VARDHAMAN
COLLEGE OF ENGINEERING

CURRICULUM
For
Master of Technology
Power Electronics and Electrical Drives

Under

Choice Based Credit System (CBCS)

M. Tech. - Regular Two-Year Degree Program
(For batches admitted from the Academic Year 2025 - 2026)

October 2025

VARDHAMAN COLLEGE OF ENGINEERING
(Autonomous)
Affiliated to **JNTUH,** Approved by **AICTE,** Accredited by **NAAC** with **A++** Grade
Kacharam, Shamshabad, Hyderabad- 501 218, Telangana, India
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Department Vision

Producing professionally competent graduates in the domain of electrical engineering to serve the industry/society addressing the challenges.

Department Mission

M1: Provide professional skills in electrical circuit design and simulation to the students.

M2: Bringing awareness among the students with emerging technologies to meet the dynamic needs of the society.

M3: Develop industry-institute interface for collaborative research, internship and entrepreneurial skills among the stakeholders (Students/Faculty).

M4: Encourage multi-disciplinary activities through research and continuous learning activities.

Program Educational Objectives (PEOs)

PEO1: Graduates will demonstrate peer recognized technical competency to design, analyze, develop solutions for problems in the field of power electronics and electrical drives.

PEO2: Graduates will demonstrate leadership and initiative to advance professional and organizational goals with commitment to ethical standards of profession, teamwork and respect for diverse cultural background.

PEO3: Graduates will be engaged in ongoing learning and professional development through pursuing higher education and self study.

PEO4: Graduates will be committed to creative practice of engineering and other professions in a responsible manner contributing to the socio-economic development of the society.

Knowledge and Attitude Profile (WK)

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost,reuse of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

Program Outcomes (POs)

PO1: An ability to independently carry out research/investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: An ability to demonstrate a degree of mastery in the domain of power electronics and electrical drives.

PO4: An ability to identify Power Electronics based solutions to improve power conversion, power quality and reliability in electrical systems.

PO5: An ability to conceptualize, design and analyze various control strategies for energy efficient drives.

United Nations Sustainable Development Goals (SDGs)

SDG1: **No Poverty** – End poverty in all its forms everywhere.

SDG2: **Zero Hunger** – End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

SDG3: **Good Health and Well-Being** – Ensure healthy lives and promote well-being for all at all ages.

SDG4: **Quality Education** – Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

SDG5: **Gender Equality** – Achieve gender equality and empower all women and girls.

SDG6: **Clean Water and Sanitation** – Ensure availability and sustainable management of water and sanitation for all.

SDG7: **Affordable and Clean Energy** – Ensure access to affordable, reliable, sustainable and modern energy for all.

SDG8: **Decent Work and Economic Growth** – Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

SDG9: **Industry, Innovation and Infrastructure** – Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

SDG10: **Reduced Inequalities** – Reduce inequality within and among countries.

SDG11: **Sustainable Cities and Communities** – Make cities and human settlements inclusive, safe, resilient and sustainable.

SDG12: **Responsible Consumption and Production** – Ensure sustainable consumption and production patterns.

SDG13: **Climate Action** – Take urgent action to combat climate change and its impacts.

SDG14: **Life Below Water** – Conserve and sustainably use the oceans, seas and marine resources for sustainable development.

SDG15: **Life on Land** – Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

SDG16: Peace, Justice and Strong Institutions – Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.

SDG17: Partnerships for the Goals – Strengthen the means of implementation and revitalize the global partnership for sustainable development.

I M.Tech. I Semester													
#	Course Code	Title of the Course	Category	Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
				CI		LI	TW + SL	H	C	CIE	SEE	Total
				L	T	P	SL					
Theory Courses												
1	B7301	Analysis of Power Converters	PC	45	-	-	45	90	3	40	60	100
2	B7302	Machine Modelling and Analysis	PC	45	-	-	45	90	3	40	60	100
3	B7001	Research Methodology and IPR	MC	30	-	-	30	60	2	40	60	100
Professional Elective – I												
4	B7351	Power Semiconductor Devices and Modelling	PE	45	-	-	45	90	3	40	60	100
	B7352	Reactive Power Compensation and Management										
	B7353	High Frequency Magnetic Design										
	B7354	Sustainable Energy Solutions										
Professional Elective – II												
5	B7355	Power Quality Improvement Techniques	PE	45	-	-	45	90	3	40	60	100
	B7356	Battery Technologies										
	B7357	Distributed Generation and Microgrid Technologies										
	B7358	Modern Control Theory										
Practical Courses												
6	B7303	Analysis of Power Converters Laboratory	PC	-	-	60	-	60	2	40	60	100
7	B7304	Machine Modelling and Analysis Laboratory	PC	-	-	60	-	60	2	40	60	100
Audit Course												
8		Audit Course - I	AC	30	-	-	-	30	0	100	-	100
Total				240	0	120	210	570	18	380	420	800

I M.Tech. II Semester												
#	Course Code	Title of the Course	Category	Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
				CI		LI	TW + SL	H	C	CIE	SEE	Total
				L	T	P	SL					
Theory Courses												
1	B7305	Electrical Drives	PC	45	-	-	45	90	3	40	60	100
2	B7306	Analysis of Advanced Power Converters	PC	45	-	-	45	90	3	40	60	100
Professional Elective – III												
3	B7359	Power Electronics for Renewable Energy Systems	PE	45	-	-	45	90	3	40	60	100
	B7360	Advanced Control Techniques for power converters										
	B7361	Microcontroller Applications to Power Electronics										
	B7362	Smart Metering and Communication Protocols										
Professional Elective – IV												
4	B7363	Electric Vehicle Technologies	PE	45	-	-	45	90	3	40	60	100
	B7364	Wide Band Gap Devices for Power Electronics Applications										
	B7365	Digital Signal Processing										
	B7366	Dynamics of Electrical Machines										
Practical Courses												
5	B7307	Electrical Drives Laboratory	PC	-	-	60	-	60	2	40	60	100
6	B7308	Analysis of Advanced Power Converters Laboratory	PC	-	-	60	-	60	2	40	60	100
Experiential Learning Course												
7	B7041	Mini-Project with seminar	PW	-	-	-	90	90	2	40	60	100
8		Dissertation Work Review - I	PW	-	-	-	-	-	-	-	-	-
Audit Course												
9		Audit Course - II	AC	30	-	-	-	30	0	100	-	100
Total				210	0	120	270	600	18	380	420	800

II M.Tech. I Semester												
#	Course Code	Title of the Course	Category	Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
				CI		LI	TW + SL	H	C	CIE	SEE	Total
				L	T	P	SL					
Professional Elective – V												
1	B7367	Electric Vehicle Charging Techniques	PE	45	-	-	45	90	3	40	60	100
	B7368	DSP Based Drive Control										
	B7369	Digital Control of Power Electronic Drives										
	B7370	Data Science Applications in Power Engineering										
Open Elective												
2	B7081	Business Analytics	OE	45	-	-	45	90	3	40	60	100
	B7082	Waste to Energy										
	B7083	Operations Research										
	B7084	Blockchain Technology										
	B7085	Cyber Security										
Experiential Learning Course												
3	B7042	Dissertation Work Review – II	PW	-	-	-	270	270	6	100	-	100
Total				90	0	0	360	450	12	180	120	300

II M.Tech. II Semester												
#	Course Code	Title of the Course	Category	Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
				CI		LI	TW + SL	H	C	CIE	SEE	Total
				L	T	P	SL					
Experiential Learning Course												
1	B7043	Dissertation Work Review – III	PW	-	-	-	270	270	6	100	-	100
2	B7044	Dissertation Viva-Voce	PW	-	-	-	630	630	14	-	100	100
Total				0	0	0	900	900	20	100	100	200

List of Audit Courses

#	Course Code	Title of the Course
1	B7091	Disaster Management
2	B7092	Value Education
3	B7093	Constitution of India
4	B7094	Stress Management by Yoga
5	B7095	Pedagogy Studies
6	B7096	English for Research Paper Writing

Common Abbreviations Used in the Curriculum

PC	– Professional Core	L	– Lecture Hours
MC	– Mandatory Course	T	– Tutorial Hours
AC	– Audit Course	P	– Practical Hours
PE	– Professional Elective	TW	– Team Work
OE	– Open Elective	SL	– Self Learning
PW	– Project Work	H	– Hours
CI	– Classroom Instruction	C	– Credits
LI	– Laboratory Instruction	CIE	– Continuous Internal Evaluation
SDG	– Sustainable Development Goals	SEE	– Semester End Examination

I M.Tech. I Semester

B7301 – Analysis of Power Converters

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces the principles, analysis, and control of power electronic converters and inverters. It covers single-phase and three-phase controlled converters, pulse-width modulated inverters, and advanced modulation strategies for performance improvement. The course also discusses three-phase inverter operation, voltage control methods, and various PWM techniques, along with the study of multilevel inverter topologies and their applications. Emphasis is placed on performance evaluation, harmonic reduction, and suitability for modern power systems and drives.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation and Infrastructure
SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

- B7301.1. Analyze the operation and performance of single-phase power electronic converters
- B7301.2. Analyze the characteristics and control strategies of three-phase power electronic converters.
- B7301.3. Apply pulse width modulation techniques for effective control of inverters.
- B7301.4. Evaluate the performance of three-phase inverters under various modulation and control methods.
- B7301.5. Compare different multilevel inverter topologies and assess their suitability for power system applications.

Course Syllabus

Unit-I:

Single Phase Converters: Half controlled and fully controlled converters, Evaluation of input power factor and harmonic factor, continuous and Discontinuous load current, Single phase dual converters, Power factor Improvement Techniques, Extinction angle control, Symmetrical angle control, Single phase sinusoidal PWM.

Unit-II:

Three Phase Converters: Half controlled and fully controlled converters, Evaluation of input power factor and harmonic factor, Continuous and Discontinuous load current, three phase dual converters, Power factor Improvement Techniques, Three-phase PWM, Twelve-pulse converters.

Unit-III:

Pulse Width Modulated Inverters: Principle of operation, Performance parameters, Single phase bridge inverter, Evaluation of output voltage and current with resistive, inductive and capacitive loads, Voltage control of single-phase inverters, Single PWM, Multiple PWM, Sinusoidal PWM, Modified PWM, Phase displacement

Control, Advanced modulation techniques for improved performance, Trapezoidal, Staircase, Stepped, Harmonic injection and Delta modulation, Advantages. .

Unit-IV:

Three Phase Inverters: Introduction to Three phase inverter, Analysis of 180-degree conduction for output voltage And current with resistive, inductive loads, Analysis of 120-degree Conduction, Voltage control of three phase inverters, Sinusoidal PWM, Third Harmonic PWM, 60-degree PWM, Space vector modulation, Comparison of PWM techniques, Harmonic reductions.

Unit-V:

Multilevel Inverters: Multilevel concept, Classification of multilevel inverters, Principle of operation, main features and comparison of Diode clamped, Improved diode Clamped, Flying capacitors, Cascaded multilevel inverters, Multilevel inverter applications, Reactive power compensation, DC link capacitor voltage balancing.

Books and Materials

Text Books:

1. Mohammed H. Rashid *Power Electronics* , 2nd ed., Pearson Education, 3rd Edition, 1st Indian reprint, 2004.
2. Ned Mohan Tore M. Undeland and William P. Robbins *Power Electronics* , 3rd ed., John Wiley & Sons, 2nd Edition, 1995.

Reference Books:

1. Shepherd, W., Zhang, L., *Power Converter Circuits* , 3rd 1st ed., CRC Press, 2004.
2. Marian P. Kazmierkowski, R. Krishnan, Frede Blaabjerg. *Control in Power Electronics: Selected Problems* , 2nd Academic Press, 2002.

B7302 – Machine Modelling and Analysis

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces the modeling and analysis of electrical machines based on the principles of electromagnetic energy conversion. It covers steady-state and dynamic characteristics of DC, induction, and synchronous machines, along with reference frame theory for variable transformation. Emphasis is placed on deriving machine equations, analyzing performance under varying load conditions, and applying digital simulation techniques for accurate representation of machine behavior.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 7 – Affordable and Clean Energy
SDG 9 – Industry, Innovation and Infrastructure

Course Outcomes

After the completion of the course, the student will be able to:

- B7302.1. Apply the principles of electromagnetic energy conversion to evaluate force, torque, and inductance in electrical machines.
- B7302.2. Analyze the steady-state and dynamic characteristics of permanent-magnet and shunt DC machines using equations, block diagrams, transfer functions, and digital simulation.
- B7302.3. Utilize reference frame theory and transformation techniques for simplifying the analysis of electrical machine variables.
- B7302.4. Analyze and simulate the steady-state and dynamic performance of induction machines under different loading conditions
- B7302.5. Develop models of synchronous machines and evaluate their steady-state and dynamic performance using reference frame theory.

Course Syllabus

Unit-I:

Principles of Electro Magnetic Energy Conversion: 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: Elementary DC machine and analysis of steady state operation - Voltage and torque equations – dynamic characteristics of permanent magnet and shunt DC motors – electrical and mechanical time constants - Time domain block diagrams –transfer function of DC motor-responses – digital computer simulation of permanent magnet and shunt DC machines.

Unit-III:
Reference Frame Theory: 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:
Induction Machines: Three phase induction machine, equivalent circuit and analysis of steady state operation –free acceleration characteristics – voltage and torque equations in machine variables and arbitrary reference frame variables – analysis of dynamic performance for load torque variations – modeling of multiphase machines - digital computer simulation of three phase induction machines.

Unit-V:
Synchronous Machines: Three phase synchronous machine and analysis of steady state operation - voltage and torque equations in machine variables and rotor reference frame variables (Park's equations) – analysis of dynamic performance for load torque variations – digital computer simulation of synchronous machines.

Books and Materials

Text Books:

1. P.S. Bimbhra *Generalized Theory of Electrical Machines* , 2nd ed., Khanna Publishers, 7th Edition, 2021
2. Paul Krause, Oleg Wasynezuk, Scott Shroff. *Analysis of Electric Machinery and Drives Systems.*, 3rd ed., 2nd Edition, Wiley-IEEE Press, 2002.

Reference Books:

1. R. Krishnan *Electric motor drives modeling, analysis and control.*, 3rd ed., PHI-India-2009.
2. G. K. Dubey *Fundamentals of electric Drives* , 2nd ed., Narosa Publishing House", 2nd Edition, 2011.
3. R Ramanujam *Modelling and Analysis of Electrical Machines* , 2nd ed., I.K International Publishing Pvt. Ltd., New Delhi, 2018.

B7001 – Research Methodology and IPR

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
30	0	0	30	60	2	40	60	100

Course Description

Course Overview

Research is an art of scientific investigation. Research is an original contribution to the existing stock of knowledge making for its advancement. It is the pursuit of truth with the help of study, observation, comparison and experiment. This course will help students to understand about the research process, tools, importance of ethics. Students can learn about the law of patent and copyrights and knowledge on IPR (Intellectual Property rights).

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation and Infrastructure
SDG 16 – Peace, Justice and Strong Institutions

Course Outcomes

After the completion of the course, the student will be able to:

B7001.1. Identify an appropriate research problem in their suitable domain.
B7001.2. Construct a well-structured research paper and scientific presentations.
B7001.3. Express the importance of research ethics in scientific community.
B7001.4. Explore on various component of IPR and process of filing.
B7001.5. Gain knowledge on patents and copyrights.

Course Syllabus

Unit-I:

Research Problem: Scope and objectives, Selection criteria, Research Problems, Research Approaches, Data collection, Data analysis, Ethics, Instrumentation, Interpretation.

Unit-II:

Literature Studies: Effective literature studies, Types of literature review, Process and Purpose, Survey, Critical analysis, classification and comparison, case study, identifying the knowledge gap and propose a action plan.

Unit-III:

Technical Writing: Effective Report/Article/Thesis writing, tools required, documentation using suitable application (Word, LaTeX, Pages), data representation using graphs, bar diagrams, pi-charts, preparation of manuscript, plagiarism, presentation of research work, Abstract and Conclusion.

Unit-IV:

Research proposal: Problem defining, national and international Scenario of proposed research, key factors, cost and contingencies, preparing timeline for research plan, funding agencies, collaboration, product and patent development.

