Shri Rawatpura Sarkar University, Raipur

Scheme of Teaching, Examination and Syllabus

for

M.Tech. (Power Electronics)

Semester-III

(Effective from the session: 2022-23)

SHRI RAWATPURA SARKAR UNIVERSITY, RAIPUR, CHHATTISGARH
FACULTY OF ENGINEERING

Two Years M.Tech. Programme

Scheme of Teaching and Examination

M.Tech. Third Semester Power Electronics

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the Academic Year 2022-2023)

S.No.	Course Code	Course Title	Hours / Week			Credits	Maximum Marks			Sem End Exam Duration (Hrs)
			L	T	P		Continuous Evaluation	Sem End Exam	Total	
1	MENPE301T	Static VAR Controller & Harmonic Filtering	3	1	-	4	30	70	100	3
2	MENPE302T	Elective-III	3	1	-	4	30	70	100	3
3	MENPE303P	Technical paper writing and seminar	-	-	4	2	100	-	100	-
4	MENPE304P	Pre Dissertation (Literature review/ Problem formulation/Synopsis)	-	-	28	14	60	140	200	-
						24			500	

Elective-III

(A) Digital Control Theory.
(B) Advanced Control of PWM Inverters fed induction motor.
(C) Power Electronics in wind & Solar Power Converters.

<table>
<tr><td>Course Title</td><td colspan="5">Static Var Control & Harmonic Filtering</td></tr>
<tr><td>Course Code</td><td colspan="5">MENPE301T</td></tr>
<tr><td rowspan="2">Course Credits</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td><td></td></tr>
<tr><td>Prerequisites</td><td colspan="5">FACTS</td></tr>
<tr><td>Course Objectives</td><td colspan="5">• A Flexible Alternating Current Transmission System (FACTS) is a system composed of static equipment used for the AC transmission of electrical energy.
• To enhance controllability and increase power transfer capability of the network.</td></tr>
<tr><td>Course Contents</td><td colspan="5">UNIT- I
Fundamentals of Load Compensation , Steady-State Reactive Power Control in Electric Transmission Systems , Reactive Power Compensation and Dynamic Performance of Transmission Systems . Power Quality Issues. Sags, Swells, Unbalance, Flicker , Distortion , Current Harmonics
UNIT-II
Static Reactive Power Compensators and their control. Shunt Compensators, SVCs of Thyristor Switched and Thyristor Controlled types and their control, STATCOMs and their control, Series Compensators of Thyristor Switched and Controlled Type and their Control, SSSC and its Control, Sub-Synchronous Resonance and damping.
UNIT-III
Converters for Static Compensation . Single Phase and Three Phase Converters and Standard Modulation Strategies (Programmed Harmonic Elimination and SPWM) . GTO Inverters . Multi-Pulse Converters and Interface Magnetics . Multi-Level Inverters of Diode Clamped Type and Flying Capacitor Type and suitable modulation strategies (includes SVM) . Multi-level inverters of Cascade Type and their modulation . Current Control of Inverters.
UNIT-IV
Passive Harmonic Filtering . Single Phase Shunt Current Injection Type Filter and its Control, Three Phase Three-wire Shunt Active Filtering and their control using p-q theory and d-q modelling .Threephase four-wire shunt active filters . Hybrid Filtering using Shunt Active Filters . Series Active Filtering in Harmonic Cancellation Mode . Series Active Filtering in Harmonic Isolation Mode.</td></tr>
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	UNIT-V Sources of Harmonics in Distribution Systems and Its Effects . Use of STATCOMs and SSSCs for Transient and Dynamic Stability Improvement in Power Systems Dynamic Voltage Restorer and its control . Power Quality Conditioner
Course Outcomes	**After studying the contents of the syllabus in detail the students will be able to:** • Understand about the Static Var • Understand about various Transformer connection • Understand about the Compensators • Understand Power flow controller etc.
Text Books	• T.J.E Miller : Reactive Power Control in Electric Systems, John Wiley & Sons • N.G. Hingorani& L. Gyugyi :Understanding FACTS: Concepts and Technology of Flexible AC Transmission, Systems. IEEE Press, 2000.
Reference Books	• Ned Mohan et.al :Power Electronics. John Wiley and Sons.

