTURAL LIGHTING **(09 Hrs)**

Fundamental architectural lighting design practices – Daylight factor and Sky factor – day lighting systems – Fenestration design aspects – calculation of interior illuminance due to daylight. Design and analysis of lighting for exterior and interior applications - economic analysis of lighting systems, Green Lighting for Modern Buildings and designing daylight - responsive control systems.

UNIT III SOLID STATE LIGHTING AND CONTROL **(09 Hrs)**

Introduction -.Review of Light sources- Basics of solid state lamps - light generation at different wavelengths, white light generation techniques - Characterization of LEDs for illumination application - Power LEDs- High brightness LEDs - Electrical and optical properties – LED driver considerations- color issues of white LEDs- Dimming of LED sources - Designing usable lamp from white LEDs - Luminaire design steps - SSL test standards.

UNIT IV LIGHTING POWER CONDITIONING, MONITORING AND CONTROL **(09 Hrs)**

Lighting control strategies, techniques and equipment, sensors and timers, switches versus dimming control algorithm, harmonics- EI from lighting equipment – its measurement and suppression techniques. Impact of lighting control, protocols for lighting control- Status monitoring, fault monitoring- electrical load monitoring- lamp life monitoring system- applications- Energy Management and building control systems- Impact of Lighting Controls on HVAC -Power Quality issues – Integration of lighting controls with Building Management Systems.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Case studies: Color rendering properties of novel light sources - Dynamic Lighting in Classrooms – Demonstration of Vintage Lighting Instruments – Horticulture lighting – POE Lighting, DALI Lighting, DMX Lighting, Li-Fi - Underwater Solid-State Lighting Based on RGB Laser Diodes Mixed White -Light - Visible Light Communications for Sensing and Lighting Control.

Text Books

1. Craig DiLouie, "Lighting Control", The Fairmont Press, Inc., 1st Edition, 2008.
2. David L.DiLaura, Kevin W.Houser, Richard G.Mistrick, Gary R.Steffy, "IES Lighting Handbook" , ESNA,10th Edition, 2011.

Reference Books

1. Craig DiLouie, "Advanced Lighting Controls: Energy Saving Productivity, Technology & Applications", Fairmont Press, Inc., 1st Edition, 2005.
2. Davies, "Handbook of Condition Monitoring: Techniques and Methodology", Springer Science & Business Media, 1st Edition, 2012.

Web References

1. https://nptel.ac.in/courses/108/105/108105061/
2. www.aboutlightingcontrols.org.
3. https://www.zumtobel.com/
4. https://ndl.iitkgp.ac.in/
5. https://www.youtube.com/user/cecedusat

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
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2	3	-	2	2	2	-	3	3	3
3	3	-	2	2	2	-	3	3	3
4	3	-	2	2	2	-	3	3	3
5	3	-	2	2	2	-	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PEE322	AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS	L	T	P	C	Hours
		3	0	0	3	45

Course Objectives

- To understand the basic concepts of batteries, testing methods and starter drive mechanism.
- To gain knowledge on different electrical and electronic components in an automobiles.
- To study about the electronic controls in engine system.
- To enhance knowledge in sensor applications in vehicle control systems.
- To understand automotive embedded systems and communication protocols.

Course Outcomes

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

CO1 - Test and diagnose the faults in batteries used in automobiles. **(K3)**
CO2 - Describe the components for charging, lighting systems. **(K3)**
CO3 - Distinguish the conventional and electronic ignition system in engines. **(K2)**
CO4 - Develop the sensor based applications for automobiles. **(K3)**
CO5 - Configure the communication protocols for automobiles. **(K3)**

UNIT I BATTERIES AND STARTING SYSTEMS **(09 Hrs)**

Types of batteries – principle, construction, working – characteristics, rating – battery capacity – charging methodology – state of charge – short circuit current – depth of discharge – efficiency – gravimetric tests – fault diagnosis – requirement of starting system – starter motor construction and working – starter drive mechanism – bendix drive, pinion type, axial sliding armature starter – slipping and overrunning of clutches – automatic switches for starting – cold starting devices.

UNIT II CHARGING SYSTEM AND LIGHTING AUXILIARIES **(09 Hrs)**

DC generator, alternators – characteristics – alternator charging circuits – testing – relay/cut-out, mechanical and electronic voltage regulator – drive for charging system – interior and exterior lighting system – wiring requirements – design – head light dazzling and preventive methods – horn, wiper system and trafficator.

UNIT III ELECTRONIC ENGINE MANAGEMENT SYSTEM **(09 Hrs)**

Fuel injectors – testing of fuel injectors – conventional ignition system, electronic ignition system, programmed ignition system, distributor less ignition system - digital engine control modes – EGR control, variable valve timing – ignition controlling – voltage and current required for spark – spark plug, characteristic – spark advance correction scheme.

UNIT IV SENSORS AND ACTUATORS **(09 Hrs)**

Review of sensors – sensor interface to ECU – types of sensors – LIDAR sensor, oxygen sensor, hot wire anemometer sensor, vehicle speed sensor, detonation sensor, accelerometer sensor, crank position sensor – exhaust gas recirculation actuators – stepper motor actuator – vacuum operated actuator – voice warning system, travel information system, keyless entry system, automatic transmission system, electronic steering system.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Case study: Vehicle communication protocols – CAN, LIN, FLEXRAY, MOST, KWP 2000 – GPS Navigation – GPS Structure and Dead Reckoning using Inertial Navigation System. Electronic Control System Diagnostics, OBDII, Diagnostics Fault Codes – MAF Sensor calibration.

Text Books

1. Tom Denton, "Automotive Electrical and Electronic Systems", Elsevier, 5th Edition, 2017.
2. Robert Bosch, "Bosch Automotive Handbook", Bentley Publishers, 10th Edition,2018.
3. Jean J. Labrosse, "µC/OS-II Real Time Kernel", CMP Books, 2nd Edition, 2002.

Reference Books

1. Nicolus N F S Lion, "Automotive Embedded System Hand Book", CRC Press, 1st Edition, 2009.
2. Joerg Schaeuffele, Thomas Zurawka, "Automotive Software Engineering - Principles, Processes, Methods and Tools", SAE International, 1st Edition, 2005.