Unit-V:

Patent Rights and IPR: Process of Patenting and Development, Copyright, Trademark, Licensing and transfer of technology, Patent information and databases, New Developments in IPR, Administration of Patent System, Trade Secret, Copyright Infringement.

Books and Materials

Text Books:

1. C.R. Kothari, Gaurav Garg, Research Methodology : Methods And Techniques, New Age International Publishers; 4^{th} edition, 2019
2. P Suganda Devi, Research Methodology: A Handbook for Beginners, Notion Press; 1st edition, 2017

Reference Books:

1. Brad Sherman and Lionel Bently, Intellectual Property Law, Oxford University Press, 4^{th} edition, 2014

PROFESSIONAL ELECTIVE-I

B7351 – Power Semiconductor Devices and Modelling

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces the fundamental principles, characteristics, and applications of power semiconductor devices used in modern power electronics. It covers power diodes, BJTs, thyristors, TRIACs, GTOs, MOSFETs, and IGBTs, emphasizing switching behavior, on/off-state characteristics, and device protection. Advanced topics include MOS-gated thyristors, thermal design, and snubber circuits. The course also focuses on modeling, simulation, and practical design considerations for reliable and efficient power electronic systems.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation and Infrastructure
SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

- B7351.1. Apply the knowledge of power diodes and BJTs to analyze switching characteristics and snubber requirements.
- B7351.2. Analyze the operation and control of SCRs, TRIACs, and GTOs under dynamic conditions.
- B7351.3. Apply the principles of MOSFETs and IGBTs to evaluate switching losses, FBSOA/RBSOA, and protection circuits.
- B7351.4. Analyze advanced power semiconductor devices and their gate/control requirements for modern applications.
- B7351.5. Apply thermal design principles to model, simulate, and design heat management for power electronic devices.

Course Syllabus

Unit-I:

Power Diodes and BJTs: Power Diodes: Structure, V-I characteristics, breakdown voltage control, on-state losses, switching transients (turn-on/off and reverse recovery), Schottky diodes, diode snubber, snubber design, modeling and simulation. Power BJTs: Structure, V-I characteristics, secondary breakdown and control, FBSOA/RBSOA curves, on-state losses, resistive and clamped inductive switching specifications, turn-on/off transients, storage time, base drive requirements, switching losses, device protection, snubber circuits, switching aids, modeling and simulation.

Unit-II:

SCRs and TRIACS: Silicon Controlled Rectifiers (Thyristors) – Basic structure, V-I characteristics, Turn-on process, On-state operation, Turn-off process, Switching characteristics, Turn-on transient and di/dt limitations, Turn-off transient and dv/dt limitations, Gate drive requirements, Ratings of thyristors, Snubber requirements and snubber design, Modelling and simulation of Thyristor. Triacs – Basic structure and operation, V-I characteristics, Ratings, Snubber requirements, Modelling and simulation of Triacs.

Unit-III:

GTOs and MOSFETs: GTOs – Structure, switching characteristics, turn-on/off transients, minimum on/off times, gate drive requirements, maximum controllable anode current, overcurrent protection, modeling and simulation. Power MOSFETs – Structure, V-I characteristics, turn-on/off processes, resistive and clamped inductive switching specifications, FBSOA/RBSOA curves, effect of reverse recovery transients on switching stresses, dv/dt limitations, gate charge, ratings, device protection, snubber design, modeling and simulation.

Unit-IV:

IGBTs: Structure, operation, latch-up, switching characteristics, current tailing, resistive and clamped inductive switching specifications, FBSOA/RBSOA, minimum on/off times, switching losses, gating requirements, short-circuit protection, overcurrent protection, snubber requirements and design, modeling and simulation, switching frequency capability.

Unit-V:

Advanced Devices and Thermal Design: Advanced Devices – MOS gated thyristors, MOS controlled thyristors or MOS GTO'S, Base resistance-controlled thyristors, Emitter switched thyristors. Thermal Design – Heat transfer by conduction, convection, and radiation, transient thermal impedance, heat sinks, heat sink selection for power devices, thermal modeling, and simulation.

Books and Materials

Text Books:

1. M.H. Rashid. *Power Electronics: Circuits, Devices and Applications* , 4th ed., Pearson, 2014.
2. B. Jayant Baliga. *Power Semiconductor Devices.*, 3rd ed., PWS Publishing, 2010.
3. N. Mohan, T.M. Undeland, W.P. Robbins. *Power Electronics: Converters, Applications, and Design.*, 3rd ed., Wiley, 2003.

Reference Books:

1. V. Benda, J. Gowar, D. A. Grant. *Discrete and Integrated Power Semiconductor Devices: Theory and Applications.*, John Wiley & Sons, 1999.
2. Giuseppe Massabrio, Paolo Antognetti. *Semiconductor Device Modeling with Spice* , McGraw Hill, 2010.

B7352 – Reactive Power Compensation and Management

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces the principles of reactive power control and management in power systems. Topics include load compensation, voltage regulation, and power factor correction. Transmission system compensation is covered for both steady and transient states. The course also addresses reactive power coordination, demand- and distribution-side management, and power quality issues. User-side applications in domestic systems, electric traction, and arc furnaces are included to provide practical insights into compensation strategies.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 7 – Affordable and Clean Energy
SDG 9 – Industry, Innovation and Infrastructure

Course Outcomes

After the completion of the course, the student will be able to:

- B7352.1. Apply reactive power characteristics to design load compensators for voltage regulation, phase balancing, and power factor correction.
- B7352.2. Analyze steady-state and transient compensation methods for improving transmission performance.
- B7352.3. Apply mathematical modeling to plan reactive power operation and analyze its impact on transmission efficiency and power quality.
- B7352.4. Apply economic planning techniques for capacitor placement and analyze loss reduction methods in demand-side and distribution-side systems.
- B7352.5. Analyze reactive power requirements in domestic appliances, traction systems, and arc furnaces, and apply suitable compensation strategies.

Course Syllabus

Unit-I:

Load Compensation: Objectives and specifications, Reactive power characteristics, Inductive and capacitive approximate biasing, Load compensator as a voltage regulator, Phase balancing and power factor correction of unsymmetrical loads, Examples.

Unit-II:

Reactive Power Compensation in Transmission Systems: Steady State - Uncompensated line, Types of compensation, Passive shunt and series and dynamic shunt compensation, Examples. Transient State - Characteristic time periods, Passive shunt compensation, Static compensation, Series capacitor compensation, Compensation using synchronous condenser, Examples.

Unit-III:
Reactive Power Coordination: Objective, Mathematical modeling, Operation planning, Transmission benefits, Basic concepts of quality of power supply, Disturbances, Steady–state variations, Effect of under-voltages, Frequency, Harmonics, Radio frequency and electromagnetic interference.

Unit-IV:
Demand Side Management: Load patterns, Basic methods load shaping, Power tariffs, KVAr based tariffs penalties for voltage flickers and Harmonic voltage levels. Distribution Side Reactive Power Management - System losses, Loss reduction methods, Examples, Reactive power planning, Objectives, Economics Planning capacitor placement, Retrofitting of capacitor banks.

Unit-V:
User Side Reactive Power Management: KVAr requirements for domestic appliances, Purpose of using capacitors, Selection of capacitors, Deciding factors, Types of available capacitors, Characteristics and Limitations. Reactive Power Management in Electric Traction Systems and Arc Furnaces - Typical layout of traction systems, Reactive power control requirements, Distribution transformers, Electric arc furnaces, Basic operation, Furnaces transformer, Filter requirements, Remedial measures, Power factor of an arc furnace.

Books and Materials

Text Books:

1. Miller, T. J. E. *Reactive Power Control in Electric Systems* , 1^{st} ed., New York: Wiley, 1982.
2. Tagare, D. M. *Reactive Power Management.*, 1^{st} ed., Tata McGraw-Hill Publishing Ltd., 2004.

Reference Books:

1. W. Hofmann, J. Schlabbach, and W. Just. *Reactive Power Compensation: A Practical Guide.*, 1^{st} ed., Wiley-VCH, 2012.
2. Kundur, P. *Power system stability and control* , McGraw Hill, 1994.

B7353 – High Frequency Magnetic Design

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces the principles, modeling, and design of magnetic devices, transformers, and inductors for power electronic and high-frequency applications. Topics include magnetic circuits, core materials, and magnetic losses. High-frequency effects in windings, such as skin and proximity effects and winding resistance, are covered. Transformer and inductor design, including conventional, planar, and integrated types, is addressed. Parasitic effects and self-capacitance are also discussed to enhance efficiency, reduce losses, and ensure reliable operation.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation and Infrastructure
SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

- B7353.1. Apply magnetic circuit laws and core material properties to analyze magnetic devices and core losses.
- B7353.2. Analyze skin and proximity effects and compute high-frequency winding resistance and losses.
- B7353.3. Evaluate transformer performance, including magnetizing/leakage inductances, high-frequency behavior, and design for converters.
- B7353.4. Analyze conventional and integrated inductor structures and apply design methods for high-frequency applications.
- B7353.5. Analyze self-capacitance and parasitic effects to optimize efficiency, EMI, and reliability in inductors.

Course Syllabus

Unit-I:

Fundamentals of Magnetic Devices: Magnetic relationships and laws – flux, MMF, reluctance, magnetization curves. Magnetic circuits – core saturation, volt-second balance, inductance factor, magnetic energy storage, self-resonant frequency. Magnetic losses – hysteresis loss, eddy-current loss, total core loss, classification of power losses in magnetic components. Magnetic cores – properties of materials, permeability, and hysteresis loops, complex permeability, core geometries. Overview of materials – ferrites, iron alloys, amorphous and nano-crystalline alloys, powder cores.

Unit-II:

High-Frequency Effects in Windings: Skin effect – skin depth, ratio of AC to DC resistance, impedance of round and rectangular conductors, current density distribution. Proximity effect – in single and parallel conductors, rectangular plates, multiple-layer windings; anti-proximity effect. Winding resistance at high frequencies – round, square, and rectangular conductors, effective resistance for non-sinusoidal currents, winding losses with harmonics. Techniques to reduce losses – litz wire, optimized winding structures, leakage inductance considerations. Thermal modeling of inductors – power density, resistance variation, heating effects.

Unit-III:
Transformers: Magnetic coupling – Neumann's formula, mutual inductance, energy stored in coupled inductors, magnetizing and leakage inductances. High-frequency transformer modeling – stray capacitance, interleaved vs. non-interleaved windings, thermal model of transformers. AC current transformers – construction, modeling, and performance. Winding power losses with harmonics – analytical and numerical approaches. Transformer design – area product method, optimum flux density, fly back converter design in CCM and DCM.

Unit-IV:
Inductors and Integrated Inductors: Conventional inductors – rectangular trace, circular and polygonal loops, coaxial cables, two-wire transmission line. Integrated inductors – PCB inductors, planar spiral and multi-metal inductors, meander inductors, bond-wire inductors, MEMS inductors, RF integrated inductor modeling. Design aspects – window utilization factor, mean turn length, temperature rise, restrictions on inductors. Inductor design – area product method, AC inductor design, buck converter design in CCM and DCM. Considerations of eddy currents in integrated inductors and limitations in high-frequency applications.

Unit-V:
Parasitics: Self-capacitance components in inductors – parallel-plate capacitance, foil windings, coaxial structures, parallel conductors. Self-capacitance of single-layer and multi-layer windings – modeling and measurement. High-frequency inductor models – incorporating parasitics, eddy currents, and frequency-dependent losses. Impact of parasitics – resonance, EMI/EMC considerations, efficiency limitations, and reliability issues in high-frequency operation.

Books and Materials

Text Books:

1. Umanand L., Bhat S.R. *Design of Magnetic Components for Switched Mode Power Converters* , Wiley Eastern, 1992.
2. Marian K. Kazimierczuk. *High-Frequency Magnetic Components.*, Wiley, 2009.
3. Wm. T. McLyman. *Transformer and Inductor Design Handbook.*, 4^{th} ed., CRC Press, 2011.

Reference Books:

1. W.G. Hurley & W.H. Wölfle. *Transformers and Inductors for Power Electronics.*, Wiley, 2013.
2. Scott D. Sudhoff. *Power Magnetic Devices: A Multi-Objective Design Approach* , Wiley-IEEE Press, 2014.
3. Alex Goldman. *Magnetic Components for Power Electronics* , Springer, 2001
4. G.C. Chryssis. *High-Frequency Switching Power Supplies.*, 2^{nd} ed., McGraw-Hill, 1989.
5. Eric Lowdon. *Practical Transformer Design Handbook.*, Howard W. Sams & Co, 1980

B7354 – Sustainable Energy Solutions

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces the principles, technologies, and management strategies essential for transitioning to a sustainable energy future. It provides M.Tech students in Power Electronics and Electric Drives with a comprehensive understanding of clean energy sources, their integration into modern power systems, and the economic and environmental aspects of energy utilization.

Course Pre/Co-requisites

This course has no specific prerequisites and co-requisites.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 7 – Affordable and Clean Energy
SDG 13 – Climate Action

Course Outcomes

After the completion of the course, the student will be able to:

- B7354.1 Analyze the global and Indian energy scenario to assess social, economic, and environmental aspects of sustainability and relevant policy frameworks including UN 2030 goals
- B7354.2 Evaluate the operating principles and performance of sustainable energy technologies-solar (thermal & PV), wind, hydro, biomass, hydrogen/fuel cells, and ocean energy systems.
- B7354.3 Assess smart-grid architectures, energy-storage options, and waste-to-energy/CO_2 utilization techniques for enabling a cyclic carbon economy
- B7354.4 Examine and compare electric and hybrid electric vehicle technologies, regenerative braking, and G2V/V2G interactions for sustainable e-mobility.
- B7354.5 Apply energy-economics tools (cost analysis, life-cycle assessment, financial indicators) to plan and manage sustainable energy projects efficiently.

Course Syllabus

Unit-I:

Global Energy Scenario: Concept of Sustainability (Social, Economic and Environmental impacts). Sustainable and non-sustainable energy sources. Present global and Indian scenario. Bureau of energy efficiency. Initiatives and incentives for promoting sustainability. UN 2030 goals for clean and affordable energy.

Unit-II:

Sources of Sustainable Energy Working principles of: Solar Thermal Power Generation, Solar Photovoltaic Power Generation, Wind Power Generation, Hydro Power Generation, Biomass Power Generation, Hydrogen energy and fuel cells and Wave and Tidal Energy.

Unit-III:
Sustainable Utilization of Energy Smart grid technologies - overview, penetration of renewable energy sources. Energy storage technologies. Renewable energy to Hydrogen. Waste to energy: waste to value added materials, capture, storage and utilization of CO2 from various sources to ensure cyclic carbon economy.

Unit-IV:
Sustainability Through E-Mobility Electric vehicles. Advantages and environmental impact. Regenerative braking. Hybrid electric vehicles, modes of operation. Grid-to-Vehicle (G2V) and Vehicle-to-Grid (V2G) Technologies-fundamentals.

Unit-V:
Energy Economics and Management Energy Economics- Cost analysis, interest, accounting rate of return, Payback, Discounted cash flow, Net present value, internal rate of return, Inflation and life cycle analysis of energy systems. Energy Management: Definition, objectives, resource conservation, climate protection and cost savings.

Books and Materials

Text Books:

1. Energy, *the Environment, and the Sustainability* , 2^{nd}1st Edition, Efstathios E. Michaelides, CRC Press, 2018.
2. Modern Electric *Hybrid Electric and Fuel cell vehicles* , 3^{rd} ed., Mehrdad Ehsani, Yimin Gao, Stefano Longo, Kambiz Ebrahimi, 3rd Edition, CRC Press, 2018.

Reference Books:

1. Renewable Energy: *Power for a Sustainable Future* , 3^{rd} G. Boyle (Editor), Oxford University Press, 2012.

PROFESSIONAL ELECTIVE-II

B7355 – Power Quality Improvement Techniques

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces power quality issues, their causes, effects, and mitigation techniques with reference to international standards and monitoring methods. It covers power quality problems arising from non-linear loads and their analysis. Both passive and active compensation methods are discussed, including shunt and series compensators such as DSTATCOM and DVR, along with their control algorithms and design. Finally, the course explores Unified Power Quality Conditioners (UPQC), their classifications, principles of operation, and control strategies for improving overall system performance.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 7 – Affordable and Clean Energy
SDG 9 – Industry, Innovation and Infrastructure

Course Outcomes

After the completion of the course, the student will be able to:

- B7355.1. Apply the concepts of power quality standards, terminology, and monitoring techniques to evaluate real-time power systems.
- B7355.2. Analyze the causes and effects of power quality problems due to non-linear loads using analytical methods.
- B7355.3. Apply passive shunt and series compensation techniques in single-phase and three-phase systems for power quality improvement.
- B7355.4. Analyze the operation and control algorithms of active shunt and series compensators such as DSTATCOM and DVR.
- B7355.5. Examine the classification, operation, and control strategies of Unified Power Quality Compensators (UPQC) for mitigating multiple power quality issues.