Course Title	**Digital Control Theory**				
Course Code	**MENPE302TA**				
Course Credits	**L**	**T**	**P**	**TC**	
	3	**1**	**0**	**4**	
Prerequisites	Signal and Systems				
Course Objectives	• To give knowledge of digital control techniques applied to power converters • To give knowledge of discrete time control theory. • To give Simulating new developments in its application to switch power converters				
Course Contents	**UNIT- I** **Sampling and Reconstruction** Introduction, sample and hold operations, Sampling theorem, Reconstruction of original sampled signal to continuous-time signal. The Z – transforms: Introduction, Linear difference equations, pulse response, Z–transforms, Theorems of Z–Transforms, the inverse Z – transforms, Modified ZTransforms **UNIT-II** **Z- Plane Analysis of Discrete-Time Control System** Z-Transform method for solving difference equations; Pulse transforms function, block diagram analysis of sampled – data systems, mapping between s-plane and z-plane: Primary strips and Complementary Strips.. **UNIT-III** **State Space Analysis** State Space Representation of discrete time systems, Pulse Transfer Function Matrix solving discrete time state space equations, State transition matrix and it's Properties, Methods for Computation of State Transition Matrix, Discretization of continuous time state – space equations Concepts of Controllability and Observability, Tests for controllability and Observability. Duality between Controllability and Observability, Controllability and Observability conditions for Pulse Transfer Function. **UNIT-IV** **Stability Analysis** Stability Analysis of closed loop systems in the Z-Plane. Jury stability test – Stability Analysis by use of the Bilinear Transformation and Routh Stability criterion. Stability analysis using Liapunov theorems. Design of digital control based on the frequency response method – Bilinear Transformation and Design procedure in the w-plane, Lead, Lag and Lead-Lag compensators and digital PID controllers. Design digital control through deadbeat response method.				

	UNIT-V **State Feedback Controllers And Observers** Design of state feedback controller through pole placement – Necessary and sufficient conditions, Ackerman's formula. State Observers – Full order and Reduced order observers, Linear Quadratic Regulators, Min/Max principle, Linear Quadratic Regulators, Kalman filters, State estimation through Kalman filters, introduction to adaptive controls.
Course Outcomes	**After studying the contents of the syllabus in detail the students will be able to:** • Formulate and analyse a power electronic design at the system level and access the performance • Identify the critical area in application level and drive typical alternative solutiuon with digital controller • Compare performance of various power semiconductor devices, its controller and switch circuit.
Text Books	• Discrete-Time Control systems - K. Ogata, Pearson Education/PHI, 2nd Edition • Digital Control and State Variable Methods by M.Gopal, TMH
Reference Books	• Digital Control Systems, Kuo, Oxford University Press, 2nd Edition, 2003. • Digital Control Engineering, M.Gopal.