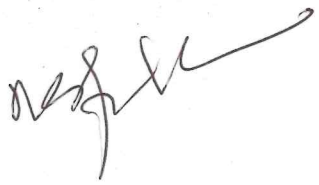
Web References

1. https://nptel.ac.in/courses/108/103/108103009/
2. https://nptel.ac.in/courses/108/108/108108147/
3. https://nptel.ac.in/courses/108/105/108105057/
4. https://www.academia.edu/8590573/Automobile_Electrical_and_Electronic_Systems_Third_Edition
5. https://en.wikipedia.org/wiki/Automotive_electronics

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	2	2	2	-	3	3	3
2	3	-	2	2	2	-	3	3	3
3	3	-	2	2	2	-	3	3	3
4	3	-	2	2	2	-	3	3	3
5	3	-	2	2	2	-	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High



P20PEE323	VIRTUAL INSTRUMENTATION	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To understand the basic concepts and architecture of virtual instrumentation.
- To understand the different programming techniques in VI.
- To enable the student to gain experience in data acquisition.
- . To make the student become competent in using state-of-the-art VI tool.
- To provide the concepts of virtual instrument for real time systems, embedded controller.

Course Outcomes

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

CO1 - Interpret architecture of virtual instrument and differentiate conventional and traditional instrument. **(K2)**
CO2 - Illustrate the concepts of VI programming techniques. **(K2)**
CO3 - Demonstrate the various techniques of data acquisition. **(K2)**
CO4 - Utilize the analysis tools for virtual instrumentation. **(K3)**
CO5 - Develop the Virtual Instrument for real time systems, embedded controller. **(K3)**

UNIT I INTRODUCTION **(09 Hrs)**

Virtual Instrumentation: Historical perspective – advantages – block diagram and architecture of a virtual instrument – conventional instruments versus traditional instruments – data-flow techniques – graphical programming in data flow – comparison with conventional programming.

UNIT II VI PROGRAMMING TECHNIQUES **(09 Hrs)**

VIs and sub-VIs – loops and charts – arrays, clusters and graphs – case and sequence structures – formula nodes – local and global variables – state machine – string and file I/O.

UNIT III DATA ACQUISITION **(09 Hrs)**

Introduction to PC based data acquisition – typical plug-in data acquisition board – multiplexing of analog inputs – single ended and differential inputs – different strategy for sampling of multi-channel analog inputs – concept of universal DAQ card – use of timers/counters.

UNIT IV TOOLSETS **(09 Hrs)**

Use of Analysis tools – Fourier transforms – power spectrum – correlation methods – windowing and filtering. Modelling of electronic energy converter for induction heating using LabVIEW – simulation of on-off controller, PID controller.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Case studies: Development of control system – industrial communication – image acquisition and processing – motion control – development of Virtual Instrument using GUI, Real-time systems, Embedded Controller.

Text Books

1. Gary Johnson, "LabVIEW Graphical Programming", McGraw Hill, Newyork, 4th Edition, 2017.
2. Wells Lisa K and Travis Jeffrey, "LabVIEW for everyone", Prentice Hall, 2nd Edition, 2001.
3. Jovitha Jerome, "Virtual Instrumentation Using LabVIEW", PHI Learning private Ltd, Eastern economy Edition, 2010.

Reference Books

1. James K, "PC Interfacing and Data Acquisition", Elsevier, 1st Edition, 2000.
2. N. Mathivanan, "PC-based Instrumentation: Concepts and Practice", PHI Learning private ltd, Eastern economy Edition, 2007.
3. Robert H.Bishop, "LabVIEW 2009 Student Edition", Pearson College Division, 2009.

Web References

1. https://nptel.ac.in/courses/108/105/108105153/
2. https://nptel.ac.in/courses/108/106/108106074/
3. https://nptel.ac.in/courses/108/105/108105064/
4. https://www.ni.com/en-in/innovations/white-papers/06/virtual-instrumentation.html
5. https://www.sensorland.com/HowPage087.html

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
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3	3	-	2	2	2	-	3	2	3
4	3	-	2	2	2	-	3	2	3
5	3	-	2	2	2	-	3	2	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PEE324 **ANALYSIS AND DESIGN OF INVERTERS**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To provide the basic understanding behind the different types of voltage source inverters.
- To have a clear knowledge about various type of current source inverter.
- To acquire knowledge on resonant inverter, multilevel inverters and its modulation techniques.
- To introduce the basic concept of type of Z-Source inverter.
- To provide strong foundation for further study of inverter circuits and its applications.

Course Outcomes

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

CO1 - Interpret the working modes and operation single and three phase voltage source inverters. **(K2)**
CO2 - Design the various types of single phase and three phase current source inverters. **(K3)**
CO3 - Analyse and comprehend the different configurations of resonant and multilevel inverters. **(K3)**
CO4 - Gain knowledge on the design and operation of type of Z-source inverter and power conditioners. **(K3)**
CO5 - Design inverters for the real time applications. **(K3)**

UNIT I VOLTAGE SOURCE INVERTERS **(09 Hrs)**

Principle of operation of half and full bridge inverters – Performance parameters – 180 degree and 120 degree conduction mode inverters with star and delta connected loads – voltage control techniques: single, multi pulse, sinusoidal and space vector modulation techniques – various harmonic elimination techniques – forced commutated thyristor inverters.

UNIT II CURRENT SOURCE INVERTERS **(09 Hrs)**

Operation of six-step thyristor inverter – inverter operation modes – load – commutated inverters – Auto sequential current source inverter (ASCI) – current pulsations–comparison of current source inverter and voltage source inverters – PWM techniques for current source inverters.

UNIT III RESONANT AND MULTILEVEL INVERTER **(09 Hrs)**

Series and parallel resonant inverters –– Voltage control of resonant inverters – Class E resonant inverter – resonant DC-link inverters. Multilevel concept – Diode clamped – Flying capacitor – Cascade type multilevel inverters – Comparison of multilevel inverters – Application of multilevel inverters – PWM techniques for MLI.

UNIT IV Z-SOURCE INVERTER AND POWER CONDITIONERS **(09 Hrs)**

Principle of operation of single and three phase Voltage fed Z-Source/Quasi Z-source inverter – Current fed Z-Source Inverter. Modulation Methods and Comparison: Sine wave pulse width modulations, Space Vector Modulations, Pulse Width Amplitude Modulations – Comparison of All modulation methods. Power line disturbances – Power conditioners – UPS: offline UPS-online UPS.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Design and simulation of inverter for refrigerator and air-conditioner – Solar powered inverter – House hold inverter – Inverter for irrigation motor pump. Mathematical modeling and simulation of inverter for motor speed control. Design and simulation of MLI in HVDC application.