Course Syllabus

Unit-I:

INTRODUCTION AND POWER QUALITY STANDARDS: Introduction, Classification of Power Quality Problems, Causes, Effects and Mitigation Techniques of Power Quality Problems, Power Quality Terminology, Standards, Definitions, Monitoring and Numerical Problems.

Unit-II:

CAUSES OF POWER QUALITY PROBLEMS: Introduction to Non-Linear Loads, Power Quality Problems caused by Non-Linear Loads, Analysis of Non-Linear Loads, Numerical Problems.

Unit-III:
PASSIVE SHUNT AND SERIES COMPENSATION: Introduction, Classification and Principle of operation of Passive Shunt and Series Compensators, Analysis and Design of Passive Shunt Compensators for Single-Phase System, Three-Phase Three Wire System and Three-Phase Four Wire System.

Unit-IV:
ACTIVE SHUNT AND SERIES COMPENSATION: Introduction to Shunt compensators: Classification of DSTATCOM's, Principle of Operation of DSTATCOM.
Different Control Algorithms of DSTATCOM: PI Controller, I-Cos ϕ Control Algorithm, Synchronous Reference Frame Theory, Single-Phase PQ theory and DQ Theory Based Control Algorithms, Analysis and Design of Shunt Compensators.
Introduction to Series Compensators: Classification of Series Compensators, Principle of Operation of DVR.
Different Control Algorithms of DVR: Synchronous Reference Frame Theory-Based Control of DVR, Analysis and Design of Active Series Compensators.

Unit-V:
UNIFIED POWER QUALITY COMPENSATORS: Introduction to Unified Power Quality Compensators (UPQC), Classification of UPQCs, Principle of Operation of UPQC.
Control of UPQCs: Synchronous Reference Frame Theory-Based UPQC, Analysis and Design of UPQCs.

Books and Materials

Text Books:

1. Bhim Singh, Ambrish Chandra, Kamal Al-Haddad. *Power Quality Problems and Mitigation Techniques* , Wiley Publications, 2015.
2. Math H J Bollen. *Understanding Power Quality Problems.*, IEEE Press, 2000.

Reference Books:

1. R.C. Dugan, M.F. McGranaghan and H.W. Beaty. *Electric Power Systems Quality.*, New York, McGraw-Hill, 1996.
2. G.T. Heydt *Electric power quality* , McGraw-Hill Professional, 2007.
3. J. Arrillaga *Power System Quality Assessment* , John wiley, 2000.
4. G.T. Heydt *Electric power quality* , 2$^{\text{nd}}$ ed., West Lafayette, IN, Stars in Circle Publications,1994.
5. R. Sastry Vedam Mulukutla S. Sarma *Power Quality VAR Compensation in Power Systems* , CRC Press.
6. A Ghosh, G. Ledwich *Power Quality Enhancement Using Custom Power Devices* , Kluwer Academic, 2002.

B7356 – Battery Technologies

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces the fundamentals of electrochemical energy storage, covering principles of redox reactions, electrode potentials, and charge transport. It explores major battery chemistries and materials, including lithium-ion and emerging technologies, along with modeling, performance, and degradation mechanisms. The role of Battery Management Systems (BMS) in monitoring, control, safety, and compliance with standards is emphasized. Applications in electric vehicles, renewable integration, grid storage, second-life usage, and recycling are discussed with industrial case studies.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 7 – Affordable and Clean Energy
SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

- B7356.1. Apply electrochemical principles to determine battery performance parameters.
- B7356.2. Analyze various battery chemistries and material systems to evaluate their advantages, limitations, and applications.
- B7356.3. Apply modeling techniques to estimate state of charge (SOC), state of health (SOH), and predict battery performance.
- B7356.4. Analyze degradation mechanisms and safety challenges in batteries with respect to cycle life and thermal stability.
- B7356.5. Apply and analyze Battery Management System (BMS) strategies and advanced applications of batteries in EVs, renewable integration, and grid storage.

Course Syllabus

Unit-I:

Fundamentals of Electrochemical Energy Storage: Electrochemical principles: redox reactions, electrode potential, Nernst equation, charge transport, Energy and power density, Coulombic efficiency, cycle life, Types of batteries: Primary vs Secondary, Thermodynamic and kinetic limitations, Overview of charge/discharge characteristics.

Unit-II:

Battery Chemistries and Materials: Lead-acid, NiCd, NiMH, Lithium-ion chemistries (LFP, NMC, NCA, LCO), Emerging chemistries: Sodium-ion, Lithium-Sulfur, Zinc-air, Solid-state batteries, Electrode materials: anode, cathode, electrolyte types (liquid, polymer, solid), Separator materials, dendrite formation, Material challenges and future directions.

Unit-III:
Battery Modeling, Performance & Degradation: Electrical equivalent circuit models (Rint, Thevenin, RC, PNGV), Thermal models and aging models, Parameters: SOC, SOH, DOD, RUL, Calendar aging, cycle aging, and degradation mechanisms, Battery diagnostics and lifetime prediction.

Unit-IV:
Battery Management Systems (BMS) and Safety: Architecture and components of BMS, SOC estimation techniques (Coulomb counting, EKF, AI-based methods), Cell balancing: passive vs active, Protection strategies: overvoltage, overcurrent, thermal events, Safety standards: IEC, ISO, UL for EVs and stationary systems, Fire hazards and thermal runaway mitigation.

Unit-V:
Applications and Advanced Topics: EV applications: Battery packs, thermal management, fast charging, Renewable systems: PV + Battery, wind + battery integration, hybrid systems, Grid storage: frequency regulation, peak shaving, time shifting, Second-life batteries: reuse in grid/Renewables, performance metrics, Battery recycling: processes, environmental impact, Case studies: Tesla, CATL, LG, BYD, ISRO.

Books and Materials

Text Books:

1. T. Reddy. *Linden's Handbook of Batteries* , McGraw Hill.
2. Gregory L. Plett. *Battery Management Systems, Volume I & II.*.
3. Jürgen Garche et al. *Electrochemical Power Sources: Batteries, Fuel Cells, and Supercapacitors.*.

Reference Books:

1. Eric Forgez. *Designing Battery Management Systems.*
2. Prof. Laxmidhar Behera / Prof. Ashok Jhunjhunwala. *IIT/NPTEL Lecture Series on Battery Technology.*
3. IEEE Transactions on Energy Storage & Power Electronics

B7357 – Distributed Generation and Microgrid Technologies

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces distributed generation (DG) technologies, comparing conventional and renewable-based systems such as solar, wind, bioenergy, hydro, fuel cells, and storage technologies. It covers interconnection issues, regulatory standards, and grid codes for integrating DG with power systems. Operational features of grid-connected DGs, including voltage, frequency, stability, and power quality constraints, are discussed. The course also explores microgrid concepts, architectures, control strategies, and modeling in both grid-connected and islanded modes, with emphasis on reliability, protection, market aspects, and emerging LVDC microgrids.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 7 – Affordable and Clean Energy
SDG 11 – Sustainable Cities and Communities

Course Outcomes

After the completion of the course, the student will be able to:

B7357.1. Apply the working principles of renewable and non-conventional DG technologies to evaluate their suitability for power generation.

B7357.2. Analyze interconnection issues, regulatory standards, and grid codes for integrating DG systems with utility grids.

B7357.3. Apply operational constraints such as voltage, frequency, and power quality to assess grid-connected DG system performance.

B7357.4. Analyze the architecture, control strategies, and operation of AC and DC microgrids in both grid-connected and islanded modes.

B7357.5. Examine reliability, protection, and market aspects of microgrids, including emerging LVDC systems.

Course Syllabus

Unit-I:

DISTRIBUTED GENERATION (DG) TECHNOLOGIES: 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 trend. 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.

Unit-II:

INTERCONNECTION ISSUES AND STANDARDS OF DGs: Concept of distributed generations (DG) or distributed energy resources (DERs), topologies, selection of source, dependence on storage facilities, regulatory standards/ framework, standards for interconnecting DGs to electric power systems: IEEE 1547. DG installation classes, security issues in DG implementations. Grid code and Islanding & non-islanding system.

Unit-III:
OPERATIONAL FEATURES OF GRID CONNECTED DG SYSTEMS: Grid interconnection issues for grid connected operation of various types of DG systems. Constraints on operational parameters: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Reliability, stability and power quality issues involved in grid connected operation of various DGs.

Unit-IV:
OPERATION, CONTROL AND MODELLING OF MICROGRID: Concept and definition of micro-grid, review of sources of microgrids, typical structure and configuration of a microgrid, microgrid implementation in Indian and international scenario, AC and DC microgrids, Power Electronics interfaces in DC and AC microgrids, communication infrastructure, modes of operation and control of microgrid: grid connected and islanded mode operation, anti-islanding schemes. Control techniques for voltage, frequency, active and reactive power control of microgrid system, Computer aided Modelling of microgrid.

Unit-V:
INTRODUCTION TO RELIABILITY AND MARKET ISSUES OF MICROGRID: Power quality issue, THD reduction techniques, protection and stability analysis of microgrid, regulatory standards, introduction to microgrid reliability. Features of microgrid economy and market. LVDC Microgrid.

Books and Materials

Text Books:

1. Godfrey Boyle. *Renewable Energy- Power for a sustainable future* , 3^{rd} ed., Oxford University Press, 2013.
2. Amirnaser Yezdani, and Reza Iravani. *Voltage Source Converters in Power Systems: Modeling, Control and Applications.*, IEEE John Wiley Publications, 2009.
3. Dorin Neacsu *Power Switching Converters: Medium and High Power.*, CRC Press, Taylor & Francis, 2006. New Delhi.
4. Nikos Hatziargyriou *Microgrids: Architectures and Control.*, ISBN: 978-1-11872068-4, 340 pages, December 2013, Wiley-IEEE Press.
5. S. Chowdhury, S.P. Chowdhury and P. Crossley *Microgrids and Active Distribution Networks.*, The Institution of Engineering and Technology, London, U.K, 2009.

Reference Books:

1. R.C. Dugan, M.F. McGranaghan and H.W. Beaty. *Electric Power Systems Quality.*,New York, McGraw-Hill, 1996.
2. G.T. Heydt. *Electric power quality* , McGraw-Hill Professional, 2007.
3. J. Arrillaga. *Power System Quality Assessment* , John wiley, 2000.
4. G.T. Heydt. *Electric Power Quality* , 2^{nd} ed., West Lafayette, IN, Stars in Circle Publications,1994.
5. R. Sastry Vedam Mulukutla S. Sarma. *Power Quality VAR Compensation in Power Systems* , CRC Press.
6. A Ghosh, G. Ledwich. *Power Quality Enhancement Using Custom Power Devices* , Kluwer Academic, 2002.

B7358 – Modern Control Theory

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course provides a comprehensive foundation in modern control theory, focusing on mathematical tools and state-space methods essential for analyzing and designing advanced power electronics and electric drive systems. It covers vector spaces, linear transformations, eigenvalues, eigenvectors and canonical forms for system representation; formulation and solution of continuous-time state equations using state transition matrices; and key concepts of controllability and observability with various canonical transformations. Students learn state feedback controller and observer design, including pole placement using Ackermann's formula, as well as modeling and stability analysis of nonlinear systems through linearization, describing functions, and phase-plane techniques. The course concludes with Lyapunov-based stability analysis and methods for constructing Lyapunov functions, enabling students to model, control, and assess the stability of both linear and nonlinear dynamic systems.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation and Infrastructure
SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

- B7358.1. Apply mathematical concepts, state-space representation, and solution techniques for linear time-invariant continuous-time systems.
- B7358.2. Analyze controllability and observability of systems and perform state transformations including diagonalization, Jordan, and controllability canonical forms.
- B7358.3. Design state feedback controllers and state observers (full-order and reduced-order) using pole assignment and Ackermann's formula.
- B7358.4. Model and analyze nonlinear systems, including linearization, describing functions, phase-plane methods, and stability of singular points.
- B7358.5. Apply Lyapunov's direct method to assess stability of linear and nonlinear systems and generate Lyapunov functions using various methods.

Course Syllabus

Unit-I:

MATHEMATICAL PRELIMINARIES AND STATE VARIABLE ANALYSIS: Fields, Vectors and Vector Spaces, Linear combinations and Bases, Linear Transformations and Matrices, Scalar Product and Norms, Eigen values, Eigen Vectors and a Canonical form representation of Linear systems, The concept of state, State space model of Dynamic systems, Time invariance and Linearity, Non-uniqueness of state model, State diagrams for Continuous-Time State models, Existence and Uniqueness of Solutions to Continuous-Time State

Equations, Solutions of Linear Time Invariant Continuous-Time State Equations, State transition matrix and it's properties.Complete solution of state space model due to zero input and due to zero state.

Unit-II:
CONTROLLABILITY AND OBSERVABILITY: General concept of controllability, Controllability tests, Different state transformations such as diagonalization, Jordon canonical forms and Controllability canonical forms for Continuous-Time Invariant Systems, General concept of Observability, Observability tests for Continuous-Time Invariant Systems, Observability of different State transformation forms.

Unit-III:
STATE FEEDBACK CONTROLLERS AND OBSERVERS: State feedback controller design through Pole Assignment, using Ackerman's formula. State observers: Full order and Reduced order observers.

Unit-IV:
NON-LINEAR SYSTEMS: Introduction to Non-Linear Systems, Types of Non-Linearities, Saturation, Dead-Zone, Backlash, Jump Phenomenon etc., Linearization of nonlinear systems, Singular Points and its types, Describing function, Describing function of different types of nonlinear elements, Stability analysis of Non-Linear systems through describing functions. Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, Stability analysis of nonlinear systems based on phase-plane method.

Unit-V:
STABILITY ANALYSIS: Stability in the sense of Lyapunov, Lyapunov's stability and Lyapunov's instability theorems, Stability Analysis of the Linear continuous time invariant systems by Lyapunov second method, Generation of Lyapunov functions, Variable gradient method, Krasooviski's method.

Books and Materials

Text Books:

1. Gopal, M. *Modern Control System Theory*. New Age International, 1984.
2. Ogata, K. *Modern Control Engineering*. Prentice Hall, 1997.

Reference Books:

1. Sinha, N. K. *Control Systems*. 3rd ed., New Age International.
2. Kirk, Donald E. *Optimal Control Theory: An Introduction*. 1st ed., Prentice Hall Network Series.

B7303 – Analysis of Power Converters Laboratory

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
0	0	60	0	60	2	40	60	100

Course Description

Course Overview

This course provides a practical and simulation-oriented study of power electronic converters and inverters using MATLAB/Simulink. Students will model, simulate, and analyze different power electronic circuits including single-phase and three-phase controlled rectifiers, half- and full-bridge inverters, and multilevel inverter topologies. Emphasis is placed on understanding switching behavior, load response (R, RL, and E loads), harmonic performance, and modulation techniques such as Space Vector Modulation (SVM). Through hands-on simulations, learners will develop the ability to apply theoretical concepts of power electronics and analyze system performance under various operating conditions.

Course Pre/Co-requisites

Power Electronics

SDG 4 – Quality Education
SDG 9 – Industry, Innovation and Infrastructure
SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

B7303.1. Apply MATLAB/Simulink tools to model and simulate single-phase and three-phase controlled rectifiers with resistive, inductive, and back emf loads.

B7303.2. Analyze the output voltage, current waveforms, and power quality of rectifiers under different firing angle and load conditions

B7303.3. Apply inverter topologies (half-bridge, H-bridge, and three-phase SVM) to evaluate their performance with different load types.

B7303.4. Analyze the harmonic spectrum, switching losses, and efficiency of multilevel inverter configurations (diode clamped, flying capacitor, and cascaded.