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<tr><td>Course Title</td><td colspan="5">Advanced Control of PWM Inverters fed induction motor</td></tr>
<tr><td>Course Code</td><td colspan="5">MENPE302TB</td></tr>
<tr><td rowspan="2">Course Credits</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td><td></td></tr>
<tr><td>Prerequisites</td><td colspan="5">Power Electronic Drives</td></tr>
<tr><td>Course Objectives</td><td colspan="5">• Develop understanding of concept of PWM converters
• Understand application of PWM converters in electrical engineering</td></tr>
<tr><td>Course Contents</td><td colspan="5">UNIT- I
Principles for vector and field-oriented control-Complex-valued dq-model of induction machines. Turns ratio and modified dq-models. Principles for field-oriented vector control of ac machines. Current controllers in stationary and synchronous coordinates.
UNIT-II
Rotor-flux oriented control of current-regulated induction machine - Dynamic model of IM in rotor-flux coordinates. Indirect rotor-flux oriented control of IM - Direct rotor-flux oriented control of IM.- Methods to estimation of rotor-flux
UNIT-III
Generalized flux-vector control using current- and voltage decoupling networks-Generalized fluxvector oriented control. Current and voltage decoupling networks. Airgap-oriented control. Voltage-fed vector control. Stator-flux oriented vector control.
UNIT-IV
Parameter sensitivity, selection of flux level, and field weakening - Parameter detuning in steady-state operation. Parameter detuning during dynamics. Selection of flux level. Control strategies for used in the over-speed region .
UNIT-V
Principles for speed sensor-less control - Principles for speed sensor-less control. Sensor-less methods for scalar control. Sensor-less methods for vector control Introduction to observer-based techniques</td></tr>
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Course Outcomes	**After studying the contents of the syllabus in detail the students will be able to:** • Know deep understanding of PWM converter • Know application in electrical drives, filters, reactive power compensations, harmonics compensation.
Text Books	• Extract of D. W. Novotny and T. A. Lipo, Vector Control and Dynamics of AC Drives, Oxford University Press, 1996. • P. L. Jansen and R. D. Lorenz, A Physically Insightful Approach to the Design and Accuracy Assessment of Flux Observers for Field Oriented Induction Machine Drives, IEEE Trans. on Industry Applications, Vol. 30, No. 1, Jan./Feb. 1994, pp. 101110. • Extract of I. Boldea and S. A. Nasar Electric Drives, CRC Press, 1998.
Reference Books	• J. Holtz, Methods for Speed Sensorless Control of AC Drives, in K. RajashekaraSensorless Control of AC motors. IEEE Press Book, 1996. Supplementary literature. • R. W. De Doncker and D. W. Novotny, The Universal Field Oriented Controller, IEEE Trans. on Industry Applications, Vol. 30, No. 1, Jan./Feb. 1994, pp. 92100. • J. Holtz, The Representation of AC Machine Dynamics by Complex Signal Flow Graphs, IEEE Transactions on Industrial Electronics, Vol. 42, No. 3, 1995, pp. 263271.

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<tr><td>Course Title</td><td colspan="5">Power Electronics in wind & Solar Power Converters</td></tr>
<tr><td>Course Code</td><td colspan="5">MENPE302TC</td></tr>
<tr><td rowspan="2">Course Credits</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td><td></td></tr>
<tr><td>Prerequisites</td><td colspan="5">Power Electronics and Non-conventional energy sources.</td></tr>
<tr><td>Course Objectives</td><td colspan="5">• To understand the basic concept electronics devices their property, behavior and application.
• To understand the concept of waves shaping circuit and constant power supply.
• To understand the concept of solid state rectifiers.
• To learn the concept of positive and negative feedback in amplifier.
• Gain experience in the designing of an electronics circuit</td></tr>
<tr><td>Course Contents</td><td colspan="5">UNIT- I
Introduction
Trends in energy consumption - world energy scenario - energy sources and their availability - conventional and renewable sources - need to develop new energy technologies.
Photovoltaic Energy Conversion:
Solar radiation and measurement - solar cells and their characteristics - influence of insulation and temperature - PV arrays - Electrical storage with batteries - solar energy availability in India - Switching devices for solar energy conversion - Maximum power point tracking.
UNIT-II
Power Conditioning Schemes
DC Power conditioning converters - maximum power point tracking algorithms - AC power conditioners - Line commutated inverters - synchronized operation with grid supply -Harmonic problem.
PV Applications:
Stand alone inverters - Charge controllers - Water pumping, audio visual equipments, street lighting - analysis of PV systems
UNIT-III
Wind Energy Systems
Basic Principle of wind energy conversion - nature of wind - wind survey in India - Power in the wind - components of a wind energy - conversion system - Performance of induction generators for WECS - classification of WECS.
UNIT-IV
Self-Excited WECS
Self excited induction generator for isolated power generators - Theory of self-</td></tr>
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	excitation - Capacitance requirements - Power conditioning schemes - controllable DC Power from SEIGs - system performance. **Grid Connected WECS:** Grid connectors concepts - wind farm and its accessories – Grid related problems - Generator control - Performance improvements - Different schemes – AC voltage controllers – Harmonics and PF improvement **UNIT-V** **Stand Alone (Remote Area) Power Supply Systems** Wind/solar PV integrated systems - selection of power conversion ratio - Optimization of system components - storage - reliability evolution
Course Outcomes	**After studying the contents of the syllabus in detail the students will be able to:** • To introduce students the basic theory of power semiconductor devices and passive components, their practical application in power electronics. • To familiarize the applications related to non conventional energy sources. • To provide the basis for further study of power electronics circuits and systems.
Text Books	• Rai, G.D. "Non-conventional energy sources", Khanna Publishers, 1993. • Rai, G.D.,"Solar energy utilization", Khanna Publishers, 1991. Gray.L.Johnson, "Wind energy systems", Prentice Hall Inc., 1985.
Reference Books	• Daniel Hunt, V,"Wind Power-A Handbook of WECS", Van Nostrend Co., New York, 1981.