Text Books

1. Rashid M.H., "Power Electronics Circuits, Devices and Applications", Prentice Hall India, New Delhi, 4th Edition, 2014.
2. Jai P.Agrawal, "Power Electronics Systems", Pearson Education, 2nd Edition, 2002.
3. Bimal K.Bose "Modern Power Electronics and AC Drives", Pearson Education, 2nd Edition, 2003.

References Books

1. Ned Mohan,T.M Undeland and W.P Robbin, "Power Electronics: converters, Application and design", John Wiley and sons, 3rd Edition, 2008.
2. Philip T. krein, "Elements of Power Electronics", Oxford University Press, 2nd Edition, 2015.
3. P.C. Sen, "Modern Power Electronics", Wheeler Publishing Co, First Edition, New Delhi, 3rd Edition, 2015.
4. P.S.Bimbra, "Power Electronics", Khanna Publishers, 11th Edition, 2003.

Web References

1. https://www.wisdomjobs.com/e-university/power-electronics-tutorial-548.html
2. https://nptel.ac.in/courses/108/102/108102145/
3. https://nptel.ac.in/courses/108/108/108108036/
4. https://in.mathworks.com/help/physmod/sps/powersys/ug/simulating-a-dc-motor-drive.html
5. https://www.tutorialspoint.com/power_electronics/index.htm

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5	3	-	3	3	3	-	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High



P20PEE325 **PLC AND SCADA SYSTEM**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To understand the basic architecture of PLC system.
- To analyze about the programming concepts used for automation.
- To familiarize with the SCADA system Components, Communication protocols and Interfacing provisions.
- To equip with the power system Monitoring and Control techniques.
- To impart the knowledge regarding the real time fault monitoring system in power sector.

Course Outcomes

After completion of the course, students will be able to

CO1 - Analyze the different Automation system and its architecture in detail. **(K3)**
CO2 - Provide solution for the problems faced in process control Industries, Robotics field etc. through PLC. **(K3)**
CO3 - Realize the components and communication protocols used in the SCADA system. **(K3)**
CO4 - Analyze the control process and applications of SCADA in power system. **(K3)**
CO5 - Design the Automated guided, monitoring systems for process industries, oil and gas, electric power generation, distribution and utilities. **(K3)**

UNIT I INTRODUCTION TO PLC **(09 Hrs)**

Introduction to PLC, requirement of PLC automation systems – architecture of industrial PLC system – power supplies and isolators –relays – switches – transducers – sensors - Actuators – seal-in circuits- Application of PLC in process control industries and Robotics.

UNIT II PROGRAMMABLE LOGIC CONTROLLERS **(09 Hrs)**

PLC programming – ladder diagram – sequential flow chart – PLC communication and networking – PLC Selection: I/O quantity and Type, Memory size and type – industrial bus systems:modbus and profibus.

UNIT III SCADA SYSTEM **(09 Hrs)**

SCADA architecture -Functional requirements -Remote Terminal Unit (RTU) -Interface units- Human- Machine Interface Units (HMI)- Display Monitors/Data Logger Systems- Intelligent Electronic Devices (IED) - Communication requirements - Structure of Communications Protocol - IEC61850 based communication architecture- Interface provisions and communication extensions- synchronization with NCC- DCC

UNIT IV SCADA MONITORING AND CONTROL **(09 Hrs)**

Online monitoring and alarm system, trends and reports- Blocking list- Event disturbance recording- Control function: Station control- bay control- breaker control and disconnector control. Applications in Generation- Transmission and Distribution sector- Substation SCADA system Functional description, System specification.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Case study: Process automation Plants control using PLC - SCADA based Communication between control centre and remote terminal units - Case Study: Implementation of Distribution automation system using SCADA.

Text Books

1. S. Mukhopadhyay, S. Sen and A. K. Deb , "Industrial Instrumentation, Control and Automation" , Jaico Publishing House, 2nd Edition, 2013.
2. Gary Dunning, "Introduction to Programmable Logic Controllers", Cengage Learning, 3rd Edition, 2007.
3. Frank lamb, "Industrial Automation: Hands On", McGraw Hill Professional, 2nd Edition, 2013.
4. Stuart A. Boyer, "SCADA-Supervisory Control and Data Acquisition", Instrument Society of America Publications,USA, 4th Edition, 2010.
5. Gordon Clarke, Deon Reynders, "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes Publications, Oxford, UK, 2004.
6. William T. Shaw, "Cybersecurity for SCADA systems", PennWell Books, 5th Edition, 2006.

References Books

1. R. Krishnan , "Electric Motor Drives, Modelling, Analysis and Control", Prentice Hall India, New Delhi, 4th Edition, 2015.
2. Singh, "Process Control", PHI Learning, 1st Edition, 2009.
3. David Bailey, Edwin Wright, "Practical SCADA for industry", IDC Technologies Pvt. Ltd., 3rd Edition, 2003.
4. Michael Wiebe, "A guide to utility automation: AMR, SCADA, and IT systems for electric Power", PennWell 1st Edition, 1999.
5. Dieter K. Hammer, Lonnie R. W elch, Dieter K. Hammer, "Engineering of Distributed Control Systems", Nova Science Publishers, USA, 1st Edition, 2001.

Web References

1. https://www.electricaltechnology.org/2015/09/scada-systems-for-electrical-distribution.html
2. https://www.watelectrical.com/scada-applications-in-power-system/
3. https://link.springer.com/chapter/10.1007/978-3-319-51118-4_15
4. https://www.powersystem.org/services/technology-communications-automation/scada-landing-page/scada-distribution-scada/
5. https://etap.com/packages/electrical-scada
6. https://www.controleng.com/articles/scada-remains-relevant-for-industrial-automation/

COs/POs/PSOs Mapping

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5	3	-	2	2	2	-	3	2	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PEE326 **ADVANCED DIGITAL SIGNAL PROCESSING**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To expose the fundamentals of digital signal processing and digital filters.
- To gain knowledge on the concepts of wavelet transform.
- To understand the fundamentals of audio signal processing and its applications.
- To discuss the architecture concepts for commercial family of digital signal processors.
- To acquire knowledge on simulation tools and application with DSP based interfacing.