B7303.5. Apply and compare different modulation techniques to determine the most suitable converter/inverter scheme for given power electronic applications.

Course Syllabus

List of Experiments:

1. MATLAB Simulation of Single-phase full converter using RL&E loads. .
2. MATLAB Simulation of Single-phase Semi converter using RL&E loads. .
3. MATLAB Simulation of Three-phase full converter using RL&E loads.
4. MATLAB Simulation of Three-phase Semi converter using RL&E loads.
5. MATLAB Simulation of Single-phase Half Bridge inverter with R and RL loads.
6. MATLAB Simulation of Single-phase H bridge inverter with R and RL loads
7. Space vector modulated three phase inverter. .

8. Single phase diode clamped multi-level inverter
9. Single phase flying capacitor multi-level inverter.
10. Single phase cascaded multi-level inverter.

Laboratory Equipment/Software/Tools Required:

1. Matlab Software
2. Desktop Computer

Books and Materials

Text Books:

1. Ned Mohan, Tore M. Undeland, William P. Robbins (2003). *Power Electronics: Converters, Applications and Design* , 2nd ed., 3rd Edition, John Wiley & Sons.
2. M. H. Rashid (1998), *Power Electronics: Circuits, Devices and Applications.*, 3rd ed., 3rd Edition, Prentice Hall of India, New Delhi.

Reference Books:

1. P. C. Sen (2001), *Power Electronics.*, 3rd ed., Tata Mc Graw Hill Publishing, New Delhi.
2. Vedam Subramanyam (1997) *Power Electronics* , 2nd ed., New Age International (P) Limited, New Delhi.

B7304 – Machine Modelling and Analysis Laboratory

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
0	0	60	0	60	2	40	60	100

Course Description

Course Overview

This course focuses on the dynamic and mathematical modeling of electric machines (DC motors, induction motors, and synchronous motors) under various control strategies. Students will learn how to represent electrical machines in different reference frames, derive mathematical models, and design open-loop and closed-loop control schemes. The course also emphasizes practical applications such as vector control, V/f control, and rotor reference frame transformations, enabling learners to analyze, simulate, and optimize the performance of electrical drives in real-world scenarios.

Course Pre/Co-requisites

Dynamic Modeling and Control of Electrical Machines.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 7 – Affordable and Clean Energy
SDG 9 – Industry, Innovation and Infrastructure

Course Outcomes

After the completion of the course, the student will be able to:

- B7304.1. Apply the principles of electromechanical energy conversion to develop open-loop and closed-loop dynamic models of DC motors.
- B7304.2. Apply Park's and Clarke's transformation techniques to convert three-phase quantities into stationary, synchronous, and rotor reference frames for dynamic analysis.
- B7304.3. Analyze the dynamic behavior of induction motors and generators by formulating their mathematical models under different operating conditions.
- B7304.4. Apply and Analyze the concept of V/f control in induction motors to evaluate the impact of frequency variation on torque-speed characteristics.
- B7304.5. Analyze the performance of synchronous and induction motors under closed-loop control strategies and compare their transient and steady-state responses.

Course Syllabus

List of Experiments:

1. Develop a dynamic model of open loop-controlled dc motor
2. Develop a dynamic model of closed loop-controlled dc motor
3. Convert ABC voltages into stationary frame
4. Convert ABC voltages into synchronous frames
5. Convert ABC voltages into rotor reference frames
6. Develop dynamic model of 3-phase Induction motor and generator
7. Develop a mathematical model for V/f controlled 3-phase Induction motor

8. Develop a mathematical model for 3-phase Synchronous motor
9. Develop a dynamic model for closed loop control of Induction Motor
10. Develop a dynamic model for closed loop control of Synchronous motor

Laboratory Equipment/Software/Tools Required:

1. Matlab Software
2. Desktop Computer

Books and Materials

Text Books:

1. P. C. Krause, O. Wasynczuk, S. D. Sudhoff, S. Pekarek. *Analysis of Electric Machinery and Drive Systems* , 2nd ed., Wiley-IEEE Press.
2. A. E. Fitzgerald, C. Kingsley, S. D. Umans *Electric Machinery* 3rd ed., McGraw Hill.

Reference Books:

1. R. Krishnan *Electric Motor Drives: Modeling, Analysis and Control.*, 3rd ed., Prentice Hall
2. D. W. Novotny, T. A. Lipo *Vector Control and Dynamics of AC Drives* , 2nd ed., Oxford University Press.

I M.Tech. II Semester

B7305 – Electrical Drives

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course focuses on the modeling, analysis, and control of electrical motor drives. It covers rectifier- and chopper-controlled DC drives, scalar and vector control techniques for induction motor drives, and control strategies for permanent magnet synchronous motor drives. Emphasis is placed on torque and speed control, controller design, and performance evaluation under steady-state and dynamic operating conditions.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation and Infrastructure
SDG 11 – Sustainable Cities and Communities

Course Outcomes

After the completion of the course, the student will be able to:

B7305.1. Analyze the operation and performance of rectifier-controlled DC motor drives under open-loop and closed-loop control.

B7305.2. Analyze the operation and performance of chopper-controlled DC motor drives, including current control strategies and controller design.

B7305.3. Apply scalar control techniques to induction motor drives and assess their steady-state and dynamic performance.

B7305.4. Analyze vector control methods for induction motor drives and evaluate their effectiveness in torque and flux control.

B7305.5. Apply control strategies for permanent magnet synchronous motor drives to achieve desired torque and speed performance.

Course Syllabus

Unit-I:

Rectifier Controlled DC Motor Drives: Separately excited DC motors and DC series motors with single phase semi converter and single-phase full converter, Three-phase controlled converter, control circuit, control modeling of three phase converter, Steady state analysis of three phase converter control DC motor drive, two quadrant three phase converter-controlled DC motor drive. Closed Loop Control of DC Drive: Transfer functions of the subsystems - DC motor, load and converter, Current and speed controllers, Current and speed feedback. Design of controllers -Current and speed controllers. Two-Quadrant DC Motor drive with field weakening, four quadrant DC motor drive.

Unit-II:

Chopper Controlled DC Motor Drives: Principle of operation of the chopper, four quadrant chopper, Chopper with other power devices, Model of the chopper, Input to the chopper, Steady state analysis of chopper-controlled DC motor drives. Closed loop operation: Speed controlled drive system, Current control loop, Pulse width modulated current controller, Hysteresis current controller, modeling of current controller, Design of current controller.

Unit-III:
Scalar Control of Induction Motor Drives: Torque production, Equivalent circuit analysis, Variable voltage operation, Variable frequency operation, Constant v/f operation, Slip power recovery drives, Static Kramer Drive, Torque expression, Speed control of Kramer Drive, Static Scheribus Drive, and Modes of operation. Voltage-fed inverter control – open loop v/f control, Speed control with slip regulation, torque and flux control, Current-fed inverter control – Independent current and frequency control, Speed and flux control, v/f control.

Unit-IV:
Vector Control of Induction Motor Drives: Principles of Vector control, direct vector control, Indirect vector control, direct torque and flux control, Adaptive control principles - Self-tuning control, Model referencing adaptive control. .

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Unit-V:
Control of Permanent Magnet Synchronous Motor Drives: Synchronous motor and its characteristics, Vector Control of PMSM, Control strategies, Constant torque angle control, Unity power factor control, Constant mutual flux linkage control, Optimum torque per ampere control, Speed controller design.

Books and Materials

Text Books:

1. R. Krishnan *Electric Motor Drives: Modeling, Analysis and control*, 1st Edition, Prentice Hall, 2002.
2. Bimal K. Bose, M. E. *Modern Power Electronics and AC Drives.*, 1st ed., Pearson Education, 2001.

Reference Books:

1. MD Murthy, FG Turn *Power Electronics and Control of AC Motors.*, 3rd ed., 1st Edition, 1988.
2. Singh, G. K. Dubey *Fundamentals of Electrical Drives* , 2nd ed., Narosa publications, 1995.

B7306 – Analysis of Advanced Power Converters

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course focuses on the analysis and modeling of advanced DC–DC converters, resonant inverters, and resonant converters with soft switching techniques. It introduces both isolated and non-isolated converter topologies, resonant pulse inverters, and zero-current and zero-voltage switching converters. The course also covers power conditioners, uninterruptible power supplies, and advanced converter configurations such as SEPIC, matrix, Luo, and interleaved converters. Emphasis is placed on performance evaluation, design considerations, and practical applications in modern power electronic systems.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation and Infrastructure
SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

- B7306.1. Analyze the operation and performance of non-isolated DC–DC converters and their regulator configurations.
- B7306.2. Analyze the performance of isolated DC–DC converter topologies and evaluate their control and design considerations.
- B7306.3. Model and analyze resonant pulse inverters and determine their frequency response and voltage control strategies.
- B7306.4. Analyze the operation of ZCS and ZVS resonant converters and compare their characteristics under different switching conditions.
- B73065. Assess the operation of power conditioners, UPS systems, and advanced DC–DC converter topologies for practical applications.

Course Syllabus

Unit-I:

Non-Isolated DC to DC Converters: Analysis of step-down and step-up dc to dc converters with Resistive and Resistive-Inductive loads, Switched mode regulators, Analysis of Buck Regulators, Boost regulators, Buck and boost regulators, Cuk regulators, Condition for continuous inductor current and capacitor voltage, Comparison of regulators, Multi output boost converters, Advantages, Applications, Problems, State space analysis of regulators.

Unit-II:

Isolated DC to DC Converters: Classification, switched mode dc power supplies, Fly back Converter, Forward converter, Push-pull converter, Half bridge converter, Full bridge converter, Control circuits, Magnetic design considerations, Applications

Unit-III:

Resonant Pulse Inverters : Resonant pulse inverters, Series resonant inverters, Series resonant inverters with unidirectional switches, Series resonant inverters with bidirectional switches, Analysis of half bridge resonant inverter, Evaluation of currents and voltages of a simple resonant inverter, Analysis of half bridge and full bridge resonant inverter with bidirectional switches, Frequency response of Series resonant, Parallel resonant, Series loaded, Parallel loaded, Series and Parallel loaded inverters, Voltage control of resonant inverters, Class-E resonant inverter, Class-E resonant rectifier, Evaluation of values of 'C' and 'L' for Class-E inverter and Class-E rectifier.

Unit-IV:

ZCS and ZVS Resonant Converters: Resonant converters, zero current switching resonant converters, L-type and M-type ZCS resonant converter, zero voltage switching resonant converters, Comparison between ZCS and ZVS resonant converters, Two quadrant ZVS resonant converters, Resonant dc-link inverters, Evaluation of 'L' and 'C' for a zero current switching inverter.

Unit-V:

Power Conditioning and Advanced Converters: Power line disturbances, Power conditioners, Uninterruptible Power supplies, Applications. Advanced Converters - Principle of operation of SEPIC converter, Matrix Converter, Luo Converter, Interleaved Converter.

Books and Materials

Text Books:

1. Mohammed H. Rashid *Power Electronics* , 2nd ed., Pearson Education, 3rd Edition, 1st Indian reprint, 2004.
2. Ned Mohan Tore M. Undeland and William P. Robbins, *Power Electronics.*, 3rd ed., John Wiley & Sons, 2nd Edition, 1995.

Reference Books:

1. Shepherd, W., Zhang, L., *Power Converter Circuits.*, 3rd ed., 1st ed., CRC Press, 2004.
2. Marian P. Kazmierkowski, R. Krishnan, Frede Blaabjerg *Control in Power Electronics: Selected Problems*, 2nd ed., Academic Press, 2002.

PROFESSIONAL ELECTIVE-III

B7359 - Power Electronics for Renewable Energy Systems

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces students to the practical and design aspects of renewable energy systems with a focus on their integration into power electronics. It covers major renewable sources, emphasizing their environmental impact and technical feasibility. Students will apply power electronic converters for renewable energy integration and design standalone and grid-connected systems using photovoltaic and wind energy. The course also covers hybrid energy systems and storage solutions, with case studies and algorithms like MPPT for maximizing efficiency.

Course Pre/Co-requisites

UG Courses - Prerequisite: Power Electronics.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 7 – Affordable and Clean Energy
SDG 13 – Climate Action

Course Outcomes

After the completion of the course, the student will be able to:

- B7359.1. Apply knowledge of renewable energy principles to assess the environmental impacts and feasibility of various renewable resources.
- B7359.2. Apply appropriate power electronic converters to interface solar and wind energy sources with to interface renewable energy sources with load and grid systems.
- B7359.3. Design standalone and grid-connected photovoltaic systems by considering the given specifications.
- B7359.4. Apply wind energy principles to select and operate suitable wind turbines and generators based on system performance requirements.
- B7359.5. ADesign hybrid renewable energy systems by integrating multiple sources with appropriate MPPT algorithms.

Course Syllabus

Unit-I:

Introduction to Renewable Energy Systems: Impacts of renewable energy generation on the environment – GHG effect, Qualitative study of renewable energy resources: Ocean, Biomass, Geothermal, Hydrogen energy systems, Solar Photovoltaic (PV) system, Wind Energy system and Fuel cells.

Unit-II:

Power Electronic Converters for Renewable Energy: Solar: Line commutated converters (inversion mode) - Boost and Buck-boost converters. Wind: Three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters - Multi-source converters.

Unit-III:
Photo Voltaic Energy Conversion Systems: Types, Equivalent circuit of PV cell, PV cell characteristics (I/V and P/V) for variation of insolation, temperature and shading effect, Standalone PV system, Grid connected PV system, Design of PV System.

Unit-IV:
Wind Energy Conversion Systems: Power contained in wind, Efficiency limit in wind, Wind control strategies, Power Curve. Induction Generator and Permanent Magnet Synchronous Generator (PMSG), Self-excited operation of Induction Generator and Variable Speed PMSG.

Unit-V:
Hybrid Renewable Energy Systems: Energy Storage systems, Need for Hybrid Systems - Range and type of Hybrid systems - Case studies of Diesel-PV, Wind-Diesel, Wind-PV, Maximum Power Point Tracking (MPPT) algorithms.

Books and Materials

Text Books:

1. Robert W. Erickson, and Dragan Maksimovic. *Fundamentals of Power Electronics* , 3rd ed., Springer, 2020.
2. Rashid M. H. *Power Electronics Handbook* , 2nd ed., Academic Press, 2006.

Reference Books:

1. S. N. Bhadra, D. Kastha, and S. Banerjee. *Wind Electrical Systems* , Oxford University Press, 2009.
2. Rai. G.D. *Non-conventional energy sources* , Khanna Publishers, 2010.
3. Rai. G.D. *Solar Energy Utilization* , 5th ed., Khanna Publishers, 2008.
4. Gray, L. Johnson. *CWind energy system* , Prentice Hall of India, 1995.
5. B. H. Khan. *Non-conventional Energy sources* , Tata McGraw-Hill Publishing Company, New Delhi, 2017.

B7360 - Advanced Control Techniques for Power Converters

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course offers an in-depth study of modeling techniques and advanced control strategies for power electronic converters. It begins with foundational converter modeling methods including linearized average models, large-signal and small-signal models, and switched models, emphasizing their interrelationships and implications for control design. Students will learn classical and modern control goals in converter operation and examine the limitations of traditional control approaches.

Course Pre/Co-requisites

UG Courses - Prerequisite: Power Electronics, Control Systems.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation and Infrastructure
SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

- B7360.1. Analyze different modeling techniques for power converters and relate their applicability to control design strategies.
- B7360.2. Design and tune advanced PID controllers, including fractional-order controllers, for power converter applications.
- B7360.3. Develop and implement Proportional Resonant (PR) controllers for improved tracking performance in DC-DC converters.
- B7360.4. Evaluate robust controller designs using loop-shaping methods such as $H\infty$ and QFT for converter systems under uncertainty.
- B7360.5. Design and compare intelligent control strategies like Sliding Mode Control (SMC), Fuzzy Logic, and AI-based methods for power converters and drives.

Course Syllabus

Unit-I:

Modeling of Power converters: Types of Models- Linearized Averaged models- Large signal and Small signal models- Switched models- Relation between various model types- Control goals in converter operation- Review of classical control methods.

