UNIVERSITY OF MUMBAI
No. UG/137 of 2016-17

CIRCULAR:-

A reference is invited to the syllabi relating to the Master of Engineering (Power Electronics & Drives) degree course **vide** this office Circular No.UG/39 of 2013-14, dated 23rd May, 2013 and the Principals of affiliated Colleges in Engineering are hereby informed that the recommendation made by Ad-hoc Board of Studies in Electrical Engineering at its meeting held on 8th July, 2016 has been accepted by the Academic Council at its meeting held on 14th July, 2016 **vide** item No. 4.8 and that in accordance therewith, the revised syllabus as per Choice Based Credit System for Master of Engineering (Power Electronics & Drives) Sem. I to IV), which is available on the University's web site (www.mu.ac.in) and that the same has been brought into force with effect from the academic year 2016-17.

(Dr.M.A.Khan)
REGISTRAR

MUMBAI – 400 032
9th November, 2016

To,

The Principals of affiliated Colleges in Engineering.

A.C/ 4.8/14/07/2016.

****

No. UG/137-A of 2016 MUMBAI-400 032 9th November, 2016

Copy forwarded with compliments for information to:-

1. The Dean, Faculty of Technology,
2. The Chairmen, Ad-hoc Board of the Studies in Electrical Engineering
3. The Director, Board of College and University Development,
4. The Controller of Examinations,
5. The Co-Ordinator, University Computerization Centre.

(Dr.M.A.Khan)
REGISTRAR

..PTO

AC 14/07/2016
Item No. 4.8

UNIVERSITY OF MUMBAI

Revised Syllabus for the

M.E. Electrical Engineering
(Power Electronics and Drives)

(As per Choice Based Credit and Grading System with effect from the academic year 2016-2017)

From Co-ordinator's Desk:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's) and course objectives and course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering education.

Choice Based Credit and Grading System enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Choice Based Credit and Grading System were implemented for First Year Master of Engineering from the academic year 2016-2017. Subsequently this system will be carried forward for Second Year Master of Engineering in the academic year 2017-2018.

Dr. Suresh K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Preamble:

The overall technical education in our country is changing rapidly in manifolds. Now it is very much challenging to maintain the quality of education with its rate of expansion. To meet present requirement a systematic approach is necessary to build the strong technical base with the quality. Accreditation will provide the quality assurance in higher education and also to achieve recognition of the institution or program meeting certain specified standards. The main focus of an accreditation process is to measure the program outcomes, essentially a range of skills and knowledge that a student will have at the time of graduation from the program that is being accredited. Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

I, as Chairman, Board of Studies in Electrical Engineering of University of Mumbai, happy to state here that, Program Educational Objectives (PEOs) were finalized for post-graduate program in Electrical Engineering (Power Electronics and Drives), more than ten senior faculty members from the different institutes affiliated to University of Mumbai were actively participated in this process. Few PEOs were finalized for post-graduate program in Electrical Engineering (Power Electronics and Drives) are listed below;

Program Educational Objectives (PEOs)

- To create the competent & skilled engineers to ensure them the careers and employment and in this way fulfill the requirement of Multinational industries.
- To develop the strong ability in data analysis & their report towards an application for design and development power electronic systems.
- Expose them by giving an opportunity as an individual as well as team.
- Inculcate professional and ethical attitude and ability to relate power system issues to society at large.
- Facilitate strong base of basic scientific & engineering knowledge with professional ethics, lifelong learning attitude society globally.
- Be successful innovative and entrepreneur in the power electronics field via consultancy work.

Program Outcomes (POs)

- Able to demonstrate & competent enough in basic knowledge in Mathematics, Engineering and Technology to obtain the solution of engineering problem.
- Have ability to formulate the engineering problem, design the setup for experimentation, analysis and interpretation of the result data, report preparation.

- Develop the competency to design power electronic converters and drives, control systems, engineering software's, simulated model and solutions etc as per desired specification & requirement as applicable/useful to public/society.
- Demonstrate the ability to work on basic engineering discipline as well as multi-disciplinary engineering teams to achieve the solution of engineering problem.
- Strong competency in using modern engineering tools like MATLAB / Simulink, for solution of electrical engineering problems.
- Able to use the acquired knowledge and professional skill and project as well as budget management towards betterment of the society.
- Understand the needs of the society worldwide in the context of his professional knowledge to ensure environmental safety and better sustainability.
- Capable to apply ethical principles with committed professional ethics and duties towards the solution of complex engineering problems.
- Motivate to work independently as well as a member of team or team leader in multi functionaries and diversified knowledge platforms.
- Develop an effective inter personnel communication skill at large with public and professional bodies. They will be able to comprehend the data and accordingly will prepare technical design details, datasheets, reports, documentation etc.
- Inculcate the lifelong learning in the purview of updates /upgrade in engineering and technology.
- Investigate the complex engineering problems using acquired knowledge in electrical engineering to develop industrial level solutions in the interest of society.

Dr. S. R. Deore,
Chairman,
Board of Studies in Electrical Engineering,
Member - Academic Council
University of Mumbai

Program Structure for
M.E. Electrical Engineering (Power Electronics and Drives)
University of Mumbai
(With Effect from 2016-2017)

Semester I

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
PEDC101	Applied Linear Algebra*	04	--	--	04	--	--	04
PEDC102	Power Electronic Technologies	04	--	--	04	--	--	04
PEDC103	Electrical Machine Modeling and Analysis	04	--	--	04	--	--	04
PEDDLO101X	Department Level Optional Course-I	04	--	--	04	--	--	04
ILO101X	Institute Level Optional Course-I	03	--	--	03	--	--	03
PEDL101	Laboratory - I	--	02	--	--	02	--	01
PEDL102	Laboratory - II	--	02	--	--	02	--	01
Total		**19**	**04**	**--**	**19**	**04**	**--**	**21**

Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract /Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
PEDC101	Applied Linear Algebra*	20	20	20	80	03	--	--	100
PEDC102	Power Electronic Technologies	20	20	20	80	03	--	--	100
PEDC103	Electrical Machine Modeling and Analysis	20	20	20	80	03	--	--	100
PEDDLO101X	Department Level Optional Course-I	20	20	20	80	03	--	--	100
ILO101X	Institute Level Optional Course-I	20	20	20	80	03	--	--	100
PEDL101	Laboratory - I	--	--	--	--	--	25	25	50
PEDL102	Laboratory - II	--	--	--	--	--	25	25	50
Total		**100**	**100**	**100**	**400**	**--**	**50**	**50**	**600**

*** Common for M.E. Electrical Engineering in Power System Engineering and Power Electronics and Drives**

Program Structure for
M.E. Electrical Engineering (Power Electronics and Drives)
University of Mumbai
(With Effect from 2016-2017)

Semester II

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
PEDC201	Power Quality Issues and Mitigation**	04	--	--	04	--	--	04
PEDC202	Advanced Power Electronic Converters	04	--	--	04	--	--	04
PEDC203	Electrical Drives and Control	04	--	--	04	--	--	04
PEDDLO202X	Department Level Optional Course-II	04	--	--	04	--	--	04
ILO202X	Institute Level Optional Course-II	03	--	--	03	--	--	03
PEDL201	Laboratory – III	--	02	--	--	02	--	01
PEDL202	Laboratory - IV	--	02	--	--	02	--	01
Total		**19**	**04**	**--**	**19**	**04**	**--**	**21**

Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
PEDC201	Power Quality Issues and Mitigation**	20	20	20	80	03	--	--	100
PEDC202	Advanced Power Electronic Converters	20	20	20	80	03	--	--	100
PEDC-203	Electrical Drives and Control	20	20	20	80	03	--	--	100
PEDDLO202X	Department Level Optional Course-II	20	20	20	80	03	--	--	100
ILO202X	Institute Level Optional Course-II	20	20	20	80	03	--	--	100
PEDL201	Laboratory – III	--	--	--	--	--	25	25	50
PEDL202	Laboratory - IV	--	--	--	--	--	25	25	50
Total		**100**	**100**	**100**	**400**	--	**50**	**50**	**600**

** **Common for M.E. Electrical Engineering in Power System Engineering and Power Electronics & Drives**

Program Structure for
M.E. Electrical Engineering (Power Electronics and Drives)
University of Mumbai
(With Effect from 2016-17)

Semester III

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theor	Pract.	Tut.	Theory	Pract.	Tut.	Total
PEDS301	Special Topic Seminar	-	06	-	-	03	-	03
PEDD301	Dissertation–I	-	24	-	-	12	-	12
Total		-	30	-	-	15	-	15

Subject Code	Subject Name	Examination Scheme						
		Theory						
		Internal Assessment			End Sem. Exam.	Term Work	Pract. /Oral	Total
		Test1	Test 2	Avg.				
PEDS301	Special Topic Seminar	-	-	-	-	50	50	100
PEDD301	Dissertation–I	-	-	-	-	100	-	100
Total		-	-	-	-	**150**	**50**	**200**

Semester IV

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theor	Pract.	Tut.	Theory	Pract.	Tut.	Total
PEDD401	Dissertation–II	-	30	-	-	15	-	15
Total		-	30	-	-	15	-	15

Subject Code	Subject Name	Examination Scheme						
		Theory						
		Internal Assessment			End Sem. Exam.	Term Work	Pract. /Oral	Total
		Test1	Test 2	Avg.				
PEDD401	Dissertation–II	-	-	-	-	100	100	200
Total		-	-	-	-	**100**	**100**	**200**

Note:

- In case of Seminar, 01 Hour / week / student should be considered for the calculation of load of a teacher
- In case of Dissertation I, 02 Hour / week / student should be considered for the calculation of load of a teacher
- In case of Dissertation II, 02 Hour / week / student should be considered for the calculation of load of a teacher
- **End Semester Examination:** In all six questions to be set, each of 20 marks, out of these any four questions to be attempted by students. Each question will comprise of mixed questions from different units of the subjects.