Course Outcomes

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

CO1 - Analyze the Time and frequency domain concepts of signal transforms. **(K3)**
CO2 - Utilize wavelet transforms and relationship of multirate signal processing to filter banks. **(K3)**
CO3 - Analyze the quality and properties of speech based on digital signal processing. **(K3)**
CO4 - Interpret and compare the architectural features of commercial digital signal processors. **(K3)**
CO5 - Simulate and design filters, DSP based interfacing. **(K3)**

UNIT I INTRODUCTION TO DIGITAL SIGNAL PROCESSING **(09 Hrs)**

Introduction to Digital Signal Processing System- Discrete Time Sequences- Time-Invariant & Time- variant Systems, Decimation and Interpolation- The Sampling Process - Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT) - Basics of Digital Filters- FIR Filters, IIR Filters--adaptive filter based on LMS.

UNIT II WAVELET TRANSFORM **(09 Hrs)**

Introduction to continuous wavelet transform- discrete wavelet transform -orthogonal wavelet decomposition- Multiresolution Analysis-Wavelet function-DWT, bases, orthogonal Basis-Scaling function, Wavelet coefficients- Multirate signal processing and their relationship to filter banks-Digital filtering interpolation (i) Decomposition filters, (ii) reconstruction, the signal- Example MRAHaar & Daubechies wavelet.

UNIT III AUDIO SIGNAL PROCESSING **(09 Hrs)**

Introduction to Speech and Audio Processing - Speech Signal Processing- Pitch-period estimation, all-pole and all-zero filters- convolution - autoregressive model, autocorrelation estimation, General structure of speech coders; Requirements of speech codecs –quality, LPC model of speech production- LPC encoders and decoders-Power spectral density, periodogram ,Spectral measures of audio signal.

UNIT IV ARCHITECTURES OF COMMERCIAL DIGITAL SIGNAL PROCESSORS **(09 Hrs)**

Introduction, categorization of DSP Processors-one case example Architecture Processor for Fixed Point (Blackfin), Floating Point & Speech Processor- Basics of Architecture – study of functional variations of Computational building blocks (with comparison onto their MAC, Bus Architecture, I/O interface, application).

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Discussions/ Miniproject / Practice on Workbench: Signal analysis, Filter design concepts with simulation tools to understand the commercial DSP processor technology and practice in programming. Application with DSP based Interfacing- Power Meter; DSP as motor control.

Text Books

1. John G. Proaks, Dimitris G. Manolakis, "Digital Signal Processing", Pearson Education, 1st Edition,2002.
2. Vinay K.Ingle,John G.Proakis, "DSP-A Matlab Based Approach",Cengage Learning, 1st Edition,2010.
3. Taan S.Elali, "Discrete Systems and Digital Signal Processing with Matlab", CRC Press, 1st Edition,2009.
4. Sen M.Kuo,Woon-Seng,S.Gan,Digital Signal Processors-Architectures, implementation and applications", Pearson Education , 1st Edition, 2008.
5. Avatar Sing, S. Srinivasan, "Digital Signal Processing- Implementation using DSP Microprocessors with Examples from TMS320C54xx", Thomson India, 1st Edition, 2004.
6. John G. Proakis, Vinay K. Ingle,"Digital Signal Processing Using MATLAB®: A Problem Solving",Cengage Learning India Pvt. Ltd., 4th Edition, 2017.

Reference Books

1. Ashok Ambardar, "Digital Signal Processing: A Modern Introduction", Thomson India Edition, 1st Edition, 2007.
2. K.P. Soman and K.L. Ramchandran, "Insight into WAVELETS from theory to practice", Eastern Economy Edition, 2008
3. Ifeachor E. C., Jervis B. W , "Digital Signal Processing: A practical approach", Pearson-Education, PHI, 1st Edition, 2002
4. B Venkataramani and M Bhaskar "Digital Signal Processors", TMH, 2nd Edition, 2010
5. A.M.Kondoz, "Digital Speech" Wiley Students_ Edition, 2nd Edition, 2004.

Web References

1. https://swayam.gov.in/nd1_noc20_ee21/preview
2. https://www.researchgate.net/publication/3051058_Teaching_DSP_Software_Development_From_Design_to_Fixed-Point_Implementations
3. https://www.researchgate.net/publication/261431677_Design_of_brushless_DC_motor_control_system_based_on_DSP
4. http://www-syscom.univ-mlv.fr/~zaidi/teaching/dsp-esipe-oc2/Course-Notes__Advanced-DSP.pdf
5. http://www.nptelvideos.in/2012/12/advanced-digital-signal-processing.html

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5	3	-	2	2	1	-	3	2	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PEE327	ROBOTICS AND CONTROL	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To introduce robot terminologies and robotic sensors and to study direct and inverse kinematic relations.
- To educate on formulation of manipulator Jacobians and introduce path planning techniques.
- To understand different motion planning strategies of Robots.
- To equip with the robot dynamics and control techniques.
- To practice the hands-on experience with the Robots.

Course Outcomes

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

CO1- Understands the components and basic terminology of Robotics. **(K2)**
CO2- Understands kinematic relations in Robotics. **(K2)**
CO3- Models the motion of Robots and analyze the workspace and trajectory panning of robots. **(K3)**
CO4- Formulates models for the control of mobile robots in various industrial applications. **(K3)**
CO5- Develop real time application based Robots. **(K3)**

UNIT I INTRODUCTION AND TERMINOLOGIES **(09 Hrs)**

Definition-Classification-History- Robots components-Degrees of freedom-Robot joints coordinates-Reference frames-workspace-Robot languages-actuators-sensors-Position, velocity and acceleration sensors-Torque sensors-tactile and touch sensors-proximity and range sensors vision system-social issues.

UNIT II KINEMATICS **(09 Hrs)**

Mechanism-matrix representation-homogenous transformation-DH representation-Inverse kinematics solution and programming-degeneracy and dexterity.