Unit-II:

Advanced PID Controller: PID controller-Tuning methods of PID controller- Set point weighting- Integrator Windup- Controller degrees of freedom- Model based Design methods: Direct Synthesis (DS) method, Internal Model Control (IMC) method- Fractional Control System (FOS) -Design of Fractional PID controller- Case Study: PID controller design for DC-DC boost converter.

Unit-III:

Resonant Controller: Necessity of resonant controller- Principle of Proportional Resonant (PR) control- Design methods of PR controller- Example of PR controller design for DC-DC boost converter.

Loop-shaping design: Concept of Loop shaping- Robust controller design using the loop shaping methods: H_∞ Control, Quantitative feedback theory (QFT)- Case Study: Loop shaping methods to design the robust controller for DC-DC converter.

Unit-IV:

Sliding mode controller (SMC): Nonlinear control preliminaries-Types of Uncertainty-Sliding surface design-Stability of SMC- Equivalent control concept- Integral Sliding Mode Control (ISMC) design- Case study: Application of SMC to design the robust controller for DC-DC converter.

Unit-V:

Fuzzy logic control and artificial Intelligence (AI) techniques: Introduction to fuzzy logic and AI techniques, application of fuzzy logic to power converters and electric drives, hardware system description, application of AI techniques to electric machines and drives.

Books and Materials

Text Books:

1. S. Bacha, I. Munteanu, and A.I. Bratcu. *Power Electronic Converters Modeling and Control with Case Studies* , 1st ed., Springer-Verlag London, 2014.
2. L. Wang, S. Chai, D. Yoo, L. Gan, and K. Ng. *PID and Predictive Control of Electrical Drives and Power Converters using MATLAB/Simulink* , 1st ed., Wiley Press, 2015.
3. A. Mehta, and B. Naik. *Sliding Mode Controllers for Power Electronic Converters* , Springer Nature, 2019.

Reference Books:

1. C. Olalla, Ramon Leyva, and I. Queinnec. *Robust Linear Control of DC-DC Converters: A Practical Approach to the Synthesis of Robust Controllers* , 1st ed., VDM Verlag- Dr. Muller, 2009.
2. S-C. Tan, Y-M. Lai, and C.K. Tse. *Sliding Mode Control of Switching Power Converters: Techniques and Implementation* , 1st ed., CRC Press, 2012.
3. Freede Blaabjerg. *Control of Power Electronic Converters and Systems* , 1st ed., Academic Press, 2018.
4. Q- C. Zhong, and T. Hornik. *Control of Power Inverters in Renewable Energy and Smart Grid Integration* , 1st ed., Wiley Press, 2013.

B7361 - Microcontroller Applications to Power Electronics

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course covers the architecture, instruction sets, and programming of 8051 and PIC16F876 microcontrollers with applications in power electronics. Emphasis is placed on pulse generation, zero-crossing detection, firing/gating circuits, and the use of MPLAB tools for implementing microcontroller-based control of power converters.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 8 – Decent Work and Economic Growth
SDG 9 – Industry, Innovation and Infrastructure

Course Outcomes

After the completion of the course, the student will be able to:

- B7361.1. Apply the instruction sets of 8051 and PIC16F876 microcontrollers to develop simple assembly programs.
- B7361.2. Develop microcontroller-based pulse generation techniques for firing and gating of single-phase and three-phase power converters.
- B7361.3. Implement interfacing of timers, ADC, and CCP modules in PIC microcontrollers for power electronic applications.
- B7361.4. Analyze the role of zero-crossing detectors and gate-drive circuits in reliable power converter operation.
- B7361.5. Examine the use of MPLAB IDE and PICSTART Plus tools for device programming and evaluate their effectiveness in generating firing/gating pulses.

Course Syllabus

Unit-I:

8051 Microcontrollers: Architecture, addressing modes, I/O ports, Instruction sets, Simple assembly language programming.

Unit-II:

Microcontroller Applications in Power Electronics: Use of microcontrollers for pulse generation in power converters, Overview of Zero-Crossing Detectors, Typical firing/gate-drive circuits, Firing/gate pulses for typical single-phase and three-phase power converters.

Unit-III:

PIC16F876 Microcontroller: Device overview, Pin diagrams, Memory organization, Special Function Registers, I/O ports, Timers, Capture/ Compare/ PWM modules (CCP).

Unit-IV:

Advanced Features of PIC16F876: Analog to Digital Converter module, Instruction set, Instruction description, Introduction to PIC microcontroller programming, Oscillator selection, Reset, Interrupts, Watch dog timer.

Unit-V:

Development Tools for Microcontrollers: Introduction to MPLAB IDE and PICSTART plus, Device Programming using MPLAB and PICSTART plus, Generation of firing / gating pulses for typical power converters.

Books and Materials

Text Books:

1. Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin McKinlay. *The 8051 Microcontroller and Embedded Systems using Assembly and C* , 2^{nd} ed., Pearson, 2006.
2. Muhammad Ali Mazidi, Rolin D. McKinlay, and Danny Causey. *PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC18* , Pearson, 2008.
3. B.W. Williams. *Power Electronics: Devices, Drivers, Applications, and Passive Components* , McGraw-Hill, 1992.

Reference Books:

1. Kenneth J. Ayala. *The 8051 Microcontroller Architecture, Programming and Applications* , 2^{nd} ed., Cengage, 2007.
2. John B. Peatman. *Design with PIC Microcontrollers* , Pearson, 1998.
3. M. H. Rashid. *Power Electronics: Circuits, Devices and Applications* , 4^{th} ed., Pearson, 2013.
4. Raj Kamal. *Microcontrollers: Architecture, Programming, Interfacing and System Design* , 2^{nd} ed., Pearson, 2011.
5. V. Subrahmanyam. *Power Electronics: Devices, Converters, and Applications* , New Age International, 1996.

B7362 - Smart Metering and Communication Protocols

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces the principles and technologies of smart metering and Advanced Metering Infrastructure (AMI) for modern smart grids. It covers smart meter architecture, communication layers (HAN, NAN, WAN) and Meter Data Management Systems (MDMS). Key topics include communication protocols and standards such as Modbus, DNP3, IEC 61850, DLMS/COSEM, OSGP, ANSI C12.22 and PLC technologies (PRIME, G3-PLC, S-FSK). Students learn networking frameworks—ISO/OSI and TCP/IP models, wired and wireless media (Ethernet, fiber, ZigBee, Wi-Fi, Cellular, NB-IoT, LTE-M)—and integration of legacy systems. The course also explores demand-side integration, dynamic pricing strategies, cloud-based data management, cyber-security measures, and IoT-driven applications integrating smart meters with SCADA, PMUs and distribution automation systems.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 7 – Affordable and Clean Energy
SDG 11 – Sustainable Cities and Communities

Course Outcomes

After the completion of the course, the student will be able to:

B7362.1. Describe the architecture and key elements of smart metering and AMI, including HAN, NAN, WAN and MDMS.

B7362.2. Analyze and differentiate major communication protocols and standards - Modbus, DNP3, IEC 61850, DLMS/COSEM, OSGP, ANSI C12.22 - and power-line communication (PLC) technologies.

B7362.3. Evaluate networking frameworks (ISO/OSI, TCP/IP) and assess wired and wireless communication options for smart grid applications.

B7362.4. Examine demand-side integration methods, dynamic pricing models and cloud-based data management approaches for efficient energy use.

B7362.5. Assess cybersecurity issues and emerging IoT-based solutions for integrating smart meters with SCADA, PMUs and distribution automation systems.

Course Syllabus

Unit-I:

Fundamentals of Smart Metering and AMI Concepts: Protocols for smart metering: Modbus, DNP3, IEC 61850, DLMS/COSEM (IEC 62056 series), Open Smart Grid Protocol (OSGP), ANSI C12.22 Power-line communication (PLC) technologies: PRIME, G3-PLC, S-FSK, broadband PLC.

Unit-II:

Communication Protocols and Standards: Protocols for smart metering: Modbus, DNP3, IEC 61850, DLMS/COSEM (IEC 62056 series), Open Smart Grid Protocol (OSGP), ANSI C12.22 Power-line communication (PLC) technologies: PRIME, G3-PLC, S-FSK, broadband PLC.

Unit-III:

Networking Models and Technologies: Computing and communication frameworks in smart grids: ISO/OSI and TCP/IP models, Network media: Wired (Ethernet, fiber), Wireless (Bluetooth, ZigBee, Wi-Fi, Cellular, NB-IoT, LTE-M), M-Bus/Wireless M-Bus Integration of communication legacies: Ethernet, CAN, I^2C, LIN, Z-Wave.

Unit-IV:

Demand-Side Integration and Data Management: Demand Side Integration (DSI): Services, hardware support, system-level implementation, Pricing Strategies: Real-time pricing, time-of-use, peak-load pricing, Data Management: MDMS, data concentrators, forecasting, cloud-based approaches.

Unit-V:

Security, Syndication & Advanced Applications: Cybersecurity in smart grids: Symmetric and asymmetric encryption, authentication, threats (data injection, load-altering attacks) Integration with SCADA, PMUs, distribution automation equipment: IEDs, RTUs, distribution management systems Emerging topics: IoT protocols (MQTT, CoAP), RESTful APIs, WebHooks for smart metering.

Books and Materials

Text Books:

1. V. C. Güngör, D. Sahin, T. Kocak, S. Ergüt, C. Buccella, C. Cecati, and G. P. Hancke. *Smart grid technologies: Communication technologies and standards* , IEEE Transactions on Industrial Informatics, vol. 7, no. 4, pp. 529–539, 2011, doi: 10.1109/TII.2011.2166794.
2. Janaka B. Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, and Akihiko Yokoyama. *Smart Grid: Technology and Applications* , Wiley, 2012.
3. K. C. Budka, J. G. Deshpande, and M. Thottan. *Communication Networks for Smart Grids* , Springer, 2014.

PROFESSIONAL ELECTIVE-IV

B7363 – ELECTRIC VEHICLE TECHNOLOGIES

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces the fundamentals of conventional, hybrid, and electric vehicles, covering vehicle performance, drive-train topologies, and propulsion systems. It explores electric machines, energy storage technologies (batteries, fuel cells, supercapacitors, flywheels), and sizing of drive components. Learners will study energy management strategies and apply concepts through case studies on designing hybrid and battery electric vehicles.

Course Pre/Co-requisites

Relevant SDG(s)

SDG 4 – Quality Education
SDG 7 – Affordable and Clean Energy
SDG 11 – Sustainable Cities and Communities

Course Outcomes

After the completion of the course, the student will be able to:

- B7363.1. Apply mathematical models and performance characteristics to evaluate conventional, hybrid, and electric vehicle drive-trains.
- B7363.2. Apply control methods for electric propulsion units using DC, induction, permanent magnet, and switched reluctance motors.
- B7363.3. Analyze the requirements and performance of different energy storage systems (batteries, fuel cells, supercapacitors, flywheels) for vehicle applications.
- B7363.4. Analyze the sizing of electric machines, ICEs, power electronics, and storage technologies for hybrid and electric vehicles.
- B7363.5. analyze energy management strategies to optimize fuel efficiency and performance in hybrid and battery electric vehicles through case studies

Course Syllabus

Unit-I:

INTRODUCTION

Conventional Vehicles: Basics of vehicle performance, Vehicle power source characterization, Transmission characteristics, Mathematical models to describe vehicle performance.

Unit-II:

INTRODUCTION TO HYBRID ELECTRIC VEHICLES History of hybrid and electric vehicles, Social and environmental importance of hybrid and electric vehicles, Impact of modern drive-trains on energy supplies. Hybrid Electric Drive-Trains: Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis.

Unit-III:
ELECTRIC TRAINS Electric Drive-Trains: Basic concept of electric traction, introduction to various electric drive train topologies, Power flow control in electric drive-train topologies, Fuel efficiency analysis. Electric Propulsion Unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, Configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, Drive system efficiency.

Unit-IV:
ENERGY STORAGE Energy Storage: Introduction to Energy Storage, Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: 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-V:
ENERGY MANAGEMENT STRATEGIES Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, Classification of different energy management strategies, Comparison of different energy management strategies, Implementation issues of energy management strategies. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Books and Materials

Text Books:

1. C. Mi, M. A. Masrur and D. W. Gao,*Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives,* John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, *Hybrid Electric Vehicles: Energy Management Strategies,* Springer, 2015.

Reference Books:

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design*, CRC Press, 2004.
2. T. Denton, *Electric and Hybrid Vehicles*, Routledge, 2016.

B7364 – WIDE BAND GAP DEVICES FOR POWER ELECTRONICS APPLICATIONS

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces wide band gap (WBG) devices such as SiC and GaN transistors, their structures, characteristics, and applications. It covers switching behavior, gate driver design, protection, and modeling of GaN devices with focus on electrical, thermal, and reliability aspects. Learners will explore high-frequency design challenges including parasitics, EMI, PCB, and thermal management. Finally, the course highlights applications of GaN in power converters, amplifiers, EVs, and renewable systems.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation and Infrastructure
SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

B7364.1. Apply the fundamentals of SiC and GaN wide band gap devices to evaluate their suitability for power electronic converters.

B7364.2. Analyze electrical and thermal models of GaN transistors to assess performance, reliability, and thermal management needs.

B7364.3. Analyze the requirements and performance of different energy storage systems (batteries, fuel cells, supercapacitors, flywheels) for vehicle applications.

B7364.4. Analyze the impact of parasitics, EMI, and PCB design strategies on high-frequency power converter operation.

B7364.5. Analyze WBG devices in applications such as AC/DC and DC/AC converters, switched-mode amplifiers, EV systems, and renewable energy technologies

Course Syllabus

Unit-I:

Wide Band Gap Devices: Introduction to basic power devices, characteristics, and applications – Silicon Power MOSFETs 1976-2010, SiC Planer Power MOSFETs, SiC Trench-Gate Power MOSFETs, Need of GaN device, Basic GaN Transistor structure, GaN Vertical Power HEFTs and Horizontal Power HEFTs, Different types of wide band gap devices, advantages and challenges in designing converters with wide band gap devices.

Unit-II:

GaN Transistor Characteristics & Driver Circuits: Turn ON and Turn OFF switching characteristics of GaN devices, Hard switching loss analysis, Gate driver design, Impact of gate resistance, dv/dt and di/dt immunity, etc., Protection design for double pulse test set-up.

Unit-III:
Modeling and Measurement of GaN Transistors: Electrical and thermal modeling of GaN transistors, Thermal management, and Reliability.

Unit-IV:
High-frequency design complexity: The impact of parasitic inductance and capacitance, EMI filter design for high-frequency power converters, and Heat sink design. PCB Design: Power circuit design, Driver circuit design, Single layer and Multilayer PCBs, separation of the power circuit and driver circuit, High-frequency power loop optimization.

Unit-V:
Applications: GaN in AC/DC & DC/AC Power Converters, GaN in Switched Mode Power Amplifiers, Electric Vehicle Applications, and Renewable Applications.

Books and Materials

Text Books:

1. A. Lidow, J. Strydom, M. D. Rooij, D. Reusch,, *GaN Transistors for Efficient Power Conversion,*Wiley, 2014.
2. G. Meneghesso, M. Meneghini, E. Zanoni,, *Gallium Nitride-enabled High Frequency and High Efficiency Power Conversion*, Springer International Publishing, 2018.

Reference Books:

1. B. J. Baliga,*Gallium Nitride and Silicon Carbide Power Devices*, World Scientific Publishing Company, 2017.
2. F. Wang, Z. Zhang and E. A. Jones *Characterization of Wide Bandgap Power Semiconductor Devices*, IET, 2018.

B7365 – DIGITAL SIGNAL PROCESSING

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces discrete-time signals and systems, Fourier and Z-transform techniques, and their properties. It covers DFT computation, IIR and FIR filter design using various methods, and implementation issues such as quantization, noise, and arithmetic errors. Learners will study signal modeling, spectral analysis, and optimum filter design for signal estimation and processing applications.

Course Pre/Co-requisites

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation and Infrastructure
SDG 8 – Decent Work and Economic Growth

Course Outcomes

After the completion of the course, the student will be able to:

- B7365.1 Apply Fourier and Z-transform techniques to represent and analyze discrete-time signals and systems.
- B7365.2 Apply DFT methods to perform linear convolution and implement IIR/FIR digital filters.
- B7365.3 Analyze the design and performance trade-offs between FIR and IIR filters using various realization structures.
- B7365.4 Analyze the impact of quantization, round-off errors, and dynamic range scaling on digital filter implementation
- B7365.5 Analyze signal modeling and spectral estimation techniques to determine the power spectrum of deterministic and random signals, and design optimum filters.