Course Title	**TECHNICAL PAPER WRITING AND SEMINAR**				
Course Code	**MENPE303P**				
Course Credits	**L**	**T**	**P**	**TC**	
	-	**-**	**4**	**2**	
Prerequisites	Industrial report writing and paper writing				
Course Objectives	**This course will enable students to:** • Describe the research process. • Outline the elements of a thesis/dissertation. • Select a research topic of importance to the profession. • Effectively work with their academic advisor and graduate committee. • Develop and follow an appropriate timeline for completion of the thesis/dissertation. • Identify an appropriate theory base for their research. • Develop a conceptual model relevant to their research.				
Course Contents	1. Each student will select a topic in the area of power system engineering and related area in the state of art area & technical development. 2. The topic will be decided by the Student, Guide and Departmental research committee. 3. Each student will make seminar presentation with audio/video aids, for the duration of 45 minutes and seminar work shall be in form of report to be submitted by the students at the end of the semester. 4. This report copies must be duly signed by guide and Head of Department. Attendance of all students for all seminars is compulsory. 5. Define the statement of research problem 6. Literature survey, familiarity with research journals 7. Broad knowledge off the available techniques to solve the problems 8. Technical writing skills 9. Presentation skills				
Course Outcomes	**After the completion of course:**				

	• Acceptable with minor or no revisions (no further approval required) • Acceptable with major revisions in content or format not acceptable
Reference Books	1. Student will learn to survey the relevant literature such as books, national/international referred journals and contact resource persons for the selected topic of research. 2. Roberts, C. M. (2010). The dissertation journey. Thousand Oaks, CA: Corwin.

M.Tech
Semester-(III)
2019-20

<table>
<tr><td>Course Title</td><td colspan="5">PREDISSERTATION (LITERATURE REVIEW/ PROBLEM FORMULATION/ SYNOPSIS)</td></tr>
<tr><td>Course Code</td><td colspan="5">MENPE304P</td></tr>
<tr><td rowspan="2">Course Credits</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>-</td><td>-</td><td>28</td><td>14</td><td></td></tr>
<tr><td>Prerequisites</td><td colspan="5">Paper writing</td></tr>
<tr><td>Course Objectives</td><td colspan="5">This course will enable students to:
Demonstrate the skills for good presentation and technical report writing skills.
Apply engineering and management principles while executing the project.</td></tr>
<tr><td>Course Contents</td><td colspan="5">Each student will select a topic in the area of power system engineering and related area in the state of art area & technical development.
Every student will carry out dissertation under the supervision of a Supervisor.
The topic shall be approved by a committee constituted by the Head of the concerned department.
Every student will be required to present two seminar talks, First at the beginning of the Dissertation (Phase-I)to present the scope of the work and to finalize the topic, and second towards the end of the semester, presenting the work carried out by him/her in the semester.
The committee constituted will screen both the presentations and work.
Define the statement of research problem
Literature survey, familiarity with research journals
Broad knowledge off the available techniques to solve the problems
Technical writing skills
Presentation skills</td></tr>
<tr><td>Course Outcomes</td><td colspan="5">After the completion of course:
Student will learn to survey the relevant literature such as books, national/international referred journals and contact resource persons for the selected topic of research.
Students will be able to use different experimental techniques.</td></tr>
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	• Students will be able to use different software/computational/analytical tools. • Students will be able to design and develop an experimental set up/equipment/test rig. • Students will be able to conduct tests on existing set ups/equipments and draw logical conclusions from the results after analyzing them. • Students will be able to either work in a research environment or in an industrial environment.
Reference Books	1. Student will learn to survey the relevant literature such as books, national/international referred journals and contact resource persons for the selected topic of research. 2. Roberts, C. M. (2010). The dissertation journey. Thousand Oaks, CA: Corwin.