Subject Code	Department Level Optional Course-I	Subject Code	Department Level Optional Course-II
PEDDLO1011	Power Electronics in Power System#	PEDDLO2021	Digital Signal Processors for Control and Power Applications
PEDDLO1012	Renewable Energy Systems and Energy Storage#	PEDDLO2022	Advanced Control System#
PEDDLO1013	Electrical and Hybrid Vehicle Technology	PEDDLO2023	Power Conditioning Systems for Renewable Energy#
PEDDLO1014	Microgrid and Smart Grid	PEDDLO2024	EHV AC Transmission System#
PEDDLO1015	Dynamic Analysis of Synchronous Machine	PEDDLO2025	Electromagnetic Interference & Compatibility in Power Electronic

 # Common for M. E. Electrical Engineering in Power System Engineering and Power Electronics & Drives

Subject Code	Institute Level Optional Course-I	Subject Code	Institute Level Optional Course-II
ILO1011	Product Lifecycle Management	ILO2021	Project Management
ILO1012	Reliability Engineering	ILO2022	Finance Management
ILO1013	Management Information System	ILO2023	Entrepreneurship Development and Management
ILO1014	Design of Experiments	ILO2024	Human Resource Management
ILO1015	Operation Research	ILO2025	Professional Ethics and Corporate Social Responsibility(CSR)
ILO1016	Cyber Security and Laws	ILO2026	Research Methodology
ILO1017	Disaster Management and Mitigation Measures	ILO2027	IPR and Patenting
ILO1018	Energy Audit and Management	ILO2028	Digital Business Management
		ILO2029	Environmental Management

Subject Code	Subject Name	Credits
PEDC101	**Applied Linear Algebra**	**04**
Course Objectives	• To introduce students to the fundamental concepts of linear algebra culminating in abstract vector spaces and linear transformations. • To enable the student to solve large systems of linear equations using direct matrix factorization, iterative numerical methods, and computer software with the understanding and knowledge of the underlying mathematical concepts.	
Course Outcomes	• Students will be familiar with the properties of matrices including how to use them to solve linear systems of equations and how they are used in linear transformations between vector spaces. • Students will understand how to choose appropriate numerical methods to solve a particular linear algebra problem.	

Module	Contents	Hours
1	**Vector space:** Solution of homogeneous and non-homogeneous systems of linear equations, Vector space, subspace, span, linear independence, basis, dimension, kernel (or null) and image (or range) subspaces, invariant subspaces, change of basis and similarity transform linear functions and transformations.	12
2	**Matrices:** norms, and condition number, Symmetric matrices and positive definite matrices.	04
3	**Solution of linear systems:** LU and Cholesky factorizations. Effect of round off errors. Standard Iterative methods for linear systems (Jacobi and Gauss-Seidel Iterations).	08
4	**Orthogonalization and Least-squares:** Orthogonality and SVD, QR factorization using Gram-Schmidt process of orthogonalization, Normal equation, Full rank and Rank deficient Least square problem.	08
5	**Eigenvalues:** Eigen values and Eigen vectors, Diagonalization of matrices, Canonical representations (Unitary & Non - unitary transform), Schur Decomposition, Power iteration, inverse iteration, Rayleigh quotient iteration, QR algorithm, computing the SVD.	12
6	**Application of Linear algebra:** Application in graphs and networks and Fourier Transform.	04

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Books Recommended:

Text Books:

1. Golub& Van Loan, Matrix Computation, John Hopkins University Press.
2. Gilbert Strang, Linear Algebra and its Applications, Cengage Learning.
3. Watkins, Fundamentals of Matrix Computations, Wiley series of Tech.
4. Madhumangal Pal, Advanced Algebra, PHI Learning.

Reference Books:

1. Trefethen and Bau, Numerical Linear Algebra.
2. Lorenzo Sadun, Applied Linear Algebra The Decoupling Principle, American Mathematical Society.

Subject Code	Subject Name	Credits
PEDC102	**Power Electronic Technologies**	**04**
Course Objectives	• To understand and acquire knowledge about various power semiconductor devices related to its characteristics, ratings, protection and to select semiconductor devices for various applications. • To introduce different methods of power conversion such as ac to dc, dc to dc, dc to ac the underlying principles of converter operation and hence to analyze different converter circuits for power conversion. • To keep abreast with the latest technologies and research going on in different areas related to power electronics. • To enhance the capability of problem solving skills. • To simulate the converter and its control for deeper understanding and detailed analysis.	
Course Outcomes	• Select and design power electronic converter topologies for a broad range of energy conversion applications. • Analyze and simulate the performance of power electronic conversion systems. • Ability to analyze various single phase and three phase power converter circuits and understand their applications. • Improved knowledge in interdisciplinary fields. • Apply the basic concepts of power electronics to design the circuits in the fields of AC and DC drives, power generation and transmission and energy conversion, industrial applications, extraction of energy from renewable sources. • Build and troubleshoot power electronics circuits. • Deliver technological solution in the field of power electronics. • Determine the drive circuit requirements in terms of electrical isolation and design heat sink, snubber circuit for protection	

Module	Contents	Hours
1	**Power semiconductor Switches:** Review of Power Devices: SCR, BJT, MOSFET, IGBT, GTO, safe operating Limits, selection of devices for various applications, introduction to SiC, GaN devices, conduction and switching losses, numericals.	06
2	**Drive circuits and protection:** Gate drive requirements, drive circuits, need for isolation, Protection circuits: Snubber circuits and its design, temperature control and heat-sinks, numericals.	06
3	**AC to DC converters:** Review of Single phase and three phase thyristor full bridge rectifier, fourier analysis of input current, effect of power factor on firing angle. Single phase PWM rectifiers, control scheme of PWM rectifiers, need for power decoupling in single phase, power decoupling techniques, applications of PWM rectifiers.	08
4	**DC to DC converters:** Review of dc to dc converter system, PWM duty ratio control, analysis of various conduction modes of Buck, Boost, Buck-Boost, Cuk and introduction to SEPIC converters, output	12

	voltage derivation, comparison of dc to dc converters, numericals.	
5	**DC to AC converters:** Review of basic concepts of VSI, operation of single phase half bridge, full bridge and three phase bridge inverters in square wave mode, output waveforms for R,R-L,C,R-C loads, harmonic analysis of load voltage, Current source inverters, comparison of VSI and CSI, numericals.	06
6	**PWM modulation strategies**: Single phase Sinusoidal PWM (unipolar, bipolar), Selective Harmonic Elimination method, Hysterisis PWM, Three phase SPWM, Third harmonic injected SPWM, Space vector modulation, effect of blanking time in PWM inverters, numericals.	10

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Books Recommended:

Text Books:

1. N. Mohan, T. M. Undeland, W.P Robbins, "Power Electronics, Converters, Applications & Design," Wiley India Pvt. Ltd.
2. M. H. Rashid, "*Hand book of Power Electronics"* , Academic Press,2001.
3. Daniel.W.Hart, "Power Electronics", Mc GrawHill Publications 2010.
4. Joseph Vithayathil, "Power Electronics", Tata McGraw Hill.
5. P.S Bhimbra, "Power Electronics",Khanna Publishers.
6. Simon Ang, Alejandro Oliva, "Power-Switching Converters" Taylor and Francis group
7. R W Erickson and D Maksimovic, "Fundamental of Power Electronics" Springer, 2nd Edition.

Other References/Journals

1. P. T. Krein, "Elements of Power Electronics", Oxford University Press.
2. L.Umanad, "Power Electronics: Essentials & Applications," Wiley.
3. IEEE Transaction journals, IECON, APEC and other power electronic related Conference Proceedings etc.

Subject Code	Subject Name	Credits
PEDC103	**Electrical Machine Modeling and Analysis**	**04**
Course Objectives	• To introduce the fundamentals of magnetic circuit and electromechanical energy conversion. • To understand the significance of d-q (two phase) model in different reference frames. • To model and analyze the DC machine, three phase induction machine and synchronous machine.	
Course Outcomes	The learner should be able to • Model and analyze DC machine, induction machine and synchronous machine.	