UNIT III DIFFERENTIAL MOTION AND PATH PLANNING **(09 Hrs)**

Jacobian-differential motion of frames-Interpretation-calculation of Jacobian-Inverse Jacobian- Robot Path planning

UNIT IV DYNAMIC MODELLING and ROBOT CONTROL SYSTEM **(09 Hrs)**

Lagrangian mechanics- Two-DOF manipulator- Lagrange-Euler formulation – Newton- Euler formulation – Inverse dynamics- Linear control schemes- joint actuators- decentralized PID control- computed torque control –force control- hybrid position force control- Impedance/ Torque control.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Robot end effectors: Mathematical modelling of arm design- Modelling of Automated car parking Robots. Colour Sensing Robot using simulation software

Text Books

1. Saeed B Niku, "Introduction to Robotics Analysis, Systems, Applications", John Wiley and Sons, 2nd Edition, 2010.
2. Mark W. Spong, Seth Hutchinson, M. Vidyasagar , "Robot Modeling and Control", John Wiley and Sons, 2nd Edition, 2020.
3. Mittal R K and Nagarath I J, "Robotics and Control", Tata McGraw Hill, 1st Edition, 2005.
4. John J. Craig, "Introduction to Robotics, Mechanics and Control", Addison – Wesley Publication, 3rd Edition 2018.

Reference Books

1. Ashitava Ghoshal, "Robotics-Fundamental Concepts and Analysis", Oxford University Press, 6th Edition 2010.
2. Spyros G Tzafestas, "Introduction to Mobile Robot Control", Elsevier Science, 1st Edition 2018.
3. K. K.AppuKuttan, "Robotics", I K International Publication, 1st Edition, 2007.
4. Bijoy K. Ghosh, T. J. Tarn, Ning Xi, "Control in Robotics and Automation: Sensor Based Integration", Academic Press,1st Edition, 2011.
5. Richard D Klafter, Thomas A.Chmielewski and Michael Negin, "Robotic Engineering: An Integrated approach", Prentice Hall of India, New Delhi, 1st Edition, 2005.

6. Michael Margolis, Make an Arduino-Controlled Robot, Maker Media, Inc, 1st Edition, 2012.

Web References

1. https://swayam.gov.in/nd1_noc20_me03/preview
2. https://robotacademy.net.au/masterclass/introduction-to-robotics/
3. https://ocw.mit.edu/courses/mechanical-engineering/2-12-introduction-to-robotics-fall-2005/
4. https://see.stanford.edu/course/cs223a
5. https://www.coursera.org/learn/mobile-robot#syllabus

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Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PEE328	POWER QUALITY	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To identify the various power quality issues in Power system and familiar with sources and mitigation techniques.
- To obtain the characteristic of different types of power quality issues with respect to nonlinear loads and to understand the various mitigation and measuring techniques.
- To understand the active compensation techniques used for power factor correction.
- To understand the active compensation techniques used for load voltage regulation.
- To familiarize with the simulation and performance analysis of various power quality improvement schemes.

Course Outcomes

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

CO1- Analyze the various Power quality problems and their effects in power system. **(K3)**
CO2- Find the measuring methods of power quality issues such as harmonics, voltage sag, voltage swell, transients etc. **(K3)**
CO3- Formulate and design the mitigation methods of power quality issues. **(K3)**
CO4- Analyze and design the load compensation methods useful for mitigating of power quality problems. **(K3)**
CO5 - Design the model of various power quality improvement schemes such as Filters, DVR, DSTACOM and UPQC using simulation software. **(K3)**

UNIT I INTRODUCTION **(09 Hrs)**

Introduction - Characteristics of Power Quality: Transients- short term and long term voltage variations -Voltage imbalance, Harmonic distortion- Noise - Voltage fluctuations – Sag - Swell - Power frequency variation, Power acceptability curves – power quality problems: poor load vs. power factor – Nonlinear and unbalanced loads - DC offset in loads - Notching in load voltage - Disturbance in supply voltage - Power quality standards.

UNIT II ANALYSIS OF SINGLE PHASE AND THREE PHASE SYSTEM **(09 Hrs)**

Single phase sinusoidal, non-sinusoidal source supplying linear and nonlinear loads – Three phase Balance system – Three phase unbalanced system – Three phase unbalanced and distorted source supplying nonlinear loads – Concept of PF in Three phase three wire and four wire system.

UNIT III LOAD COMPENSATION METHODS **(09 Hrs)**

Principle of Load compensation and Voltage regulation – Classical load balancing problem: Open loop balancing – Closed loop balancing, Current balancing – Harmonic reduction and voltage sag reduction – Analysis of unbalance – instantaneous real and reactive powers – Extraction of fundamental sequence component.

UNIT IV COMPENSATION IN POWER DISTRIBUTION SYSTEM **(09 Hrs)**

Compensation of single phase loads – Ideal three phase shunt compensator structure - Generating reference currents using instantaneous PQ theory – Instantaneous symmetrical components theory – Generation of reference currents in unbalanced systems - Realization and control of DSTATCOM - DSTATCOM in Voltage control mode. DVR Structure - Rectifier supported DVR - DC Capacitor supported DVR — voltage Restoration – Series Active Filter – Unified Power Quality Conditioner.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Simulation and comparison of power quality improvement schemes – active and passive filters, DSTATCOM, DVR and UPQC.

Text Books

1. Arindam Ghosh, "Power Quality Enhancement Using Custom Power Devices", Kluwer Academic Publishers, 1st Edition, 2002.
2. Suresh mikkili and anup kuamr panda, " power quality issues-current harmonics, CRC press, Taylor & Francis Inc CRC press, 1st Edition,2018.
3. G.T.Heydt, "Electric Power Quality", Stars in a Circle Publications, 2nd Edition, 1994.
4. R.C. Duggan, Mark.F. Mc Granaghan, SuryaSantoas and H.WayneBeaty, "Electrical Power System

Quality", McGraw-Hill, 1st Edition, 2004.
5. Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, "Power Quality: Problems and Mitigation Techniques", John Wiley & Sons, 1st Edition, 2015.

Reference Books

1. Kolar, J.W. Schafmeister, F. Round, S.D. Ertl, H. ETH Zurich and Zurich, "Novel Three-Phase AC–AC Sparse Matrix Converters", Vol.22, No.5, IEEE Transactions on Power Electronics, Sept. 2007, pp. 1649 – 1661.
2. K.R. Padiyar, "FACTS controllers in power transmission and distribution", New Age International publishers, New Delhi, 3rd Edition, 2009.
3. K.R. Padiyar, "HVDC Power Transmission Systems", New Age International publishers, New Delhi, 3rd Edition, 2016.
4. J. C. Das, "Power System Harmonics and Passive Filter Designs", John Wiley & Sons publications, 1st Edition, 2015.