Course Syllabus

Unit-I:

Discrete-Time Signals and Linear Systems: Discrete time signals, Linear shift invariant systems, Stability and causality, Sampling of continuous time signal, discrete time Fourier transforms, Discrete Fourier series, Discrete Fourier transform, Z-transforms, Properties of different transforms

Unit-II:

Digital Filter Design – IIR Filters: Linear convolution using DFT, Computation of DFT Design of IIR digital filters from analog filters, Impulse invariance method, Bi-linear transformation method.

Unit-III:

Digital Filter Design – FIR Filters and Realization Structures: FIR filter design using window functions, Comparison of IIR and FIR digital filters, Basic IIR and FIR filter realization structures, Signal flow graph representations, Quantization process and errors, Coefficient quantization effects in IIR and FIR filters.

Unit-IV:
Finite Word Length Effects and Signal Modeling: A/D conversion noise, Arithmetic round-off errors, Dynamic range scaling, Overflow oscillations and zero Input limit cycles in IIR filters, Linear Signal Models.

Unit-V: Spectral Analysis and Optimum Filtering: All pole, All zero and Pole-zero models, Power spectrum estimation, Spectral analysis of deterministic signals, Estimation of power spectrum of stationary random signals, Optimum linear filters, Optimum signal estimation, Mean square error estimation, Optimum FIR and IIR Filters.

Books and Materials

Text Books:

1. Sanjit K Mitra, *Digital Signal Processing: A computer-based approach*,TMH Edition, 1998.
2. Dimitris G. Manolakis, Vinay K. Ingle and Stephen M. Kogon,, *Statistical and Adaptive Signal Processing*, TMH International Editions, 2000.

Reference Books:

1. S Salivahanan. A. Vallavaraj C. Gnanapriya,, *Digital Signal Processing* , 2^{nd} reprint TMH, 2001.
2. Lourens R Rebinarand Bernold, *Theory and Applications of Digital Signal Processing*, Routledge, 2016.

B7366 – Dynamics of Electrical Machines

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course provides a comprehensive study of basic machine theory and electrical machine dynamics, emphasizing modeling, analysis, and dynamic performance of DC, induction, and synchronous machines. It begins with fundamental concepts such as electromechanical analogy, magnetic saturation, rotating field theory, and the operation and equivalent circuits of DC and synchronous machines. Students explore electrodynamical equations, applying Lagrange's method to rotational and translational systems and mutually coupled coils. The course covers DC machine dynamics, including steady-state and transient behavior, interconnection of machines, and Ward-Leonard speed control. It also examines induction machine dynamics during starting, braking, and normal operation, deriving equations for dynamic response and acceleration times. Finally, synchronous machine dynamics are studied, including motor and generator operation, small oscillations, and representation of oscillation equations in state-space form, equipping students with the skills to analyze and predict machine behavior under various operating conditions.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 7 – Affordable and Clean Energy
SDG 9 – Industry, Innovation and Infrastructure

Course Outcomes

After the completion of the course, the student will be able to:

- B7366.1. Explain fundamental concepts of electromechanical energy conversion, rotating field theory, magnetic saturation, and equivalent circuits of DC and synchronous machines
- B7366.2. Formulate and solve electrodynamical equations for rotational and translational systems using Lagrange's method and coupled coil analysis.
- B7366.3. Analyze steady-state and transient behavior of separately excited DC machines, including speed control using Ward-Leonard systems
- B7366.4. Evaluate induction machine dynamics during starting, braking, and normal operation, and determine dynamic response characteristics.
- B7366.5. Model synchronous machine dynamics, study small oscillations, and represent oscillation equations in state-space form for motor and generator operations.

Course Syllabus

Unit-I:

BASIC MACHINE THEORY:

Electromechanical Analogy, Magnetic Saturation, Rotating field theory, Operation of Inductor motor, Equivalent circuit, Steady state equation of DC machines, Operation of synchronous motor, Power angle characteristics.

Unit-II:
ELECTRODYNAMICAL EQUATION & THEIR SOLUTIONS:
Spring and Plunger system, Rotational motion, mutually coupled coils, Lagrange's equation, Application of Lagrange's equation, and Solution of Electro dynamical equations.

Unit-III:
DYNAMICS OF DC MACHINES: Separately excited DC generator and motors, Steady-state and Transient analysis, Interconnection of machines, Ward Leonard system of speed control.

Unit-IV:
INDUCTION MACHINE DYNAMICS: Induction machine dynamics during starting and braking, Accelerating time, Induction machine dynamic during normal operation, Equation for dynamical response of the induction motor.

Unit-V:
SYNCHRONOUS MACHINE DYNAMICS: Electromechanical equation, Motor operation, Generator operation, small oscillations, General equations for small oscillations, Representation of the oscillation equations in state variable form.

Books and Materials

Text Books:

1. Sen Gupta D.P. and J.W, *Electrical Machine Dynamics,* Macmillan Press Ltd., 1980.
2. Bimbhra P.S., *Generalized Theory of Electrical Machines*, Khanna Publishers, 2002.

Reference Books:

1. Vedam Subranmanyam,*Thyristor control of Electric Drives*, 2018.
2. Article in IEEE Transactions on *Energy Conversion, Performance Optimization of Induction motors during Voltage-Controlled soft starting*, July 2004.

B7307 – Electrical Drives Laboratory

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
0	0	60	0	60	2	40	60	100

Course Description

Course Overview

This Laboratory course gives an exposure on different speed control techniques employed and closed loop control of PMDC motor. It also provides you a practical experience on the speed control of induction machines using cyclo converter. This lab course gives an opportunity to conduct test on single phase half and full controlled converter with inductive load.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant Sustainable Development Goals (SDGs)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation and Infrastructure
SDG 11 – Sustainable Cities and Communities

Course Outcomes

After the completion of the course, the student will be able to:

- B7307.1. Demonstrate the operation of PMDC and DC motor drives (thyristorised and IGBT-based) and evaluate their speed-control characteristics under closed-loop conditions.
- B7307.2. Analyse the performance of four-quadrant chopper and cyclo-converter based drives for DC and AC motors with respect to efficiency, dynamic response and controllability.
- B7307.3. Design and implement speed-measurement circuits and feedback control schemes for different electrical machines.
- B7307.4. Compare the performance of single-phase controlled converters (full and half controlled) feeding inductive loads and interpret their output characteristics.
- B7307.5. Apply safety practices, appropriate instrumentation and experimental data analysis to validate theoretical concepts in motor control and power electronic drives.

Course Syllabus

List of Experiments:

1. Speed measurement and closed loop control using PMDC motor.
2. Thyristorised drive for PMDC motor with speed measurement and closed loop control.
3. IGBT used single 4 quadrant chopper drive for PMDC motor with speed measurement and closed loop control.
4. Thyristorised drive for 1Hp DC motor with closed loop control.
5. 3 - Phase input, Thyristorised drive, 3 Hp DC motor with closed loop.
6. 3 - Phase input IGBT, 4 quadrant chopper drive for DC motor with closed loop control equipment.
7. Cyclo-converter based AC Induction motor control equipment.
8. Speed control of 3 phase wound rotor Induction motor.

9. Single phase full controlled converter with inductive load.
10. Single phase Half controlled converter with inductive load.

Laboratory Equipment/Software/Tools Required:

1. Functional Kits of above experiments
2. Tachometer

Books and Materials

Text Books:

1. W. Leonhard *Control of Electrical drives* , 3rd ed., Springer, 2001.
2. 2. P.C. Krause , *Analysis of Electric Machine*, 3rd ed., Wiley-IEEE press.

Reference Books:

1. R. Krishnan, *Electric motor drives modeling, analysis and control*, PHI-India-2009
2. G. K. Dubey *Fundamentals of electric Drives* , 2nd ed., Narosa Publishing House, 2011.

B7308 – Analysis of Advanced Power Converters Laboratory

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
0	0	60	0	60	2	40	60	100

Course Description

Course Overview

This course provides hands-on experience in modeling, simulation, and performance analysis of various DC–DC power electronic converters using MATLAB/Simulink. Students will learn to simulate conventional converters (Buck-Boost, Cuk, SEPIC, etc.), isolated converters (Flyback, Forward, Push–Pull), and advanced resonant and dual active bridge topologies. Emphasis is placed on analyzing dynamic performance, efficiency, and suitability of converters for different applications such as renewable energy systems, electric vehicles, and power supplies. By the end of the course, learners will be able to apply simulation techniques to evaluate converter characteristics and analyze their operation under various load and control conditions.

Course Pre/Co-requisites

B7301 - Analysis of Power Converters

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation and Infrastructure
SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

- B7308.1. Apply MATLAB/Simulink tools to design and simulate non-isolated DC–DC converters such as Buck-Boost, Cuk, and SEPIC for different load conditions.
- B7308.2. Analyze the performance characteristics (voltage gain, current ripple, efficiency) of interleaved and isolated converter topologies using simulation results.
- B7308.3. Apply switching and control strategies in MATLAB simulations to regulate output voltage of Flyback, Forward, and Push-Pull converters.
- B7308.4. Analyze the dynamic response and power transfer characteristics of resonant converters (series and parallel) under varying operating conditions.
- B7308.5. Apply and analyze the operation of advanced converters such as Dual Active Bridge by comparing their performance with conventional converters in renewable energy and electric vehicle applications.

Course Syllabus

List of Experiments:

1. MATLAB Simulation of Buck-Boost Converter with RLE load.
2. MATLAB Simulation of Interleaved DC-DC converter.
3. MATLAB Simulation of DC-DC Flyback Converter.
4. MATLAB Simulation of DC-DC Forward Converter.
5. MATLAB Simulation of Cuk converter.
6. MATLAB Simulation of Push pull converter.

7. MATLAB Simulation of Series resonant converter.
8. MATLAB Simulation of Parallel resonant converter.
9. MATLAB Simulation of SEPIC Converter.
10. MATLAB Simulation of Dual Active Bridge Converter.

Laboratory Equipment/Software/Tools Required:

1. Desktop Computers
2. MATLAB Software

Books and Materials

Text Books:

1. Mohan, Ned, Tore M. Undeland, and William P. Robbins. *Power Electronics: Converters, Applications and Design*. 3rd ed., John Wiley & Sons, 2003.
2. Rashid, M. H. *Power Electronics: Circuits, Devices and Applications*. 3rd ed., Prentice Hall of India, 1998.

Reference Books:

1. Sen, P. C. *Power Electronics*. 3th ed., Tata McGraw Hill Publishing, 2001.
2. Subramanyam, Vedam. *Power Electronics*. New Age International (P) Limited, 1997.

II M.Tech. I Semester

PROFESSIONAL ELECTIVE-V

B7367 – ELECTRIC VEHICLE CHARGING TECHNIQUES

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces the fundamentals of EV charging infrastructure, including charging technologies, power ratings, and standards. It covers location planning and land allocation for public charging, methods of connecting EVs to the electricity grid, and strategies for effective EV-grid integration through smart charging. Finally, it explores implementation models in India, highlighting government, consumer, and operator-driven approaches.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 7 – Affordable and Clean Energy
SDG 11 – Sustainable Cities and Communities

Course Outcomes

After the completion of the course, the student will be able to:

B7367.1. Apply the concepts of EV supply equipment, AC/DC charging methods, and charging standards to design suitable charging solutions..

B7367.2. Apply location planning principles and spatial allocation methodologies to identify optimal sites for EV charging stations.

B7367.3. Analyze the regulatory framework and role of DISCOMs in providing electricity connections for EV charging infrastructure.

B7367.4. Analyze the impacts of EV charging loads on the electricity grid and evaluate smart charging strategies for effective grid integration

B7367.5. Analyze different implementation models to assess their suitability in the Indian context.

Course Syllabus

Unit-I:

OVERVIEW OF EV CHARGING INFRASTRUCTURE: Orients the reader to EV charging infrastructure, providing a brief introduction to technical concepts of electric vehicle supply equipment, AC and DC charging, power ratings, and charging standards.

Unit-II:

LOCATION PLANNING AND LAND ALLOCATION: Covers the location and site planning aspects for EV charging, by framing the principles of location planning and demonstrating a methodology for spatial allocation of charging demand, and identifies enabling processes and policies to integrate public charging in urban planning.

Unit-III:

CONNECTING EVs TO THE ELECTRICITY GRID: Focuses on supply of electricity for charging infrastructure, familiarizing readers with the regulations that govern electricity supply for EV charging, the role of DISCOMs in provision of EV charging connections, and the three methods of arranging for power supply for charging infrastructure.

Unit-IV:
ACHIEVING EFFECTIVE EV-GRID INTEGRATION: Zooms out from site-level considerations for supply of electricity to assess grid-level impacts, and then highlights the need for smart charging to minimize adverse impacts of EV charging loads on the grid.

Unit-V:
MODELS OF EV CHARGING IMPLEMENTATION: Defines the typical roles within an implementation model for EV charging infrastructure and identifies three models in India – the government-driven model, the consumer-driven model and the charge point operator-driven model – for charging infrastructure implementation. .

Books and Materials

Text Books:

1. Sulabh Sachan P. Sanjeevikumar, Sanchari Deb, *Smart Charging Solutions for Hybrid and Electric Vehicles*, 2^{nd} Edition, Wiley Publications, March 2022.
2. Handbook of Electric Vehicle Charging Infrastructure Implementation Version-1, 3^{nd} Edition.

Reference Books:

1. Vahid Vahidinasab, Behnam Mohammadi-Ivatloo, *Electric Vehicle Integration via Smart Charging,* , 3^{rd} Edition, Springer, 2022.
2. Alam, Mohammad Saad, Pillai, Reji Kumar, Murugesan. N, *Developing Charging Infrastructure and Technologies for Electric Vehicles*, 2^{nd} Edition, IGI Global Publisher, December 2021.

B7368 – DSP BASED DRIVE CONTROL

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces the C2xx DSP core, memory organization, peripherals, interrupts, and assembly programming. It covers ADC operations, event management, timers, and control circuitry for real-time applications. Learners will study FPGA fundamentals, architectures, HDL programming, and case studies on Xilinx boards. The course concludes with applications in the control of DC, BLDC, and PMSM motors.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation and Infrastructure
SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

B7368.1. Apply the concepts of C2xx DSP architecture, memory, and instruction set to develop assembly programs for signal processing applications.

B7368.2. Apply interrupt handling, ADC operations, and event management features of DSPs in real-time control applications.

B7368.3. Analyze the architecture and functionality of FPGAs, including CLBs, IOBs, and interconnects, to evaluate their suitability for digital system design

B7368.4. Analyze HDL-based FPGA implementations using Xilinx devices through case studies to assess performance and design trade-offs

B7368.5. Analyze DSP and FPGA techniques for the control of DC, BLDC, and PMSM motors in embedded system applications

Course Syllabus

Unit-I:

C2xx DSP Core Architecture and Programming: Introduction to the C2xx DSP core and code generation, the components of the C2xx DSP core, mapping external devices to the C2xx core, Peripherals and Peripheral Interface, System configuration registers, Memory, Types of Physical Memory, Memory addressing Modes, Assembly Programming using C2xx DSP, Instruction Set, Software Tools.

Unit-II:

Pin Multiplexing and Interrupt Handling: Pin Multiplexing (MUX) and General Purpose I/O Overview, Multiplexing and General Purpose I/O Control Registers, Introduction to Interrupts, Interrupt Hierarchy, Interrupt Control Registers, Initializing and Servicing Interrupts in Software.

Unit-III:

ADC and Event Manager in DSP: ADC Overview, Operation of the ADC in the DSP, Overview of the Event manager (EV), Event Manager Interrupts, General Purpose (GP) Timers, Compare Units, Capture Units and Quadrature Enclosed Pulse (QEP) Circuitry, General Event Manager Information.

Unit-IV:

Field Programmable Gate Arrays (FPGAs): Introduction to Field Programmable Gate Arrays (FPGA), CPLD Vs FPGA, Types of FPGA, Xilinx XC3000 series, Configurable logic Blocks (CLB), Input/output Block (IOB), Programmable Interconnect Point (PIP), Xilinx 4000 series, HDL programming, Overview of Spartan 3E and Virtex II pro FPGA boards case study.