Module	Contents	Hours
1	**Basic Principle for Electrical Machine Analysis:** Introduction, magnetically coupled circuit, electromechanical energy conversion, machine winding and air gap MMF, winding inductance and voltage equation.	10
2	**Direct Current Machines:** Elementary DC machine, voltage and torque equations, basic types of DC machines, dynamic characteristics of permanent magnet and shunt DC motors, time domain block diagram and state equation, solution of dynamic characteristics.	05
3	**Reference Frame Theory:** Introduction, equations of transformations, stationary circuit variables transformed to arbitrary reference frame, commonly used reference frame, transformation between reference frames, transformation of a balanced set, balanced steady state phasor relationship, balanced steady state voltage equations.	09
4	**Symmetrical Induction Machine:** Introduction, voltage equations in machine variables, torque equations in machine variables, voltage equations in arbitrary reference frame variables, torque equations in arbitrary reference frame variables, commonly used reference frames, analysis of steady state operations, free acceleration characteristics, reduced order machine equation.	12
5	**Synchronous Machines:** Introduction, voltage equations and torque equations, Park's equations.	06
6	**Control of Induction Motor:** Concept of space vector, introduction to field oriented control and direct torque control of induction motor.	06

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or

course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Books Recommended:

Text Books:

1. "Analysis of Electric Machinery" P.C. Krause, McGraw Hill, New York
2. "Modern Power Electronics and A.C. Drive", B. K. Bose, , PHI
3. "Electric Motor Drives, Modeling, Analysis and Control" , R.Krishnan, PHI
4. "Generalized Theory of Electrical Machines", Dr. P.S.Bimbhra, Khanna Publishers

Reference Books:

1. "Control of Electrical Drives" W. Leonhard. Springer Verlag,
2. "Fundamentals of Electrical Drives", G. K. Dubey, Narosa Publishing House.

Subject Code	Subject Name	Credits
PEDDLO1011	**Power Electronics in Power System**	**04**
Course Objectives	• To know the basic principle of conventional active and reactive power flow control in power systems and problems associated with long distance power transmission. • To make students aware how power electronics devices can be used to find solution to the problems in long distance power transmission.	
Course Outcomes	• Students should be able to select and implement proper compensator to solve the problems occurring in long distance power transmission.	

Module	Contents	Hours
1	**Introduction**- Steady state and dynamic problems in AC systems- Transmission interconnections- Flow of power in an AC system- Loading capability- Power flow and dynamic stability considerations of a transmission interconnection- Relative importance of controllable parameters- Basic types of FACTS controllers- Brief description and definitions- Benefits from FACTS technology- In perspective: HVDC or FACTS	10
2	**Static shunt compensators:** Objectives of shunt compensation, Methods of controllable Var generation- Variable impedance type static Var generators (TCR, TSR, TSC, FC-TCR), Switching converter type Var generators.	10
3	**Static series compensation:** Objectives of series compensation- Variable impedance type series compensation-TSSC and TCSC , Basic operating control schemes for TSSC and TCSC, Switching converter type series compensators - SSSC, Transmitted power versus transmission angle characteristic	08
4	**Static voltage and phase angle regulators:** Objectives of voltage and phase angle regulators, Approaches to TCVR and TCPAR, Switching converter based voltage and phase angle regulators	08
5	**Compensation using DSTATCOM and DVR:** Compensating single phase loads using DSTATCOM, Ideal three phase shunt compensator structure, Series compensation of power distribution system using DVR- Rectifier supported DVR, DC Capacitor supported DVR(Fundamental Frequency series compensator characteristic)	08
6	**Unified Power Quality Conditioner:** UPQC configurations, Right shunt UPQC characteristics, Left shunt UPQC characteristics	04

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Books Recommended:

Text Books:

1. Narain G. Hingorani and Laszlo Gyugyi, "Understanding FACTS Concepts and Technology of Flexible AC Transmission Systems," IEEE Press.
2. Arindam Ghosh and Gerard Ledwich, " Power Quality Enhancement Using Custom Power Devices," Kluwer Academic Publishers
3. Roger C. Dugan, Mark F. McGranaghan and H.WayneBeaty "Electrical Power System Quality" , Mc Graw Hill
4. J. Arrillaga, N.R.Watson and S.Chen " Power System Quality Assessment," John Wiley & Sons
5. Yong Hua Song "Flexible AC transmission system" Institution of Electrical Engineers, London

Reference Book/ Journals*:*

1. Jos Arrillaga and Neville R Watson "Power System Harmonics" Wiley Publications
2. G.T.Heydt , "Electric Power Quality," Stars in a Circle Publications
3. IEEE Transaction on Power Systems
4. IEEE Transaction on Power Delivery
5. IEEE Transaction on Power Electronics

Subject Code	Subject Name	Credits
PEDDLO1012	**Renewable Energy Systems and Energy Storage (RESES)**	**04**
Course Objectives	• To introduce the new paradigm of power generation in the form of renewable energy and the various means used for power processing and optimization. • To relate and study the various energy storage technology and their significance in the context of renewable energy based applications.	
Course Outcomes	Learner will be able to • Understand current scenario of depleting world's production and reserves of fossil fuels, bad impact of fossil fuel power plants on environment and the means of mitigating these issues with different renewable energy alternatives based distributed generation. • Understand the process of power generation through solar thermal and solar photovoltaics, I-V and P-V characteristics of SPV with various essential parameters and power optimization using MPPT techniques to determine the requirements of solar PV modules and power topologies and their control. • Understand the various other renewable sources like Wind Energy system (WES), concept Fuel cell technology tidal, wave, biomass and their • Understand and describe the importance of various forms of energy storage, importance of storage system in new power generation scenario, their characteristics and performance with various applications • Analyze and calculate the power sharing and fault scenarios in hybrid combinations renewable energy sources and energy storage elements.	

Module	Contents	Hours
1	**Introduction:** Review of reserves and production of commercial energy sources, India's production and reserves, energy alternatives, Review of non conventional energy sources. Distributed generation: merits and demerits, renewable energy policies of India; Issues with large scale integration of renewable energy sources (RES) and role of energy storage in its mitigation.	05
2	**Solar Energy:** Review of solar thermal applications-solar thermal conversion systems and components and storage applications. Review of solar photovoltaic (PV) cells, principle of power generation using solar PV; Solar PV cell model, emerging solar cell technologies; Solar PV modules: Issues of mismatch and hot spots in the PV modules, means of mitigation. Design and structure of PV modules, PV module power output, I-V and power curve of module. BOS of PV system**,** battery charge controllers, MPPT, and different algorithms for MPPT, distributed MPPT, Types of PV systems; Design methodology of standalone PV system. Solar PV Micro-inverters. Review of regulatory standards. Design of rooftop solar PV plant	12

3	**Wind Energy:** Review of wind energy system and its components, types of wind turbines, characteristics; Power generation and control in wind energy systems, performance calculations of wind energy systems. Topologies of WES power processing, Power Converters for Doubly Fed Induction Generators (DFIG) in Wind Turbines.	08
4	**Fuel Cell Technology:** Review of fuel cells and their principle of operation, Review of types of fuel cell and their performance comparison. Topologies of fuel cell power systems, applications.	05
5	**Other Energy Alternatives:** Review of other nonconventional sources, their features and applications: Biomass, Tidal, Wave, Geothermal, and Micro-hydro electric generation	06
6	**Energy Storage:** Forms of energy storage (ES), importance of storage system in new power generation scenario; Types, characteristics and performance evaluation of: batteries, ultra-capacitors, flywheels, SME, pumped hydro storage system; Applications of Energy storage in distributed generation. Assessment of reliability and stability enhancement in renewable energy system. Examples of hybrid power generation based on renewable energy and energy storage.	12

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Books Recommended:

Reference Book:

1. Heinrich Ha¨berlin, *Photovoltaics :System Design And Practice*, John Wiley and Sons. 2012
2. Hashem Nehrir and Caisheng Wang, Modeling *and control of fuel cells: Distributed Generation Applications,* IEEE Press, 2009
3. J.F. Manwell and J.G. McGowan, *Wind Energy Explained, theory design and applications*, Wiley publication 4. D. D. Hall and R. P. Grover, *Biomass Regenerable Energy,* John Wiley, New York, 1987.
5. Felix A. Farret and M. Godoy Simoes, *Integration of Alternative Sources of Energy*, 2006, John Wiley and Sons.
6. S. Chakraborty, M. G. Simões and W. E. Kramer, *Power Electronics for Renewable and Distributed Energy System*, Springer 2013
7. Ahmed Faheem Zobaa, *Energy storage – Technologies and Applications*, InTech Publication 2013.
8. Robert A. Huggins, Energy Storage, Springer 2010
9. N. Femia • G. Petrone, G. Spagnuolo and M. Vitelli, *Power Electronics and Control Techniques for Maximum Energy Harvesting in Photovoltaic Systems,* CRC Press, 2013

Subject Code	Subject Name	Credits
PEDDLO1013	**Electric and Hybrid Vehicle Technology (EHVT)**	**04**
Course Objectives	▪ To introduce the fundamental concepts, principles and various drive-train topologies of electric and hybrid electric vehicles. ▪ To model, analyze and understand the design considerations of electric and hybrid electric vehicles.	
Course Outcomes	Learner will be able • To identify and describe the history and evolvement of electric & hybrid electric vehicles to emphasize on the need and importance of EV/HEV for sustainable future. • To identify and describe the principles of various EV/HEVs drive train topologies along with their power flow control and fuel efficiency estimation. • To design and select electric propulsion system components for EV/HEV drives suitability for the desirable performance and control**.** • To compare and evaluate various energy sources and energy storage components for EV and HEV applications. • To model, analyze and design EV/HEV drive train with energy management strategies**.**	