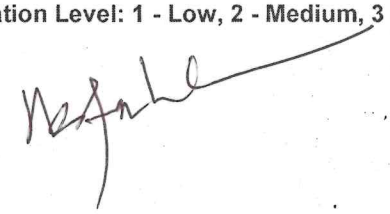
Web References

1. https://swayam.gov.in/nd1_noc20_ee10/preview
2. https://nptel.ac.in/courses/108/107/108107157/
3. https://nptel.ac.in/courses/108/106/108106025/
4. https://new.siemens.com/global/en/products/energy/high-voltage/facts.html
5. https://ieeexplore.ieee.org/document/8728052

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	2	2	2	-	3	3	3
2	3	-	2	2	2	-	3	3	3
3	3	-	2	2	2	-	3	3	3
4	3	-	2	2	2	-	3	3	3
5	3	-	2	2	2	-	3	3	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High



P20PEE329	ADVANCED DIGITAL SYSTEM DESIGN	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To learn about sequential machines and ASM charts.
- To design asynchronous sequential circuit design and to learn about hazards and race occurrences in it.
- To learn and design Finite State Machines.
- To impart the knowledge on system controllers using combinational circuits.
- To simulate the designed digital circuits and implement the FPGA based design.

Course Outcomes

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

CO 1- Design and analyze the synchronous sequential circuits and ASM charts. **(K3)**
CO 2- Design and analyze the asynchronous sequential circuits. **(K3)**
CO 3- Design the multi input system control design and concepts related to conditional outputs. **(K3)**
CO 4- Design the system controllers using combinational circuits. **(K3)**
CO 5- Design and analyze digital systems with various constraints and the implementation of FPGA based Design **(K3)**

UNIT I SYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN **(09 Hrs)**

Analysis of clocked synchronous sequential circuits and modeling- state diagram - state table - state table assignment and reduction - design of iterative circuits - ASM chart and realization using ASM.

UNIT II ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN **(09 Hrs)**

Analysis of asynchronous sequential circuit – Cycles – Races - Static, Dynamic and Essential hazards – Primitive Flow Table - State Reductions and State Assignment - Design of asynchronous sequential circuits.

UNIT III VEM AND INTRODUCTION TO MULTI-INPUT SYSTEM CONTROLLER DESIGN **(09 Hrs)**

Variable Entered Maps – simplification - System Controllers – Design Phases – MDS Diagram Generation – MDSD Symbology – Choosing the controller architecture – State Assignment – Next State decoder – Examples of 2s complement system and Pop Vending Machine – Concepts related to the use of conditional outputs.

UNIT IV SYSTEM CONTROLLERS USING COMBINATIONAL MSI / LSI CIRCUITS **(09 Hrs)**

Decoders and Multiplexers in system controllers – Indirect-Addressed MUX configuration – System controllers using ROM.

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Simulation of synchronous/ asynchronous sequential circuits: System controllers using Shift Registers and Counters- Logic compilation - two level and multi-level logic synthesis - sequential logic synthesis -technology mapping - tools for mapping to PLDs and FPGAs- FPGA based systems design: Implementation of simple systems using FPGA exercising the timing closure paths-Physical design automation: Partitioning, floor-planning, placement, routing; clock design considerations, timing margins, clock skew, clock distribution networks.

Text Books

1. Charles H R Jr, Larry L K, — Fundamentals of Logic Design ll, 7th Edition, Global Engineering, 2004.
2. Stephen Brown, and Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog Design", 3rd Edition, McGraw-Hill, 2014, ISBN 978-0-07-338054-4.
3. O. Hamblen, T. S. Hall, and M. D. Furman, "Rapid Prototyping of Digital Systems", SPOC Edition, Springer, 2008.
4. Steve Kilts., "Advanced FPGA Design: Architecture, Implementation, and Optimization", ISBN: 9780470054376, Publishers: Wiley, 2007.

Reference Books

1. William I. Fletcher, " An Engineering Approach to Digital Design", Prentice Hall India, 2011.
2. Nripendra N Biswas , "Logic Design Theory", Prentice Hall of India,2001.
3. Programming FPGAs-Getting Started with Verilog by Simon Monk, ISBN: 978- 1259643767, McGrawHill Publications. LBE Books, ISBN: 978-0982497098,

Web References

1. http://nptel.ac.in/courses/117108040/downloads/Digital%20System%20Design.pdf
2. https://www.doulos.com/knowhow/verilog_designers_guide/
3. https://www.nandland.com/
4. https://freevideolectures.com/course/3541/digital-system-design
5. https://www.xilinx.com/products/boards-and-kits/1-8dyf-11.html

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
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4	3	-	2	2	2	-	3	2	3
5	3	-	2	2	2	-	3	2	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High

P20PEE330 **CONTROL SYSTEM DESIGN**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To explore conceptual techniques in the design of sliding mode controller.
- To impart the knowledge on the design of model Predictive controllers.
- To introduce norms, random spaces and robustness measures.
- To educate the students on the LMI approach of H-infinity control.
- To introduce the control techniques for control of non-linear behaviour in power electronic systems.

Course Outcomes

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

CO1 -. Analyze and design multivariable and multi-loop control systems. **(K3)**
CO2 - Use different single-loop control and model based control schemes. **(K3)**
CO3 - Identify the need for robust control and use them for control and estimation. **(K3)**
CO4 - Explain various types of fault tolerant control schemes such as Passive and active approaches. **(K3)**
CO5 - Implement modern linear and nonlinear control strategies for power electronics devices **(K3)**

UNIT I SLIDING MODE CONTROL **(09 Hrs)**

Sliding Surfaces - Continuous approximations of Switching Control laws - The Modelling / Performance Trade-Offs- MIMO Systems. Analysis using computer simulations

UNIT II MODEL BASED PREDICTIVE CONTROL **(09 Hrs)**

MPC strategy – MPC elements – prediction models – objective function – obtaining the control law – review of MPC algorithms – Introduction to Non-linear predictive control – Applications

UNIT III ROBUST CONTROL **(09 Hrs)**

Norms of vectors and matrices – norms of systems – calculation of operator norms – vector random spaces-specification for feedback systems – co-prime factorization and inner functions –structured and unstructured uncertainty- robustness synthesis of robust controllers – small gain theorem – d-k – iteration- robust control of second-order plant- Applications.