Unit-V:

Motor Control Applications: Control of DC motor, Permanent magnet Brushless DC motor, Permanent magnet synchronous motor.

Books and Materials

Textbooks:

1. Wakerly, John F. *Microcomputer Architecture and Programming.* 2nd ed., John Wiley and Sons, 1981.
2. Gaonker, Ramesh S. *Microprocessor Architecture, Programming and Applications with the 8085.* 3rd ed., Penram International Publishing (India), 1994.

Reference Books:

1. Toliyat, Hamid A., and Steven G. Campbell. *DSP Based Electromechanical Motion Control.* 3rd ed., CRC Press, 2004.
2. Xilinx, Inc. *XC 3000 Series Datasheet*, version 3.1, 2nd ed., 1998.
3. Xilinx, Inc. *XC 4000 Series Datasheet*, version 1.6, 1999.
4. Wolf, Wayne. *FPGA-Based System Design.* Prentice Hall, 2004.

B7369 – Digital Control of Power Electronic and Drives Systems

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

Digital control of power electronics and drive systems is a theory course intended to enhance the knowledge of students in various control aspects of electrical drives. This course deals with simulation of single phase and three-phase controlled converter based DC motor control, Chopper based control of DC motors and four quadrant operation of DC drives. This course also deals with speed control of Induction motor with single phase and three phase inverters. It also deals with application of numerical methods to solve DC and AC transients. This course is an extension of power electronics applications to AC and DC drives which gives knowledge about power semiconductor drives and motor control.

Course Pre/Co-requisites

B7301 - Analysis of Power Converters
B7302 - Machine Modelling and Analysis

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation and Infrastructure
SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

- B7369.1. Apply numerical methods to simulate transients in DC and AC circuits with R, L, and C components.
- B7369.2. Apply device models (diode, SCR, TRIAC, IGBT, power transistors) in circuit simulations including gate/base drives and snubber circuits.
- B7369.3. Analyze state-space models of electrical machines and drives to assess system dynamics and stability.
- B7369.4. Analyze the performance of rectifiers, choppers, and inverters under different control strategies through simulation
- B7369.5. Analyze simulation techniques for converter- and inverter-fed electric drives, evaluating their operation and control using PWM and space vector methods

Course Syllabus

Unit-I:

Numerical Methods for Electrical Transients: Review of numerical methods, Application of numerical methods to solve transients in D.C, Switched R, L, R- L, R-C and R-L-C circuits. Extension to AC circuits.Modelling of diode in simulation, Diode with R, R-L, R-C and R-L-C load with AC supply,

Unit-II:

Modeling and Simulation of Power Electronic Devices: Modelling of SCR, TRIAC, IGBT and Power Transistors in simulation, Application of numerical methods to R, L, C circuits with power electronic switches. Simulation of gate/base drive circuits, simulation of snubber circuits.

Unit-III:

State-Space Modeling and Electrical Machine Simulation: State space modelling and simulation of linear systems. Introduction to electrical machine modelling: induction, DC, and synchronous machines, simulation of basic electric drives, stability aspects.

Unit-IV:

Simulation of Converters and DC Drives: Simulation of single phase and three phase uncontrolled and controlled (SCR) rectifiers. Converters with self-commutated devices- simulation of power factor correction schemes. Simulation of converter fed DC motor drives. Simulation of thyristor choppers with voltage. Current and load commutation schemes. Simulation of chopper fed DC motor.

Unit-V:

Simulation of Inverters and Induction Motor Drives: Simulation of single and three phase inverters with thyristors and self-commutated devices. Space vector representation. Pulse-width modulation methods for voltage control. Waveform control. Simulation of inverter fed induction motor drives.

Books and Materials

Books:

1. Kumar, John L. Ashok, A. Kalaiyarasi, and Y. Uma Maheswari. *Power Electronics with MATLAB*. 2nd ed., Cambridge University Press, 2017.
2. *Simulink Reference Manual*. 3rd ed., MathWorks, USA.

Reference Books:

1. Shaffer, Randal. *Fundamentals of Power Electronics with MATLAB*. 3rd ed., Charles River Media, 2006.
2. Iyer, Narayanaswamy P. R. *Power Electronic Converters: Interactive Modelling Using Simulink*. 2nd ed., CRC Press, 2018.

B7370 – Data Science Applications in Power Engineering

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course explores data science and machine learning applications in power engineering, equipping students with tools to analyze, model, and optimize power generation and consumption. It begins with an introduction to data science, machine learning, and the role of AI in the power industry, including climate change mitigation and operational efficiency. Students learn data preparation, statistical analysis, and time-series modeling, covering outlier removal, feature engineering, dimensionality reduction, and dataset quality assessment. The course introduces machine learning techniques such as supervised and unsupervised learning, regression, classification, neural networks, SVM, random forests, and Bayesian networks, along with model training, validation, and performance evaluation. Applications in the power generation industry include predictive maintenance, demand-supply forecasting, consumer modeling, and integration with Building Management Systems, demonstrated through case studies like electrical consumption forecasting using multilayer perceptron ANNs. The course also addresses forecasting failures in wind power plants, including damage mechanisms, vibration analysis, and predictive maintenance strategies to optimize reliability and reduce lifetime costs.

Course Pre/Co-requisites

B7301 - Analysis of Power Converters
B7302 - Machine Modelling and Analysis

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation and Infrastructure
SDG 8 – Decent Work and Economic Growth

Course Outcomes

After the completion of the course, the student will be able to:

- B7370.1. Explain fundamental concepts of data science, machine learning, and their relevance to the power generation industry and climate change mitigation.
- B7370.2. Prepare, clean, and analyze datasets, perform time-series analysis, feature engineering, and dimensionality reduction for power engineering applications.
- B7370.3. Apply machine learning techniques—including regression, classification, neural networks, SVM, and random forests—to model and predict power system behavior.
- B7370.4. Implement predictive maintenance, demand-supply forecasting, and consumer load modeling in power plants and smart energy systems. using machine learning methods.
- B7370.5. Evaluate and forecast failures in wind power plants, including turbine blades, rotors, and generators, using data-driven and predictive analytics approaches

Course Syllabus

Unit-I:

Introduction to Data Science: Introduction to data science, introduction to machine learning, overview of the power generation industry, artificial intelligence in the power generation industry, climate change and the power industry, machine learning for industry transition, mitigation of problems using machine learning.

Unit-II:
Data Science, Statistics, and Time Series: Preparing a clean dataset, measuring and storing data in control systems, data uncertainty, time-series analysis, data correlation, mathematical representation and modeling, data representation and significance, outlier removal, model goodness, feature engineering, dimensionality reduction, practical checklist for dataset preparation.

Unit-III:
Machine Learning : Introduction to machine learning concepts, supervised and unsupervised learning, regression and classification, bias-variance trade off, model complexity, neural networks (feed-forward and recurrent), support vector machines (SVM), random forest, self-organizing maps (SOM), Bayesian networks, training a model, splitting datasets (training, testing, validation), cross-validation, assessing model performance, role of a domain expert, practical advice for a machine learning project

Unit-IV:
Machine Learning in the Power Generation Industry & Electrical Consumption Forecasting: Machine learning studies in power plants and for power users, predictive maintenance, forecasting supply and demand, modeling physical relationships, consumer modeling, practical applications of machine learning in the power industry, case study of electrical consumption forecasting in a medical clinic, integration with Building Management Systems, artificial neural network (ANN) implementation, multilayer perceptron ANN, backpropagation training algorithm, ANN inputs (loads, day type, time, weather), formal procedure for ANN parameter selection.

Unit-V:
Forecasting Wind Power Plant Failures Topic : Wind power plant damage mechanisms, impact on lifetime cost and power production, vibration spectra analysis for damage detection, predictive maintenance, forecasting failures on turbine blades, rotors, and generators

Books and Materials

Text Books:

1. Bangert, Patrick, editor. *Machine Learning and Data Science in the Power Generation Industry: Best Practices, Tools, and Case Studies.* 2nd ed., Elsevier, 2020. ISBN: 9780128197424.
2. Sidorov, Denis N., editor. *Machine Learning for Energy Systems.* MDPI Books, Dec. 2020. ISBN: 978-3-03943-382-7 (hardback); 978-3-03943-383-4 (PDF).
3. Rengaswamy, Raghunathan, and Resmi Suresh. *Data Science for Engineers.* CRC Press, 16 Dec. 2022. ISBN: 9780367754266 (hardback); 9781003353584 (eBook).

Reference Books:

1. Nazari-Heris, Morteza, et al., editors. *Application of Machine Learning and Deep Learning Methods to Power System Problems.* Springer International Publishing, 2021.
2. Prasath, T. Mari, and V. Kirubakaran. *Real-World Applications of Artificial Intelligence and Machine Learning in Power Systems: A Code Approach.* Nova Science Publishers, 2025.

OPEN ELECTIVES

B7081 - Business Analytics

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course addresses the scope of business analytics, process and tools used to get competitive advantages of business analytics. It covers the forecasting techniques to predict the given data for various decision making. Apart from prediction it also establishes the relationship between the given data to formulate the strategies for business decisions..

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 8 – Decent Work and Economic Growth
SDG 9 – Industry, Innovation and Infrastructure

Course Outcomes

After the completion of the course, the student will be able to:

B7081.1 Describe the fundamentals and techniques of data analytics.

B7081.2 Evaluate data and apply critical thinking to make informed decisions using deep analytics.

B7081.3 Develop predictive models to support business decision-making.

B7081.4 Design prescriptive models to recommend optimal business solutions.

B7081.5 Interpret analytical results and present them as clear, actionable insights.

Course Syllabus

Unit-I:

Business analytics and Statistical Tools: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

Unit-II:

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

Unit-III:

Organization Structures of Business Analytics:, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

Unit-IV:

Forecasting Techniques and Monte Carlo Simulation and Risk Analysis: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model,Overbooking Model, Cash Budget Model.

Unit-V:

Decision Analysis and recent trends: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making. Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

Books and Materials

Text Books:

1. Varshney, N., and Maheswari. *Business Analytics: Principles, Concepts, and Applications.* By Marc J. Schniederjans, Dara G. Schniederjans, and Christopher M. Starkey, 1st ed., Pearson FT Press, 2014.

Reference Books:

1. Evans, James R. *Business Analytics.* Global Edition, Pearson Higher Education & Professional Group, 2020.

B7082 - Waste to Energy

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

The course deals with the production of energy from different types of wastes through thermal, biological and chemical routes. This course provides insights into waste management options by reducing the waste destined for disposal and encouraging the use of waste as a resource for alternate energy production. This course is explores Biomass Pyrolysis, Biomass gasification, Biomass combustions and Bio energy systems.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 7 – Affordable and Clean Energy
SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

B7082.1. Classify different waste material produces from all sources.

B7082.2. Analyze Bio energy systems resources, process and application.

B7082.3. Apply emerging methods for Bio mass Pyrolysis, gasification and combustion to improve the efficiency.

B7082.4. Analyze different case studies for understanding success and failure of waste to energy technologies.

Course Syllabus

Unit-I:

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.

Unit-II:

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Unit-III:

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers - Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Unit-IV:

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Unit-V:

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Books and Materials

Text Books:

1. Desai, Ashok V. *Non-Conventional Energy.* Wiley Eastern Ltd., 1990.
2. Khandelwal, K. C., and S. S. Mahdi. *Biogas Technology: A Practical Handbook.* Vols. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.

Reference Books:

1. Challal, D. S. *Food, Feed and Fuel from Biomass.* IBH Publishing Co. Pvt. Ltd., 1991.
2. WereKo-Brobby, C. Y., and E. B. Hagan. *Biomass Conversion and Technology.* John Wiley & Sons, 1996.

B7083 - Operations Research

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

The courses in Operational Research offer a unique blend of traditional coursework, practical skills, and real-world problem-solving experience designed to position students for success in today's competitive world. This course covers Linear Programming, Non-Linear Programming Problem, Mathematical Models and problems.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation and Infrastructure
SDG 12 – Responsible Consumption and Production

Course Outcomes

After the completion of the course, the student will be able to:

B7083.1. Gain knowledge in concepts and techniques of Operations Research.
B7083.2. Determine the optimal solution for Linear Programming problems.
B7083.3. Formulate and obtain the optimal solution for non- Linear Programming problems.
B7083.4. Solve to get optimal solution using queuing and inventory models.
B7083.5. Determine solution for non- Linear Programming problems using dynamic programming.

Course Syllabus

Unit-I:

Linear Programming Problem & Its Application I: Introduction, Formulation of LPP. Slack Variable, Surplus Variable and Artificial Variables. Standard Form and Matrix Form. Concept of Duality. Graphical Method. Simplex Method. Big - M method & Two - Phase Method. Problems of Degeneracy.

Unit-II:

Linear Programming Problem & Its Application II: Parametric Programming introduction . Types of Linear Variations. Graphical and Analytical Sensitivity Analysis.

Unit-III:

Non-Linear Programming Problem I: Introduction, Formulation and Graphical Method, Kuhn-Tucker Conditions, Quadratic Programming Problems by Wolfe's and Beale's Method.

Unit-IV:

Non-Linear Programming Problem II: Geometric programming introduction and analytical methods , Fractional programming introduction and analytical methods, Dynamic programming introduction and analytical methods.

Unit-V:

General Mathematical Models: Sequencing - n Jobs and m Machines, Inventory Control - introduction and its analytical methods. Single server queuing model.

Books and Materials

Text Books:

1. Desai, Ashok V. *Non-Conventional Energy.* Wiley Eastern Ltd., 1990.
2. Khandelwal, K. C., and S. S. Mahdi. *Biogas Technology: A Practical Handbook.* Vols. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.

Reference Books:

1. Challal, D. S. *Food, Feed and Fuel from Biomass.* IBH Publishing Co. Pvt. Ltd., 1991.
2. WereKo-Brobby, C. Y., and E. B. Hagan. *Biomass Conversion and Technology.* John Wiley & Sons, 1996.

B7084 - Blockchain Technology

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course introduces blockchain, a revolutionary technology that enables peer-to-peer transfer of digital assets without any intermediaries, and is predicted to be just as impactful as the Internet. A blockchain is a permanent, sequential list of transaction records distributed over a network. The course introduces consensus, proof of work, mining, in Bitcoin. The course introduces ethereum blockchain and smart contracts.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation and Infrastructure
SDG 16 – Peace, Justice and Strong Institutions

Course Outcomes

After the completion of the course, the student will be able to:

B7084.1. Identify and explain the fundamental concepts, architecture, and working principles of blockchain technology.

B7084.2. Demonstrate the process of cryptocurrency transactions using Bitcoin and analyze its underlying mechanisms.

B7084.3. Compare and choose suitable blockchain platforms such as Ethereum for ensuring data security and integrity.

B7084.4. Design and implement smart contracts based on given problem requirements using Ethereum or similar platforms.

B7084.5. Evaluate blockchain applications and deployment on Testnet environments for real-world use cases.

Course Syllabus

Unit-I:

Introduction to Cryptocurrencies: Cryptographic Hash Functions, Hash Pointers and Data Structures, Digital Signatures, Public Keys as Identities, A Simple Cryptocurrency. How Bitcoin Achieves Decentralization: Centralization vs. Decentralization, Distributed Consensus, Consensus without Identity: the Block Chain, Incentives and Proof of Work, Putting It All Together.

Unit-II:

Mechanics of Bitcoin: Bitcoin Transactions, Bitcoin Scripts, Applications of Bitcoin Scripts, Bitcoin Blocks, The Bitcoin Network, Limitations Improvements. Store Usage: How to Store and Use Bitcoins, Hot and Cold Storage, Splitting and Sharing Keys, Online Wallets and Exchanges, Payment Services, Transaction Fees, Currency Exchange Markets.

Unit-III:
Bitcoin Mining: The Task of Bitcoin Miners, Mining Hardware, Energy Consumption Ecology, Mining Pools, Mining Incentives and Strategies. Bitcoin and Anonymity: Anonymity Basics, How to de-anonymizeBitcoin, Mixing, Decentralized Mixing, Zerocoin and Zerocash, Tor and the Silk Road.