Module	Contents	Hours
1	**Introduction:** History of electric vehicles (EV) and hybrid electric vehicles (HEV), Power/Energy supplies requirements for EV/HEV applications, vehicle power source characterization, and transmission characteristics. Comparison of EV/HEV with conventional vehicle technology, Fuel Economy analysis	04
2	**Drive-train Topologies:** various electric drive-train topologies, hybridization, basics of hybrid traction system, various hybrid drive-train topologies, power flow control in drive-train topologies, fuel efficiency analysis., Plug-in Hybrid Vehicles	06
3	**Electrical Drive for Propulsion Applications:** Electric system components for EV/HEV, suitability of DC and AC machines, AC and DC Motor drives. Modeling and control of electrical drive system for EV/HEV. Design considerations for electrical drive used in two wheeler and four wheeler EV/HEV	10
4	**Energy Sources for EV/HEV:** Requirements of energy supplies and storage in EV/HEV, Review of batteries, fuel cells, flywheels and ultra-capacitors as energy sources for EV/HEV, characteristics and comparison of energy sources for EV/HEV, hybridization of different energy sources. Charging stations of EV, various technologies in charging.	10
5	**Modeling and design of the drive trains:** Modeling and analysis of EV/HEV drive train, sizing of motor, and design of traction power electronics, various vehicle subsystems.	10

6	**Energy Management Strategies and Energy Efficiency:** EV/HEV energy management strategies, classification and comparison of various energy management strategies, energy efficiency comparison for various EV and HEV variants	08

Assessment:

Internal assessment consists of two tests out of which one should be compulsory class test (on minimum 02 modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Books Recommended:

Reference Books*:*

1. Iqbal. Hussein, *Electric and Hybrid Vehicles: Design Fundamentals*, CRC Press, 2003.
2. M. Ehsani, Y. Gao, S.E. Gay and Ali Emadi, *Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design*, CRC Press. 2005
3. J. Larminie and J. Lowry, *Electric Vehicle Technology Explained*, Wiley, 2003
4. Sheldon S. Williamson, *Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles,* Springer 2013
5. Robert A. Huggins, Energy Storage, Springer 2010
6. C. MI, M. Abul and D. W. Gao, *Hybrid Electrical Vehicle Principles and Application with Practical Perspectives,*
7. B.D. McNicol and D.A.J. Rand, *Power Sources for Electric Vehicles,* Elsevier Publications. *1998*
8. N. Mohan, T.M.Undeland, W.P Robbins, *Power Electronics, Converters, Applications & Design,* Wiley India Pvt. Ltd., 2003

Website Reference:

http://nptel.iitm.ac.in: Introduction to Hybrid and Electric Vehicles - Web course

Subject Code	Subject Name	Credits
PEDDLO1014	**Microgrid and Smart Grid (MAS)**	**4**
Course Objectives	▪ To introduce the fundamental concept, various power architectures and control of distributed generation and microgrids. ▪ To review various regulatory standards and state of the art of microgrids ▪ To understand the microgrid and Smart Grid deployments for large scale integration of clean energy sources, various technologies, automation and ICT infrastructure requirements.	
Course Outcomes	Learner will be able • To identify and describe the impact of renewable energy integration for mitigating energy crises and sustainable future. • To identify and describe the concept of Microgrid and its various topologies, modes of operation control and communication architecture. • To identify and describe the concept of Smart Grid, its features and the state of the art. • To understand various Smart Grid technologies, automation, resiliency and its adoption in current power system.	

Module	Contents	Hours
1	**Introduction:** Energy crises and sustainable alternatives, review of conventional and non conventional energy sources and power generation; Comparison of renewable technologies: Solar Photovoltaics, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources. Impact of grid integration of renewable energy resources on existing power system: reliability, stability and power quality issues, Role of Energy storage system in enhancement of performance	06
2	**Distributed Generations (DG) and Microgrids:** DG topologies, regulatory standards/ framework: IEEE 1547, Limits on operational parameters,: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues; Concept of microgrid, review of sources of microgrids, typical structure and configuration of a microgrid, AC and DC microgrids, Power Electronics interfaces in DC and AC microgrids, modes of operation and control of microgrid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques, Microgrid economics.	12
3	**Introduction to Smart Grid:** Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient & Self Healing Grid, Present development & International policies in Smart Grid. Case study of Smart Grid. CDM opportunities in Smart Grid	08

4	**Smart Grid Technologies:** Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers	08
5	**Smart Grid Operations and Automation:** Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).	06
6	**Communication Technology for Microgrids & Smart Grid:** Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN). Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication, Wireless Mesh Network, Basics of CLOUD Computing & Cyber Security for Smart Grid. Broadband over Power line (BPL). IP based protocols	08

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Books Recommended: *Reference Books:*

1 A. Yezdani, and Reza Iravani, Voltage *Source Converters in Power Systems: Modeling, Control and Applications,* John Wiley Publications, 2010
2 Dorin Neacsu, *Power Switching Converters: Medium and High Power*, CRC Press, 2006
3 A. Keyhani, M. N. Marwali, M. Dai, *Integration of Green and Renewable Energy in Electric Power Systems*, Wiley, 2009
4 B. M. Buchholz and Z. Styczynski, *Smart Grids – Fundamentals and Technologies in Electricity Networks,* Springer, 2014
5 C. W. Gellings, *The Smart Grid: Enabling Energy Efficiency and Demand Response*, CRC Press, 2009
6 J. Ekanayake, N. Jenkins, K. Liyanage, J. Wu, A. Yokoyama, *Smart Grid: Technology and Applications*, Wiley, 2012
7 J. C. Sabonnadière and N. Hadjsaïd, *Smart Grids*, John Wiley & Sons and ISTE, 2012
8 IEEE standards "IEEE-1547-2003: IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems" IEEE standards 2003
9 IEEE standards "IEEE 1547-4-2011: IEEE Guide for Design Operation & Integration of Distributed Resources Island System with Electric Power System,
10 Consortium for Electric Reliability Technology Solutions (CERTS) white paper on Integration of Distributed Energy Resources: 'The CERTS Microgrid Concept' 2002

Subject Code	Subject Name	Credits
PEDDLO1015	**Dynamic Analysis of Synchronous Machine (DASM)**	**04**
Course Objectives	▪ To introduce the modeling of synchronous machine and its steady state and transient analysis ▪ To model subsystems like excitation system, transmission lines, SVCs and analyze dynamics behavior of synchronous Generator ▪ To introduce single machine and multi machine models for small signal analysis.	
Course Outcomes	Learner will be able ▪ To identify and describe the synchronous machine model with its steady state and transient analysis • To identify and describe the modeling of other subsystems like excitation system, transmission lines and SVCs • To understand dynamics behavior of a synchronous generator connected to infinite bus. • To understand and evaluate small signal model of single machine system. • To understand multi-machine system model and evaluate large power system performance	

Module	Contents	Hours
1	**Basic Concepts:** Review of classical methods of analysis of synchronous machine	04
2	**Modeling of Synchronous Machine:** Synchronous Machine, Park's Transformation, Analysis of Steady State Performance, Per Unit Quantities, Equivalent Circuits of synchronous Machine, Determination of parameters of equivalent circuits, Transient Analysis of synchronous machine	12
3	**Modeling of** Excitation system, Transmission lines, Static Var Compensator, Loads	08
4	**Dynamics of synchronous Generator connected to infinite bus:** System model and simulation, Inclusion of SVC Model	08
5	**Analysis of Single Machine System:** Small Signal Analysis with Block Diagram Representation, Characteristic equation and application of Routh Hurwitz Criterion, Synchronizing and damping torques analysis, Small Signal Model, Nonlinear oscillation	10
6	**Analysis of Multi-machine System Model:** Detail models, Inclusion of load and SVC Dynamics, Model Analysis of large power system	06

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Books Recommended:

Text books/Reference books

1. K R Padiyar, *Power system Dynamics Stability and Control*, B S Publication
2. Peter W. Sauer and M A Pai, *Power system Dynamics Stability*, Pearson Education
3. P Kundur, *Power system Dynamics Stability and Control*,
4. P M Anderson and A.A Fouad, *Power system Control and Stability*,

Subject Code	Subject Name	Credits
ILO1011	**Product Life Cycle Management**	**03**
Course Objectives	• To familiarize the students with the need, benefits and components of PLM • To acquaint students with Product Data Management & PLM strategies • To give insights into new product development program and guidelines for designing and developing a product • To familiarize the students with Virtual Product Development	
Course Outcomes	Learner will be able to… • Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation. • Illustrate various approaches and techniques for designing and developing products. • Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc. • Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant	

Module	Detailed Contents	Hrs
1	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	12
2	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and	09

	Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	
3	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	06
4	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	06
5	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	06
6	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	06