UNIT IV OPTIMAL CONTROLLERS **(09 Hrs)**

H2 and H-infinity control – loop shaping design – Formulation – characterization of H-infinity sub-optimal controllers by means of Riccati equations – H-infinity control with full information – H-infinity estimation. LQG controller

UNIT V INSTRUCTIONAL ACTIVITY **(09 Hrs)**

Design of Model Predictive controllers for Inverters – Case Study on Sliding mode controller for Electric Vehicles.

Text Books

1. Sinha A, "Linear Systems: Optimal and Robust Control", CRC Press, 1st Edition, 2007.
2. Naidu D.S, "Optimal Control System", CRC Press, 1st Edition, 2002.
3. Hebertt Sira-Ramírez, Ramón Silva-Ortigoza, "Control Design Techniques in Power Electronics Devices", Springer, 1st Edition, 2006.
4. Bianca Lupei, "Advanced Model Predictive Control", Scitus Academics, 1st Edition, 2017.

Reference Books

1. Da-Wei G, Petkov PH and Konstantinov MM, "Robust Control Design with MATLAB®", Springer, 2nd Edition, 2013.
2. Kirk D.E, "Optimal Control Theory: An Introduction", Dover publication, 1st Edition, 2004.

Web References

1. http://www.nptelvideos.com/lecture.php?id=1988
2. https://www.coursera.org/lecture/mobile-robot/sliding-mode-control-GJ3qW
3. https://nptel.ac.in/courses/108/105/108105019/

4. https://nptel.ac.in/courses/108/107/108107098/
5. https://nptel.ac.in/courses/108/107/108107115/

COs/POs/PSOs Mapping

COs	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	3	3	2	-	3	2	3
2	3	-	3	3	2	-	3	2	3
3	3	-	3	3	2	-	3	2	3
4	3	-	3	3	2	-	3	2	3
5	3	-	3	3	2	-	3	2	3

Correlation Level: 1 - Low, 2 - Medium, 3 - High

AUDIT COURSES

P20ACTX01	ENGLISH FOR RESEARCH PAPER WRITING (Common to all M.Tech Programme)	L	T	P	C	Hrs
		2	0	0	0	30

Course Objectives

- Teach improve writing skills and level of readability.
- Tell about what to write in each section.
- Summarize the skills needed when writing a Title.
- Infer the skills needed when writing the Conclusion.
- Ensure the quality of paper at very first-time submission.

Course Outcomes

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

CO1- Understand that how to improve your writing skills and level of readability. **(K2)**
CO2- Learn about what to write in each section. **(K2)**
CO3- Understand the skills needed when writing a Title. **(K2)**
CO4- Understand the skills needed when writing the Conclusion. **(K2)**
CO5- Ensure the good quality of paper at very first-time submission. **(K2)**

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING **(06 Hrs)**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

UNIT II PRESENTATION SKILLS **(06 Hrs)**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

UNIT III TITLE WRITING SKILLS **(06 Hrs)**

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT IV RESULT WRITING SKILLS **(06 Hrs)**

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

UNIT V VERIFICATION SKILLS **(06 Hrs)**

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

References

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press, 2006.
3. Goldbort R Writing for Science, Yale University Press (available on Google Books), 2006.
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book, 1998.

P20ACTX02 **DISASTER MANAGEMENT** (Common to all M.Tech Programme)

L	T	P	C	Hrs
2	0	0	0	30

Course Objectives

- Summarize basics of disaster explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches.

Course Outcomes

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

CO1- Ability to summarize basics of disaster.

CO2- Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3- Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4- Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5- Ability to develop the strengths and weaknesses of disaster management approaches.

UNIT I INTRODUCTION **(06 Hrs)**

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS **(06 Hrs)**

Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA **(06 Hrs)**

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics.

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT **(06 Hrs)**

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT **(06 Hrs)**

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

Reference Books

1. Goel S. L., "Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi, 2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies", New Royal book Company, 2007.
3. Sahni, Pardeep Et.Al. , "Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi, 2001.

P20ACTX03	SANSKRIT FOR TECHNICAL KNOWLEDGE (Common to all M.Tech Programme)	L	T	P	C	Hrs
		2	0	0	0	30

Course Objectives

- Illustrate the basic Sanskrit language.
- Recognize Sanskrit, the scientific language in the world.
- Appraise learning of Sanskrit to improve brain functioning.
- Relate Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

Course Outcomes

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

CO1- Understanding basic Sanskrit language. **(K2)**
CO2- Write sentences. **(K3)**
CO3- Know the order and roots of Sanskrit. **(K2)**
CO4- Know about technical information about Sanskrit literature. **(K2)**
CO5- Understand the technical concepts of Engineering. **(K2)**

UNIT I ALPHABETS **(06 Hrs)**

Alphabets in Sanskrit.

UNIT II TENSES AND SENTENCES **(06 Hrs)**

Past/Present/Future Tense - Simple Sentences.

UNIT III ORDER AND ROOTS **(06 Hrs)**

Order - Introduction of roots of Engineering-Electrical, Mechanical, Architecture, Mathematics.

UNIT IV SANSKRIT LITERATURE **(06 Hrs)**

Technical information about Sanskrit Literature.

UNIT V TECHNICAL CONCEPTS OF ENGINEERING **(06 Hrs)**

Technical concepts.

References

1. "Abhyaspustakam" – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi.
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication.
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

P20ACTX04	VALUE EDUCATION (Common to all M.Tech Programme)	L	T	P	C	Hrs
		2	0	0	0	30

Course Objectives

Students will be able to

- Understand value of education and self-development.
- Imbibe good values in students.
- Let the should know about the importance of character.

Course Outcomes

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

- Gain Knowledge of self-development. **(K2)**
- Learn the importance of Human values. **(K2)**
- Developing the overall personality. **(K2)**

UNIT I

Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

UNIT II

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

UNIT III

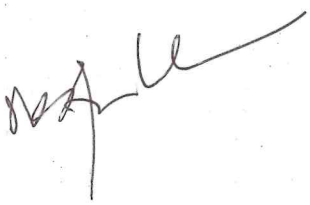
Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature.

UNIT IV

Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role.