Unit-IV:
Ethereum: What is Ethereum, smart contracts, Solidity Ethereum Virturalmachine. Installing solidity ethereum wallet, basics of solidity by example, Layout of a solidity source file structure of smart contracts, General value types, ether units, Time units, Globally available variables and functions.

Unit-V:
Operators: Arithmetic, Logical Bitwise operators, Control structure (if-else, for, while, do-while), Scoping and declarations, Input parameters and output parameters, Function calls return types, Function Modifiers, Fallback functions, Abstract contract, Creating contracts via new operator, Inheriting smart contracts, Importing smart contracts compiling contracts, Events logging, exceptions, Examples of smart contract : crowd funding, voting ballot.

Books and Materials

Text Books:

1. Narayanan, A., Bonneau, J., Felten, E., Miller, A., Goldfeder, S.,Bitcoin and Cryptocurrency Technologies: a comprehensive introduction, Princeton University Press, 2016.
2. Dave Hoover, Kevin Solorio, and Randall Kanna., Hands–On Smart Contract Development with Solidity and Ethereum, O'Reilly Media, Inc., 2019.

Reference Books:

1. Andreas M. Antonopoulos, Mastering Bitcoin: Unlocking Digital Cryptocurrencies, 1st Edition, O'Reilly Media, Inc., 2019.

B7085 - Cyber Security

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
45	0	0	45	90	3	40	60	100

Course Description

Course Overview

This course drawing upon a wealth of experience from academia, industry, and government service, Cyber Security details and dissects, in current organizational cyber security policy issues on a global scale—taking great care to educate students on the history and current approaches to the security of cyberspace. It includes thorough descriptions of Cyber Offences, Cyber Crime, tools and methods used in Cyber Crime. It also delves into organizational implementation issues, and equips students with descriptions of the positive and negative impact of specific policy choices.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 9 – Industry, Innovation and Infrastructure
SDG 16 – Peace, Justice and Strong Institutions

Course Outcomes

After the completion of the course, the student will be able to:

B7085.1. Demonstrate the basics of cybercrime in computer, networked device or a network.
B7085.2. Identify various cyber offences in real time.
B7085.3. Identify the different attacks in cybercrime.
B7085.4. Use various methods and tools to control cybercrimes and cyber offences.
B7085.5. Examine how to protect organizations from intruders, attackers and cyber criminals.

Course Syllabus

Unit-I:

Introduction to Cybercrime: Introduction, Cybercrime, and Information Security, who are Cybercriminals, Classifications of Cybercrimes. The legal Perspectives and Indian Perspective, Cybercrime and the Indian ITA 2000, A Global Perspective on Cybercrimes.

Unit-II:

Cyber Offenses: How Criminals Plan Them: Introduction, How Criminals plan the Attacks, Social Engineering, Cyber stalking, Cyber cafe and Cybercrimes. Botnets: The Fuel for Cybercrime, Attack Vector, and Cloud Computing.

Unit-III:

Cybercrime: Mobile and Wireless Devices: Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.

Unit-IV:
Tools and Methods: Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horse and Backdoors, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Overflow.

Unit-V:
Cyber Security: Organizational Implications Introduction, Cost of Cybercrimes and IPR issues, Web threats for Organizations, Security and Privacy Implications. Social media marketing: Security Risks and Perils for Organizations, Social Computing and the associated challenges for Organizations.

Books and Materials

Text Books:

1. Godbole, Nina, and Sunil Belapure. *Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives.* 1st ed., Wiley India, 2011.

Reference Books:

1. Graham, James, Richard Howard, and Ryan Otson. *Cyber Security Essentials.* 1st ed., CRC Press, 2011.
2. Wu, Chwan-Hwa (John), and J. David Irwin. *Introduction to Cyber Security.* 1st ed., CRC Press/T&F Group, 2013.
3. Clarke, Richard A., and Robert Knake. *Cyberwar: The Next Threat to National Security & What to Do About It.* Ecco, 2010.

AUDIT COURSES

B7091 – Disaster Management

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
30	0	0	0	30	0	100	-	100

Course Description

Course Overview

The course has been framed with an intention to provide a general concept in the dimensions of disasters caused by nature beyond human control as well as the disasters and environmental hazards induced by human activities with emphasis on Natural disaster, Man-made disaster, vulnerability and risks of disasters, Disaster Management Mechanism, Capacity Building and disaster coping Strategies and Disaster management planning.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 11 – Sustainable Cities and Communities
SDG 13 – Climate Action

Course Outcomes

After the completion of the course, the student will be able to:

B7091.1. Identify concepts, hazards and vulnerabilities of different types of disasters.
B7091.2. Examine the components of disaster management mechanism.
B7091.3. Select suitable capacity building framework for disaster management.
B7091.4. Interpret various disaster coping strategies.
B7091.5. Develop Strategies for disaster management planning.

Course Syllabus

Unit-I:

Introduction: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude. *Disaster Prone Areas in India:* 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-II:

Repercussions of Disasters and Hazards: 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 Preparedness and Management: 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-IV:

Risk Assessment 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.

Unit-V:

Disaster Mitigation: Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

Books and Materials

Text Books:

1. Nishith, R., and A. K. Singh. *Disaster Management in India: Perspectives, Issues and Strategies.* New Royal Book Company.
2. Sahni, Pardeep, et al., editors. *Disaster Mitigation: Experiences and Reflections.* Prentice Hall of India, New Delhi.
3. Goel, S. L. *Disaster Administration and Management: Text and Case Studies.* Deep & Deep Publication Pvt. Ltd., New Delhi.

B7092 – Value Education

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
30	0	0	0	30	0	100	-	100

Course Description

Course Overview

The present education system does not prepare students well for dealing with life. Primarily, it prepares them for profession or jobs. It concentrates on providing "How to do" rather than "What to do" or "Why to do?". This course will be helpful for students to develop critical ability, commitment and courage in real life problems. Students will learn about happiness, character development, self control, honesty, time management.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 16 – Peace, Justice and Strong Institutions
SDG 10 – Reduced Inequalities

Course Outcomes

After the completion of the course, the student will be able to:

B7092.1. Identify the importance of value-based living for character development.
B7092.2. Emerge as responsible citizens with clear conviction to practice values and ethics in life.
B7092.3. Interpret their role in nation building for a better tomorrow.
B7092.4. Develop a sense of commitment and decision-making capability.
B7092.5. Demonstrate ethical reasoning and leadership in personal and professional life.

Course Syllabus

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 judgments.

Unit-II:

Importance of Cultivation of Values: Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truth fullness, 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.

Unit-IV:

Achieving Happiness: Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood 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-V:
Character and Competence: Holy Books vs Blind faith. Self-Management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, and Studying effectively.

Books and Materials

Text Books:

1. Chakroborty, S. K. *Values and Ethics for Organizations: Theory and Practice.* Oxford University Press, New Delhi.
2. Aspin, David N., and Judith D. Chapman. *Values Education and Lifelong Learning: Principles, Policies, Programmes.* Springer, 2007.

B7093 – Constitution of India

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
30	0	0	0	30	0	100	-	100

Course Description

Course Overview

This course enables the students to understand the constitution of India as the Supreme law of India. The student will also gain knowledge about the parliament of India and how it functions. This course will survey the basic structure and operative dimensions of the Indian constitution. It will explore various aspects of the Indian political and legal system from a historical perspective highlighting the various events that led to the making of the Indian constitution.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 16 – Peace, Justice and Strong Institutions
SDG 10 – Reduced Inequalities

Course Outcomes

After the completion of the course, the student will be able to:

B7093.1. Identify the important components of Indian Constitution.
B7093.2. Explore the basics of Constitutional right in various domains .
B7093.3. Illustrate the evolution of Indian Constitution.
B7093.4. Analyze the Administrative process in India from grass-root level.
B7093.5. Relate the basic concepts of democracy, liberty, equality, secular and justice.

Course Syllabus

Unit-I:

History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working), **Philosophy of the Indian Constitution:** Preamble, Salient Features.

Unit-II:

Contours of Constitutional Rights & Duties: 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-III:

Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualification, Powers and Functions.

Unit-IV:

Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of 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-V:
Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

Books and Materials

Text Books:

1. The Constitution of India, 1950. Government Publication.
2. Busi, S. N., and B. R. Ambedkar. *Framing of the Indian Constitution.* 1st ed., 2015.

Reference Books:

1. Jain, M. P. *Indian Constitution Law.* 7th ed., Lexis Nexis, 2014.
2. Basu, D. D. *Introduction to the Constitution of India.* Lexis Nexis, 2015.

B7094 - Stress Management by Yoga

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
30	0	0	0	30	0	100	-	100

Course Description

Course Overview

Stress has been determined to be a key factor of illness and disease. Prolonged stress in any person can lead to negative thinking, depression and worse. The course is based on managing stress by practice of yogic principles that are proven to be highly effective and easy to learn. In this course the students will learn about different types of yoga practices, Meditation, Yoga asanas, Pranayama for stress, anger and fear management.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 3 – Good Health and Well-being
SDG 4 – Quality Education
SDG 8 – Decent Work and Economic Growth

Course Outcomes

After the completion of the course, the student will be able to:

B7094.1. Make use of yoga for stress management in educational environments.
B7094.2. Improve emotional intelligence to better deal with stress.
B7094.3. Develop flexibility through participation in yoga.
B7094.4. Learn methods of performing asanas, pranayama, mudras and bandhas.
B7094.5. Practice meditation for holistic living.

Course Syllabus

Unit-I:

Meaning and Definition of Stress: Eutress, Distress, Anticipatory Anxiety, Intense Anxiety and Depression. Necessity of Stress Management, Concept of Stress according to Yoga.

Unit-II:

Introduction to Yoga: Definition and Meaning of Yoga, Historical Perceptive on yoga – yoga before the time of Patanjali (Indus valley civilization, Vedas, Brahmnas, Upanishads, Epics, Puranas).

Unit-III:

Schools of Yoga: Eight Limbs of Yoga: Yama, Niyama, Asana, Pranayama, Pratyahara, Dharana, Dhyana & Samathi. General principles of practicing Asana, Pranay- ama, Meditation, Kriyas Bandhas and Mudra.

Unit-IV:

Essentials of yoga practices: Prayer, Disciplines in Yogic Practices, Place & Timing, Diet & Schedule for Yoga Practitioner. Obstacles in the Path of Yoga Practice, Sequence for yogic practices, Different between yogic & non yogic system of exercise. Do's and donts during Yoga.

Unit-V:
Personality development by yoga: Yoga and development of Social qualities of personality, Co-operation, Simplicity, Tolerance, Social adjustments, Yoga and personal efficiency. Improvement of personal efficiency through yoga.

Books and Materials

Text Books:

1. Andrews, Wasmer Linda. *Stress Control for Peace of Mind.* Barnes & Noble Publisher, 2005.
2. Nagendra, H. R., and R. Nagarathana. *Yoga Practices for Anxiety & Depression.* Bangalore: Swami Sukhabodhanandha Yoga Prakashana, 2004.

Reference Books:

1. Iyengar, B. K. S. *The Art of Yoga.* New Delhi: Harper Collins Publishers, 2003.

B7095 - Pedagogy Studies

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
30	0	0	0	30	0	100	-	100

Course Description

Course Overview

Pedagogy is the relationship between learning techniques and culture. It requires meaningful classroom interactions between educators and learners. The objective of this course is to help students build on prior learning and develop skills and attitudes. Furthermore it can improve the quality of your teaching and the way students learn, helping them gain a deeper grasp of fundamental material.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 8 – Decent Work and Economic Growth
SDG 9 – Industry, Innovation and Infrastructure

Course Outcomes

After the completion of the course, the student will be able to:

B7095.1. Develop a positive attitude towards life and the teaching profession.
B7095.2. Critically analyze classroom teaching, learning processes, and student behavior.
B7095.3. Compare teaching and learning practices in educational institutes over the past decade.
B7095.4. Summarize the aspects of an effective teaching process.
B7095.5. Apply innovative strategies to enhance teaching and learning outcomes.

Course Syllabus

Unit-I:

Introduction and Methodology: 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: Pedagogical practices in formal and informal classrooms in developing countries, Curriculum development, Teacher education.

Unit-III:

Evidence on the Effectiveness of Pedagogical Practices : 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: Alignment with classroom practices and followup 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: Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment. Dissemination and research impact.

Books and Materials

Text Books:

1. Ackers, J., and F. Hardman. "Classroom Interaction in Kenyan Primary Schools." *Compare*, vol. 31, no. 2, 2001, pp. 245-261.
2. Agrawal, M. "Curricular Reform in Schools: The Importance of Evaluation." *Journal of Curriculum Studies*, vol. 36, no. 3, 2004, pp. 361-379.
3. Akyeampong, K. *Teacher Training in Ghana—Does It Count?* Multi-site Teacher Education Research Project (MUSTER) Country Report 1, London: DFID, 2003.

Reference Books:

1. Akyeampong, K., K. Lussier, J. Pryor, and J. Westbrook. "Improving Teaching and Learning of Basic Maths and Reading in Africa: Does Teacher Preparation Count?" *International Journal of Educational Development*, vol. 33, no. 3, 2013, pp. 272–282.
2. Alexander, R. J. *Culture and Pedagogy: International Comparisons in Primary Education.* Oxford and Boston: Blackwell, 2001.
3. Chavan, M. *Read India: A Mass Scale, Rapid, 'Learning to Read' Campaign.* 2003.

B7096 - English for Research Paper Writing

Teaching and Learning Scheme				Hours	Credits	Assessment Marks		
CI		LI	TW+SL	H	C	CIE	SEE	Total
L	T	P	SL					
30	0	0	0	30	0	100	-	100

Course Description

Course Overview

This course equips students with essential academic writing skills, including sentence and paragraph structuring, clarity, conciseness, and avoidance of ambiguity. Students will learn to structure research papers effectively, covering abstracts, introductions, literature reviews, methods, results, discussions, and conclusions. Emphasis is placed on ethical writing practices, paraphrasing, and avoiding plagiarism. By the end of the course, students will be able to produce clear, coherent, and professionally written research papers suitable for publication.

Course Pre/Co-requisites

This course has no specific prerequisite and co-requisite.

Relevant SDG(s)

SDG 4 – Quality Education
SDG 8 – Decent Work and Economic Growth
SDG 9 – Industry, Innovation and Infrastructure

Course Outcomes

After the completion of the course, the student will be able to:

B7096.1. Develop effective planning and preparation skills for academic writing, including sentence structuring and paragraph development.

B7096.2. Apply techniques to clarify meaning, avoid ambiguity, and maintain conciseness and coherence in writing.

B7096.3. Demonstrate the ability to structure research papers, including abstracts, introductions, literature review, methods, results, discussion, and conclusions.

B7096.4. Utilize skills for proper paraphrasing, citation, avoiding plagiarism, and critically analyzing findings in research writing.

B7096.5. Employ advanced writing skills for finalizing papers, including crafting titles, abstracts, and ensuring first-time submission quality.

Course Syllabus

Unit-I:

Planning and Preparation: Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

Unit-II:

Clarifying and Writing Techniques: Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

Unit-III:

Paper Structure: Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Unit-IV:

Writing Key Sections of a Research Paper: Skills needed when writing a Title, Abstract, Introduction, and Review of the Literature.

Unit-V:

Writing and Finalizing Research Papers: Skills needed when writing the Methods, Results, Discussion, Conclusions, useful phrases, and ensuring the paper is as good as possible for first-time submission.

Books and Materials

Text Books:

1. Goldbort, R. *Writing for Science*. Yale University Press, 2006. Available on Google Books.
2. Day, R. *How to Write and Publish a Scientific Paper*. Cambridge University Press, 2006.

Reference Books:

1. Highman, N. *Handbook of Writing for the Mathematical Sciences*. SIAM, 1998.
2. Wallwork, Adrian. *English for Writing Research Papers*. Springer, New York, Dordrecht, Heidelberg, London, 2011.

Vision

To be a pioneer institute and leader in engineering education to address societal needs through education and practice.

Mission

- To adopt innovative student centric learning methods.
- To enhance professional and entrepreneurial skills through industry institute interaction.
- To train the students to meet dynamic needs of the society.
- To promote research and continuing education.

Quality Policy

We at Vardhaman College of Engineering, endeavor to uphold excellence in all spheres by adopting the best practices in effort and effect.

VARDHAMAN
COLLEGE OF ENGINEERING

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(Autonomous)
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