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, ImmonenAnselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Subject Code	Subject Name	Credits
ILO1012	**Reliability Engineering**	**03**
Course Objectives	• To familiarize the students with various aspects of probability theory • To acquaint the students with reliability and its concepts • To introduce the students to methods of estimating the system reliability of simple and complex systems • To understand the various aspects of Maintainability, Availability and FMEA procedure	
Course Outcomes	Learner will be able to… • Understand and apply the concept of Probability to engineering problems • Apply various reliability concepts to calculate different reliability parameters • Estimate the system reliability of simple and complex systems • Carry out a Failure Mode Effect and Criticality Analysis	

Module	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	10
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	10
03	**System Reliability** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	10

05	**Maintainability and Availability** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Subject Code	Subject Name	Credits
ILO1013	**Management Information System**	**03**
Course Objective	• The course is blend of Management and Technical field. • Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built • Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage • Identify the basic steps in systems development • Define and analyze various MIS management responsibilities, including planning, budgeting, project management, and personnel management • Discuss critical ethical and social issues in information systems	
Course Outcomes	Learner will be able to… 1. Explain how information systems Transform Business 2. Identify the impact information systems have on an organization 3. Describe IT infrastructure and its components and its current trends 4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making **5.** Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses	

Module	Detailed Contents	Hrs
01	**Introduction To Information Systems (IS):** Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	7
02	**Data and Knowledge Management:** Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	9
03	**Ethical issues and Privacy:** Information Security. Threat to IS, and Security Controls	6
04	**Social Computing** (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing,	6

	Cloud computing model.	
06	**Information System within Organization**: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	10

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Management Information Systems: Kelly Rainer, Brad Prince by Wiley
2. Management Information Systems: Managing the Digital Firm (10th Edition). K.C. Laudon and J.P. Laudon, Prentice Hall, 2007.
3. Managing Information Systems: Strategy and Organization, D. Boddy, A. Boonstra, Prentice Hall, 2008

Subject Code	Subject Name	Credits
ILO1014	**Design of Experiments**	**03**
Course Objectives	• To understand the issues and principles of Design of Experiments (DOE). • To list the guidelines for designing experiments. • To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization	
Course Outcomes:	Learner will be able to… • Plan data collection, to turn data into information and to make decisions that lead to appropriate action. • Apply the methods taught to real life situations. • Plan, analyze, and interpret the results of experiments	

Module	Detailed Contents	Hrs
01	**Introduction:** Strategy of Experimentation, Typical Applications of Experimental Design, Guidelines for Designing Experiments, Response Surface Methodology.	06
02	**Fitting Regression Models:** Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression, Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack of fit.	08
03	**Two-Level Factorial Designs:** The 2^2Design, The 2^3 Design, The General 2^k Design, A Single Replicate of the 2^kDesign, The Addition of Center Points to the 2^kDesign, Blocking in the 2^kFactorial Design, Split-Plot Designs.	07
04	**Two-Level Fractional Factorial Designs:** The One-Half Fraction of the 2^k Design, The One-Quarter Fraction of the 2^k Design, The General 2^{k-p} Fractional Factorial Design, Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs.	07
05	**Conducting Tests:** Testing Logistics, Statistical aspects of conducting tests, Characteristics of good and bad data sets, Example experiments, Attribute Vs Variable data sets.	07
06	**Taguchi Approach:** Crossed Array Designs and Signal-to-Noise Ratios, Analysis Methods, Robust design examples.	04

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss
6. Philip J Ross, "Taguchi Technique for Quality Engineering," McGraw Hill.
7. Madhav S Phadake, "Quality Engineering using Robust Design," Prentice Hall.

Subject Code	Subject Name	Credits
ILO1015	**Operations Research**	**03**
Course Objectives	• Formulate a real-world problem as a mathematical programming model. • Understand the mathematical tools that are needed to solve optimization problems. • Use mathematical software to solve the proposed models.	
Course Outcomes	Learner will be able to… • Understand the theoretical workings of the simplex method for linear programming and perform iterations of it by hand. • Understand the relationship between a linear program and its dual, including strong duality and complementary slackness. • Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change. • Solve specialized linear programming problems like the transportation and assignment problems. • Solve network models like the shortest path, minimum spanning tree, and maximum flow problems. • Understand the applications of, basic methods for, and challenges in integer programming • Model a dynamic system as a queuing model and compute important performance measures	

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research***:* Introduction, Historical Background, Scope of Operations Research , Features of Operations Research, Phases of Operations Research, Types of Operations Research Models, Operations Research Methodology, Operations Research Techniques and Tools , Structure of the Mathematical Model, Limitations of Operations Research	02
02	**Linear Programming***:* Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, *Simplex Method* Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, ***Duality***, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis	06
03	**Transportation Problem***:* Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone	06

	method and MODI method. **Assignment Problem***:* Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem	
04	**Integer Programming Problem***:* Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	06
05	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	06
06	**Simulation***:* Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation *Monte-Carlo Method:* Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	04
07	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	04
08	**GamesTheory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	04
09	**InventoryModels**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	04

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

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1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

4. Only Four question need to be solved.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Subject Code	Subject Name	Credits
ILO1016	**Cyber Security and Laws**	**03**
Course Objectives	• To understand and identify different types cyber crime and cyber law • To recognized Indian IT Act 2008 and its latest amendments • To learn various types of security standards compliances	
Course Outcomes	Learner will be able to… • Understand the concept of cyber crime and its effect on outside world • Interpret and apply IT law in various legal issues • Distinguish different aspects of cyber law • Apply Information Security Standards compliance during software design and development	

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cybercafé and Cybercrimes, Botnets, Attack vector, Cloud computing, 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, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	10
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data	8

	Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	
05	**Indian IT Act.** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000,IT Act. 2008 and its Amendments	8
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Subject Code	Subject Name	Credits
ILO1017	**Disaster Management and Mitigation Measures**	**03**
Course Objectives	• To understand the various types of disaster occurring around the world • To identify extent and damaging capacity of a disaster • To study and understand the means of losses and methods to overcome /minimize it. • To understand role of individual and various organization during and after disaster • To know warning systems, their implementation and based on this to initiate training to a laymen • To understand application of GIS in the field of disaster management • To understand the emergency government response structures before, during and after disaster	
Course Outcomes	Learner will be able to… • Understand natural as well as manmade disaster and their extent and possible effects on the economy. • Planning of national importance structures based upon the previous history. • Understand government policies, acts and various organizational structure associated with an emergency. • Know the simple do's and don'ts in such extreme events and act accordingly	

Module	Detailed Contents	Hrs
01	**Introduction:** Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	**Natural Disaster and Manmade disasters**: Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion . Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	06
03	**Disaster Management, Policy and Administration:** Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. Policy and	06

	administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	
04	**Institutional Framework for Disaster Management in India:** Importance of public awareness, Preparation and execution of emergency management programme. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
05	**Financing Relief Measures**: Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. International relief aid agencies and their role in extreme events.	09
06	**Preventive and Mitigation Measures**: Pre-disaster, during disaster and post-disaster measures in some events in general, Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication. Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

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End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

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3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by RajdeepDasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Subject Code	Subject Name	Credits
ILO1018	**Energy Audit and Management**	**03**
Course Objectives	• To understand the importance energy security for sustainable development and the fundamentals of energy conservation. • To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management • To relate the data collected during performance evaluation of systems for identification of energy saving opportunities	
Course Outcomes	**Learner will be able to…** • To identify and describe present state of energy security and its importance. • To identify and describe the basic principles and methodologies adopted in energy audit of an utility. • To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities. • To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities • To analyze the data collected during performance evaluation and recommend energy saving measures	

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings.	10

	Energy efficiency measures in lighting system, Lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons

4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Subject Code	Subject Name	Credits
PEDL101	Laboratory - I	01

Course Objectives: Analysis of basic power electronic circuits (open loop) using various simulation softwares (eg. MATLAB, PSPICE, Proteus Software, Sci lab, C-PROGRAM, SEQUEL). Minimum two softwares to be used. Minimum eight simulations based on the subjects taught to be carried out. Suggested list of experiments/simulations are given below

Module	Detailed Content	Lab. Sessions
1	**Using C program write two program such as** • Generate a sinusoidal waveform • FFT analysis for any signal	02
2	**Simulation** • Three phase controlled rectifier including source inductance • Non isolated DC-DC converter • Isolated DC-DC converter • Bidirectional Covereter • Synchronous Rectifier • Two machine model simulation without and with compensators • Modelling and control of DC Motor • Modelling and control of induction motor	10

Term work: Term work consists of performing 08 practical mentioned as above. Final certification and acceptance of the term work ensures satisfactory performance of laboratory work

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners

Subject Code	Subject Name	Credits
PEDL102	Laboratory - II	01

Course Objectives: Hardware Implementation of basic power electronic circuit (open loop) mentioned in Laboratory-I. Minimum two hardware implementation and its detailed analysis must be carried out. Maximum two students in a group. Suggested list of hardware is given below.