Suggested reading

1. Chakroborty, S.K."Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi.



P20ACTX05	CONSTITUTION OF INDIA (Common to all M.Tech Programme)	L	T	P	C	Hrs
		2	0	0	0	30

Course Objectives

- Understand the premises informing the twin themes of liberty and freedom from a civil rights Perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional.
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

Course Outcomes

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

CO1- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics. **(K2)**

CO2- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India. **(K2)**

CO3- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections. **(K2)**

CO4- Discuss the passage of the Hindu Code Bill of 1956. **(K2)**

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION **(05 Hrs)**

History, Drafting Committee, (Composition & Working).

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION **(05 Hrs)**

Preamble, Salient Features.

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES **(05 Hrs)**

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE **(05 Hrs)**

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION **(05 Hrs)**

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION **(05 Hrs)**

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

Suggested reading

1. "The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edition, Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015 "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

P20ACTX06	PEDAGOGY STUDIES (Common to all M.Tech Programme)	L	T	P	C	Hrs
		2	0	0	0	30

Course Objectives

- Review existing evidence on there view topic to inform programme design and policy.
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

Course Outcomes

Students will be able to understand:

CO1- What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?**(K2)**

CO2- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners? **(K2)**

CO3- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? **(K2)**

UNIT I INTRODUCTION AND METHODOLOGY: **(06 Hrs)**

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions – Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW **(06 Hrs)**

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES **(06 Hrs)**

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT **(06 Hrs)**

Professional development: alignment with classroom practices and follows up support – Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes.

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS **(06 Hrs)**

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

Suggested reading

1. Ackers J, HardmanF (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245- 261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36(3):361-379.
3. Akyeampong K (2003) Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1.London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.
5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M(2003) Read India: Amass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

P20ACTX07	STRESS MANAGEMENT BY YOGA (Common to all M.Tech Programme)	L	T	P	C	Hrs
		2	0	0	0	30

Course Objectives

- To achieve overall health of body and mind.
- To overcome stress.

Course Outcomes

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

CO1- Develop healthy mind in a healthy body thus improving social health also **(K3)**

CO2- Improve efficiency. **(K3)**

UNIT I

Definitions of Eight parts of yoga.(Ashtanga).

UNIT II

Yam and Niyam - Do`s and Don't's in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III

Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam.

Suggested reading

1. 'Yogic Asanas for Group Tarining-Part-I":Janardan Swami Yoga bhyasi Mandal, Nagpur.
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata.

P20ACTX08	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS (Common to all M.Tech Programme)	L	T	P	C	Hrs
		2	0	0	0	30

Course Objectives

- To learn to achieve the highest goal happily.
- To become a person with stable mind, pleasing personality and determination.
- To awaken wisdom in students.

Course Outcomes

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

CO1- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life. **(K2)**

CO2- The person who has studied Geeta will lead the nation and mankind to peace and prosperity. **(K3)**

CO3- Study of Neet is hatakam will help in developing versatile personality of students. **(K3)**

UNIT I

Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's) 4-Verses 18, 38,39 Chapter18 – Verses37,38,63.

UNIT II

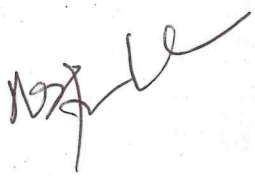
Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.model – shrimad bhagwad geeta - Chapter2- Verses 17, Chapter 3-Verses 36,37,42 – Chapter.

UNIT III

Statements of basic knowledge – Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter12 -Verses 13, 14, 15, 16,17, 18 - Personality of role.

Suggested reading

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar- vairagya, New Delhi,2010.
2. Swami Swarupananda ,Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.



P20ADC109	UNNAT BHARATH ABHIYAN (Common to all M.Tech Programme)	L	T	P	C	Hrs
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Course Objectives

- To develop an appreciation of rural culture, life-style and wisdom amongst students
- To learn about the status of various agricultural and rural development programmes
- To understand causes for rural distress and poverty and explore solutions for the same
- To apply classroom knowledge of courses to field realities and there by improve quality of learning.

Course Outcomes

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

CO1 -Gain an understanding of rural life, culture and social realities
CO2 -Develop a sense of empathy and bonds of mutuality with local community
CO3 -Appreciate significant contributions of local communities to Indian society and economy
CO4 -Learn to value the local knowledge and wisdom of the community
CO5 -Identify opportunities for contributing to community's socio-economic improvements.

UNIT I APPRECIATIONOFRURALSOCIETY (4 Hrs)

Rural lifestyle, rural society ,caste and gender relations, rural values with respect to community, nature and resources, elaboration of "soul of India lies in villages'(Gandhi), rural infrastructure.

UNIT II UNDERSTANDINGRURALECONOMY and LIVELIHOOD (4 Hrs)

Agriculture, farming, landownership, water management, animal husbandry, non-farm livelihoods and artisans, rural entrepreneurs, rural markets

UNIT III RURALINSTITUTIONS (4 Hrs)

Traditional rural organizations, Self-help Groups, Panchayat irajinstitutions (Gram Sabha, Gram Panchayat, Standing Committees),local civil society, local administration.

UNIT IV RURALDEVELOPMENTPROGRAMMES (4 Hrs)

History of rural development in India, current national programmes: Sarva Shiksha Abhiyan,BetiBachao, Beti Padhao ,Ayushman Bharat, Swatchh Bharat, PM Awaas Yojana, SkillIndia, Gram Panchayat Decentralized Planning, NRLM, MNREGA, etc.

UNIT VFIELD BASED PRACTICL ACTIVITIES (14 Hrs)

Visit MGNREGS project sites .Swachh Bharat project sites, Conduct Mission Antyodaya surveys, Interactive community exercise with local leaders, panchayat functionaries, Visit Rural Schools/mid- day meal centres, study Academic and infrastructural resources and gaps, Participate in Gram Sabha meetings, Visit local Anganwadi Centre, Conduct soil health test, drinking water analysis

Reference Books

1. .Singh,Katar,RuralDevelopment:Principles,PoliciesandManagement,SagePublications, NewDelhi, 2015.
2. AHandbookonVillagePanchayatAdministration,RajivGandhiChairforPanchayatiRajStudies, 2002.
3. UnitedNations, Sustainable Development Goals, 2015
4. M.P.Boraian, Best Practice sin Rural Development, Shanlax Publishers, 201

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