Module	Detailed content	Lab. Sessions
1	**Design and Hardware Implementation(any two)** • Static var compensator • DC-DC Converter • DC-AC Converter • DC motor drive • AC motor drive	10
2	**Characteristics of Renewable Sources (Any One)** • I-V and P-V Characteristics of solar panel at different Atmospheric Conditions • I-V and P-V Characteristics of fuel cell • Characterization of Wind Energy Systems output	02

Term work: Term work consists of performing 08 practical mentioned as above. Final certification and acceptance of the term work ensures satisfactory performance of laboratory work

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners

Subject Code	Subject Name	Credits
PEDC201	**Power Quality Issues and Mitigation**	**04**
Course Objective	• To know various power quality issues, it causes and effects • To understand effects of harmonics due to non-linear load • To learn mitigation methods for harmonics	
Course Outcomes	Students should be able: • To identify the problems in power system due to harmonics • To suggest solutions to the problems due to power quality	

Module	Contents	Hours
1	**Introduction:** • Power Quality • Importance of power quality • Power Quality Evaluation • Terms and definitions of power quality issues as per IEEE std. 1159. • Transients • Long-Duration Voltage Variations • Short-Duration Voltage Variations • Voltage Imbalance • Waveform Distortion • Voltage Fluctuation • Power Frequency Variations	4
2	**Voltage Sags And Interruptions:** • Sources of Sags and Interruptions • Estimating Voltage Sag Performance • Fundamental Principles of Protection • Solutions at the End-User Level • Motor-Starting Sags • Utility System Fault-Clearing Issues	7
3	**Transient Over voltages:** • Sources of Transient Overvoltages • Principles of Overvoltage Protection • Devices for Overvoltage Protection • Utility Capacitor-Switching Transients • Utility System Lightning Protection • Managing Ferroresonance • Switching Transient Problems with Loads	7
4	**Fundamentals of Harmonics** • Harmonic Distortion	10

	• Voltage versus Current Distortion • Harmonics versus Transients • Harmonic Indexes • Harmonic Sources from Commercial Loads • Harmonic Sources from Industrial Loads • Locating Harmonic Sources • System Response Characteristics • Effects of Harmonic Distortion • Interharmonics	
5	• Power Factor Compensation- • Linear circuits with Sinusoidal Supply-Basic relationship, complex power, apparent power, power factor and power factor compensation. • Non-Linear circuits with Sinusoidal Supply-Basic relationship, complex power, apparent power, power factor and power factor compensation. • Linear circuits with non-Sinusoidal Supply-Basic relationship, complex power, apparent power, power factor and power factor compensation. • Non-Linear circuits with non-Sinusoidal Supply-Basic relationship, complex power, apparent power, power factor and power factor compensation.	12
6	• Power Quality Mitigation Techniques- • Passive Filters • Shunt Active Filters • Series Active Filters • Unified Power Quality Compensators	08

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Books Recommended:

Text Books:

1. Roger C. Dugan, Mark F. McGranaghan and H.WayneBeaty, "Electrical Power System Quality," MC Graw Hill
2. G.T.Heydt , "Electric Power Quality," Stars in a Circle Publications

3. J. Arrillaga, N.R.Watson and S.Chen, " Power System Quality Assessment," John Wiley & Sons
4. W. Shepherd and P. Zand, " Energy flow and power factor in non-sinusoidal circuits" Cambridge university press
5. IEEE-519: 1992, IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems

- Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, Power Quality: Problems and Mitigation Techniques, John Wiley & Sons, First Edition 2015

Reference Book/Journals:

1. Jos Arrillaga, B.C.Smith, Neville R Watson and A.R.Wood, "Power System Harmonics Analysis" Wiley 1997
2. Math H.J.Bollen, " Understanding Power Quality Problems,Voltage Sag and Interruptions " Wiley-IEEE Press
3. IEEE Transactions on Power Systems
4. IEEE Transactions on Power Delivery
5. IEEE Transaction on Power Electronics

Subject Code	Subject Name	Credits
PEDC202	**Advanced Power Electronic Converters**	**04**
Course Objectives	• To understand dc to dc conversion with isolation, the underlying principles of converter operation and hence to analyze different converter circuits for power conversion. • To understand the principles of design of magnetics such as high frequency transformers and inductors. • To keep abreast with the latest technologies and research going on in different areas related to power electronics. • To enhance the capability of problem solving skills. • To model the converter and design the controller for deeper understanding and detailed analysis.	
Course Outcomes	• Select and design power electronic converter topologies for a broad range of energy conversion applications. • Analyze and simulate the performance of power electronic conversion systems. • Ability to model and design controllers for the closed loop operation of power converters. • Improved knowledge in interdisciplinary fields. • Apply the basic concepts of power electronics to design the circuits in the fields of AC and DC drives, power generation and transmission and energy conversion, industrial applications, extraction of energy from renewable sources. • Build and troubleshoot power electronics circuits. • Deliver technological solution in the field of power electronics.	

Module	Contents	Hours
1	**Isolated dc to dc converters:** Overview of switching power supplies, unidirectional and bidirectional core excitation, fly back, forward, push-pull, half bridge and full bridge converters, transformer core selection, power supply protection, designing to meet power supply specification, Selection of converters for various applications, numerical.	14
2	**Resonant dc to dc converters:** Drawbacks of switch-mode converters, classification of resonant converters, basic resonant circuit concepts, Load resonant converters, series and parallel loaded, steady state operating characteristics, Resonant switch converters - ZVS,ZCS, comparison of resonant converters, applications of resonant converters, numericals.	06
3	**Design of Magnetics::** Review of magnetic concepts, volt-sec balance, area product, design of inductor, design of high frequency transformer, numericals of design of inductor and transformer for dc to dc converters.	04
4	**Modeling and control of dc to dc converters:** Review of classical methods of modeling, State space model of various ideal and non-	12

	ideal dc to dc converters, state space averaging techniques, small signal analysis, transfer function, feedback control, compensator design, voltage feed forward PWM control, current mode control, slope compensation, comparison of current mode and voltage mode control.	
5	**Multi-Level Inverter:** Need for multilevel inverters, Diode clamped, flying capacitor and cascaded MLI, Phase shifted and level shifted PWM techniques, introduction to SVM for three level inverter, Applications of multilevel inverters, Need for Four leg inverters and its applications.	08
6	**Applications of power electronic converters:** Residential applications, Industrial Applications, Electric utility applications, Renewable energy technology applications.	04

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Books Recommended:

Text Books:

1. N.Mohan, T.M.Undeland, W.P Robbins, "Power Electronics, Converters, Applications & Design," Wiley IndiaPvt.Ltd.
2. R W Erickson and D Maksimovic, "Fundamental of Power Electronics" Springer, 2nd Edition.
3. M.H.Rashid, "*Hand book of Power Electronics"* , Academic Press,2001
4. Joseph Vithayathil "Power Electronics", Tata McGraw Hill
5. Daniel.W.Hart, "Power Electronics", Mc GrawHill Publications 2010
6. P.S Bhimbra, "Power Electronics",Khanna Publishers.
7. Simon Ang, Alejandro Oliva, "Power-Switching Converters" Taylor and Francis group

Other References/Journals:

1. P. T. Krein, "Elements of Power Electronics", Oxford University Press.
2. L. Umanad, "Power Electronics: Essentials & Applications," Wiley.
3. A Yazdani, R. Iravani, Voltage- Sourced Converters in Power Systems, Wiley, IEEE press.
4. IEEE Transaction journals, IECON, APEC and other power electronic related Conference Proceedings etc.

Subject Code	Subject Name	Credits
PEDC203	**Electrical Drives and Control**	**04**
Course Objectives	• To know the various schemes of V/f control. To learn direct vector control and indirect vector control. • To study how to achieve sensorless vector control. • To learn DTC and various schemes of adaptive control. • To study wound rotor induction motor control and synchronous motor drives.	
Course Outcomes	The learner will be able to • Develop the block diagram and will be knowing how to simulate and analyze the characteristics of variable frequency drive, vector controlled drive and DTC.	

Module	Contents	Hours
1	**Introduction:** Variable frequency operation of three phase symmetrical induction machine, scalar control methods (voltage fed inverter control and current fed inverter control), efficiency optimization control by flux program.	06
2	**Vector control of induction machine:** Introduction, direct or feedback vector control, flux vector estimation (voltage and current control), indirect or feed forward vector control, vector control of line side PWM rectifier, stator flux oriented vector control, vector control of current fed inverter drive.	14
3	**Sensorless vector control:** Slip calculation, direct synthesis from state equations, Model Referencing Adaptive System (MRAS), speed adaptive flux observer, extended Kalman filter.	08
4	**Direct Torque and Flux Control (DTC): Adaptive control –** Self tuning control, MRAC, Sliding mode control, Fuzzy control, Neural control.	07
5	**Wound Rotor Induction Motor Control:** Static rotor resistance control, static Scherbius drive, Improvement in power factor, Introduction to variable speed constant frequency (VSCF) generation	05
6	**Synchronous Motor Drives:** Sinusoidal SPM Machine Drives: V/Hz control, self control model, Vector control. Synchronous Reluctance Machine Drives. Current vector control of SRM Drives, Sinusoidal IPM machine drives.	08

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Books Recommended:

Text Books:

1. "Modern Power Electronics and A.C. Drive", B. K. Bose, PHI.
2. "Electric Motor Drives: Modeling, Analysis and Control" ,R.Krishnan,.PHI
3. "Control of Electrical drives", W. Leonhard, Springer-Verlag,.

Reference Books:

6. "Power Semiconductor Controlled Drives" ,G. K. Dubey, Prentice-Hall International.
7. "Fundamentals of Electrical Drives", G. K. Dubey, Narosa Publishing House.
8. "Analysis of Electric Machinery" P.C. Krause, McGraw Hill, New York

Subject Code	Subject Name	Credits
PEDDLO2021	**Digital Signal Processors for Control and Power Applications (DSPCPA)**	**04**
Course Objectives	• To introduce digital signal processors (DSP) architecture, its specifications, functionalities and programming for simple applications. • To introduce the numerical integration techniques and its use in implementation of digital compensator • To introduce various applications of DSPs in power system and power electronics and their practical design aspects.	
Course Outcomes	Learner will be able • To identify and describe DSP/DSC architecture and its features along with number representation used. • To write a program code for DSP for simple applications • To compare and evaluate various numerical integration methods used for digital control implementation. • To model, analyze and design various compensators for converter/ inverter control • To understand various applications of DSP in power electronics and power systems • To design solar PV systems for various modes of operation.	

Module	Contents	Hours
1	**Introduction:** Digital signal processors (DSP) and digital signal controller (DSC) architectures; Fixed and floating-point processors, Fixed point and floating point number representations. Review of commonly used DSPs/DSCs in power and control applications, Introductions to TMS320C2000 processors	06
2	**DSP/DSC Architecture, peripherals and programming:** Overview of TMS320C2000 DSC family – Features, Architecture, Memory map, Clock system- Digital I/O -CPU Timers, Analog to Digital Converter (ADC), Pulse Width Modulator (PWM) Capture Module, Quadrature Encoder Pulse Module and communication ports. Programming: assembler, linker processes, code structure, Code Composer Studio (CCS), Programming for: generation of PWM, Sine PWM, measurement of AC/ DC voltage/ currents, use of CPU timers and Digital I/Os	14
3	**Mathematical tools for Real Time DSP implementation:** Review of numerical integration: Euler's implicit and explicit method, Heun's Method, Trapezoidal Method. Implementation of low pass filter. Review of reference frame transformation theory.	06
4	**Digital Controller Design**: Modeling buck, boost converter and 3 phase inverter with LC filter, Design of compensators voltage and current mode control for their closed loop applications. Design of PI, Type II and Type III controllers.	10

5	**Applications in Power Systems and Power Electronics:** Implementation of Active filters in DSP/DSC under balanced and unbalanced condition, harmonic oscillator and 3 phase lock loop, Static VAR Compensator.	07
6	**DSC based System Design:** Design of a DSC controlled Solar PV based Converter/Inverter system for standalone and grid connected modes.	05

Assessment:

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Text Books:

1. N.Mohan, T.M.Undeland, W.P Robbins, *Power Electronics, Converters, Applications & Design,* Wiley India Pvt. Ltd. 2003.
2. B. K Bose, *Modern Power Electronics and AC Drives*, Pearson Education,
3. H. Toliyat and Steven Campbell, *DSP Based Electromechanical Motion Control*, CRC Press, 2003
4. Sen, M. Kuo and Woon-SengGan, *Digital Signal Processors - Architectures, Implementations, and Applications*, Prentice Hall , 2005

References books /websites

1. Code Composer Studio v6: http://processors.wiki.ti.com/index.php/Category:Code_Composer_Studio_v6
2. Texas Instrument's c2000 DSC http://processors.wiki.ti.com/index.php/Category:C2000
3. C2000 teaching ROM

Subject Code	Subject Name	Credits
PEDDLO2022	Advanced Control Systems	04
Course Objectives	• To make students understand the concept of nonlinear control, Adaptive Control and Sliding mode control. • To study the behavior of nonlinear systems using various techniques.	
Course Outcomes	• The Students will be able to understand the nonlinear system behavior by phase plane and describing function methods. • The Students will be able toanalysethe stability of nonlinear system by Lyapunov method. • Students will be familiar with the concept of Adaptive Control and Sliding mode control.	

Module	Contents	Hours
1	**Nonlinear Control Systems:** Definition of nonlinear systems, Difference between linear and nonlinear systems, Characteristics of nonlinear systems, Common physical nonlinearities	04
2	**Phase plane analysis of nonlinear systems:** Phase plane method - basic concept, trajectories, phase portrait, singular points and their classification, limit cycle and behavior of limit cycle, Construction of phase trajectories using delta method, Stability analysis using phase trajectory.	10
3	**Describing Function Analysis (DF):** Derivation of general DF, DF for different nonlinearities, saturation, dead zone, relay and their combinations, Stability analysis of nonlinear systems via describing function method.	08
4	**Lyapunov Stability Analysis:** Stability of equilibrium state, asymptotic stability, graphical representation, Lyapunov stability theorems, stability analysis of linear systems, nonlinear systems, construction of Lyapunov functions using Krasovskii method, variable gradient method	10
5	**Introduction to Adaptive Control System:** Definition of adaptive control system, functions of adaptive control, gain scheduling, model reference, series and parallel schemes and their industrial applications.	08
6	**Introduction to Sliding mode Control:** Introduction, concept of variable structure control (VSC), ideal sliding motion and chattering, switching function, reachability condition, properties of sliding motion	08

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination

Books Recommended:

Text Books:

1. M. Gopal, "Modern Control System Theory", Wiley Eastern Ltd., New Delhi.
2. K. Ogata, "Modern Control Engineering", 3 ed. Prentice Hall of India (P) Ltd., New Delhi.
3. Dr. K.P. Mohandas, “Modern Control Engineering”, revised edition, Sanguine Publishers, Bangalore, 2006.
4. Hassan K. Khalil, “Nonlinear Systems, 3rd edition, Prentice Hall.

***Reference Books**:*

1. Gene F. Franklin, J David Powell, Abbas Emami-Naeini, “Feedback Control of Dynamic Systems”, 5ed Pearson Educations.
2. Shankar Sastry, Marc Bodson, "Adaptive Control", Prentice Hall of India (P) Ltd., 1993.
3. John Doyle, Bruce Francis, Allen Tannenbaum, ìFeedback Control Theoryî.
4. Norman Nise, “Control system Engineering”, 4 ed.Wiley International Editionî.
5. Christopher Edwards, Sarah K. Spurgeon, “Sliding Mode control: Theory and Application”, 1998.
7. Karl J. Astrom, B. Wittenmark, “Adaptive Control”, 2 nd Edition, Pearson Education Asia, First Indian Reprint, 2001

Subject Code	Subject Name	Credits
PEDDLO2023	Power Conditioning Systems for Renewable Energy (PCSRE)	04
Course Objectives	▪ To introduce the distributed generation system based on renewable energy resources. ▪ To know the practical aspects of design of power conditioning systems (PCS) for renewable energy sources (RES). ▪ To know the control implementation for PCS	
Course Outcomes	Learner will be able • To identify and describe various topologies of DGs based on use of various combinations of RES. • To identify and describe the various regulatory standards applicable in PCS for RES. ▪ To design the power conditioning systems for solar PV applications. • To identify and describe the design considerations for the power conditioning systems for wind energy systems. • To identify and describe the design considerations for the power conditioning systems for fuel cell systems. • To model and design compensator for power conditioning systems**.**	

Module	Contents	Hours
1	**Introduction renewable sources:** Review of renewable energy sources, operating principles and characteristics of: Solar PV, Wind Energy Systems (WES), Fuel cells; Economics and statistics related to renewable energy. Review of energy storage systems with Batteries and ultracapacitors. Categorization of energy sources	08
2	**Distributed generation system:** Basic concepts, various topologies and design considerations for standalone systems and grid connected systems, Power quality and protection issues, review of regulatory standards related to various aspects of renewable energy systems	06
3	**Design of power conditioning system for Solar PV:** MPPT (maximum power point tracking), Design of DC-DC converters for MPPT, MPPT algorithms, Implementation of MPPT control through DSP controllers. Topologies for grid connected and standalone applications: single phase and three phase systems, Design of multi stage solar PV grid connected and standalone systems. Low and high power Applications. Integration of ES-battery and ultracapacitor for performance improvement	12
4	**Design of power conditioning system for WES:** Topologies of WES, design considerations for WES with rectifier / inverter system, Power Converters for Doubly Fed Induction Generators (DFIG) in Wind Turbines, Matrix converter topology for grid connected system.	08
5	**Design of power conditioning system for Fuel Cells:** Review of fuel cell technology, Design of DC-DC converters for PEM fuel cell, MPPT in Fuel Cell, Design considerations for multi-stage converter / inverter system for grid connected operations. Integration of ES	08

6	**Design of compensator for voltage and current control modes:** Modeling of the system, derivation of transfer function compensator for voltage and current control modes, design of PI and Type III controller in power conditioning system for renewable energy sources	06

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination

Books Recommended:

Text Books:

1. "Power Electronics, Converters, Applications & Design",N.Mohan, T.M.Undeland, W.P Robbins, Wiley India Pvt.Ltd.
2. "Voltage Source Converters in Power Systems: Modeling, Control and Applications", Amirnaser Yezdani, and Reza Iravani, IEEE John Wiley Publications
3. "Power Switching Converters: Medium and High Power", DorinNeacsu, CRC press, Taylor &Francis, 2006
4. M.H.Rashid, "Power Electronics Hand book", Academic Press,2001

References books /websites:

1 "DSP Based Electromechanical Motion Control", Hamid Toliyat and Steven Campbell, CRC Press

2 "Digital Signal Processors - Architectures, Implementations, and Applications", Sen M. Kuoand Woon-SengGan Prentice Hall

3 "Fuel Cell System", Leo J.M.J. Blomen and michael N. Mugerwa, New York, Plenum Press, 1993.

4 "Wind Energy Explained, theory design and applications," J.F. Manwell, J.G. McGowan Wiley publication

5 "Fuel Cell Systems Explained," James Larminie, Andrew Dicles, Wiley publication

6 "Principles of Solar Engineering", D. Y. Goswami, F. Kreith and J. F. Kreider, Taylor and Francis, Philadelphia, 2000

7 "Biomass Regenerable Energy", D. D. Hall and R. P. Grover, John Wiley, New York, 1987.

Subject Code	Subject Name	Credits
PEDDLO2024	**EHV AC Transmission System**	**04**
Course Objective	• To understand basic philosophy of EHV AC transmission. • To understand the concept of voltage gradient and effect of electrostatic field. • To understand the electromagnetic interference, AN, RI. • To understand basic concepts of design of EHV AC transmission system.	
Course Outcome	• Upon successful completion of this course, students will be able to understand effects of electrostatic field and electromagnetic interference for EHV AC transmission system.	

Module	Contents	Hours
1	**Introduction to EHV AC transmission:** Configuration, special features of EHV lines, power transfer ability, properties of bundled conductor, inductance and capacitance of EHV lines, positive- negative and zero sequence impedance, line parameters for modes of propagation	8
2	**Voltage gradients of conductors:** Bundled conductors, R-L-C calculations of EHV line configuration, Electrostatics- Field of sphere gap, field of line charges and their properties, charge potential relations for multi conductors, surface voltage gradient on conductor, distribution of voltage gradient on sub-conductors of bundled system.	10
3	**Electric field under transmission lines and its computation:** Calculation of electrostatic field in EHV AC lines, effect on humans, animals and plants, electrostatic induction in un-energized circuit of doubled circuit lines, electromagnetic interference, traveling wave expression and solution, reflection and refraction coefficients of traveling waves, lumped parameters of distributed lines.	10
4	**Corona in EHV lines:** Power loss due to corona, corona loss formulae, charge voltage diagram, attention of traveling waves due to corona, Audio Noise(AN)- its generation, characteristics, limitations and measurements, relation between single phase and three phase AN levels. Radio Interference(RI)- corona pulses generation, properties, limits, frequency spectrum of RI field of lines, mode of propagation, excitation function, measurement of RI and RIV.	10
5	**Design of EHV transmission system:** Overhead line insulators- ceramic and nonceramic types, insulator performance in polluted environments, EHV cable transmission- underground cables and gas insulated transmission lines, Insulation characteristics of long air gap lines, design of EHV lines based on steady state and transient limits, insulation coordination.	10

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination

Books Recommended:

Text Books:

1. EHVAC Transmission Entrepreneurship Theory at crossroads, Paradigms and Praxis, Biztrantra, 2nd edition, 2005.
2. Prasama Chandra, Projects- Planning, Analysis Selection, Implementation and Reviews, Tata McGraw-Hill, 1996.

Reference Books:

1. Extra High Voltage AC Transmission Engineering ByRakosh Das Begaumudre, Wiley Eastern limited, New Delhi – 1987.
2. Performance Operation and Control of EHV Power Transmission System ByA.Chakrabarti, D.P. Kothari, Mukhopadhyay, Wheelers Publisher.

Subject Code	Subject Name	Credits
PEDDLO2025	**Electromagnetic Interference & Compatibility in Power Electronic (EMICPE)**	**04**
Course Objectives	▪ To introduces the fundamental concepts of electromagnetic interference (EMI) & compatibility (EMC) in power electronic systems and its importance. ▪ To introduces the various means of minimizing the EMI and achieving the EMC. ▪ To know the design consideration for in power electronics system for EMC and its testing methodology.	
Course Outcomes	Learner will be able • To identify and describe fundamentals of EMI and EMC and its criticality in power electronic systems. • To identify and describe the various sources of EMI and means of minimization of EMI. • To identify and describe the various design methodology for PCB, layout and enclosures for achieving EMC. • To understand measurement of EMI/ EMC for system under test and necessary instrumentation. • To know various software and hardware tools for EMI/ EMC analysis.	

Module	Contents	Hours
1	**Fundamentals of EMI and EMC:** Electromagnetic Fields: static, quasi-static and high frequency fields, Sources of EMI and their classifications, propagation and crosstalk, effect of EMI on devices and systems,	08
2	**Management of EMI and EMC:** General interference control techniques, Human exposure limits to EM fields, Need for EMC compliance, EMC standards, Measurement and testing, general EMC design principles for power electronic systems	08
3	**Design aspects for EMC:** Fundamentals, sources, grounding, return circuit design, controlling EMI sources, decoupling power / ground planes.	06
4	**Design of PCBS and enclosures for EMC:** EMC filter Design, PCB layouts , Shielding in enclosures, EMI/EMC design for printed circuit boards for power electronics applications	10
5	**Testing for EMC Compliance:** Instrumentation: Time and frequency domain analyzers, Test facilities, open area sites, chambers , TEM and GTEM cells, Probes, Antennas, and support equipments, Testing of conducted and radiated emissions,	10
6	**Software and hardware tools for EMI and EMC:** Immunity testing and In Situ testing, troubleshooting and solutions for minimization of emissions, Software and hardware tools for EMC	06

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination

Books Recommended

Text Books:

1. "Power Electronics, Converters, Applications & Design", N. Mohan, T. M. Undeland, W.P Robbins, Wiley India Pvt. Ltd.
2. "PCB Design for Real World EMI Control", Bruce R. Archambeault, Kluwer Academic Publishers Group, 2002
3. "Electromagnetic Compatibility in Power Systems", Francesco Larrarulo, Elsevier, 2002
4. "EMI Troubleshooting Techniques" Michel Mardiguin, McGrawHill, 2000
5. "Principles and Techniques of Electromagnetic Compatibility", Christos Christopoulous, CRC Press, Second edition
6. "Electromagnetic Modelling of Power Electronic Converters", J.A Ferreira, Kluwer Academic Publishers Group
7. "Testing for EMC Compliance: Approaches and Techniques", Mark Montrose, E.M Nakauchi, IEEE Press, Wiley Interscience, 2004
8. "EMI Filter Design" Richard Lee Ozenbaugh., CRC Press
9. "Engineering Electromagnetic Compatibility", V. Prasad Kodali, IEEE Press, second edition

Subject Code	Subject Name	Credits
ILO2021	**Project Management**	**03**
Course Objectives	• To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques. • To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.	
Course Outcomes	Learner will be able to… • Apply selection criteria and select an appropriate project from different options. • Write work break down structure for a project and develop a schedule based on it. • Identify opportunities and threats to the project and decide an approach to deal with them strategically. • Use Earned value technique and determine & predict status of the project. • Capture lessons learned during project phases and document them for future reference	

Module	Detailed Contents	Hrs
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8
04	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	**Executing Projects:** Planning monitoring and controlling cycle. Information	8

	needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. **Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **Project Contracting** Project procurement management, contracting and outsourcing,	
06	**Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

Assessment:

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1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7th Ed.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Subject Code	Subject Name	Credits
ILO2022	**Finance Management**	**03**
Course Objectives	• Overview of Indian financial system, instruments and market • Basic concepts of value of money, returns and risks, corporate finance, working capital and its management • Knowledge about sources of finance, capital structure, dividend policy	
Course Outcomes	Learner will be able to… • Understand Indian finance system and corporate finance • Take investment, finance as well as dividend decisions	

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05

06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

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4. Only Four question need to be solved.

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Subject Code	Subject Name	Credits
ILO2023	**Enterpreneurship Development and Management**	**03**
Course Objectives	• To acquaint with entrepreneurship and management of business • Understand Indian environment for entrepreneurship • Idea of EDP, MSME	
Course Outcomes	Learner will be able to… • Understand the concept of business plan and ownerships • Interpret key regulations and legal aspects of entrepreneurship in India • Understand government policies for entrepreneurs	

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Assessment:

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End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by

students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
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4. Only Four question need to be solved.

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Subject Code	Subject Name	Credits
ILO2024	**Human Resource Management**	**03**
Course Objectives	• To introduce the students with basic concepts, techniques and practices of the human resource management. • To provide opportunity of learning Human resource Management (HRM) processes, related with the functions, and challenges in the emerging perspective. • To familiarize the students about the latest developments, trends & different aspects of HRM. • To acquaint the student with the importance of behavioral skills, Inter-personal, inter- group in an organizational setting. • To prepare the students as future organizational change facilitators, stable leaders and managers, using the knowledge and techniques of human resource management.	
Course Outcomes	Learner will be able to… • Gain knowledge and understand the concepts about the different aspects of the human resource management. • Understand and tackle the changes and challenges in today's diverse, dynamic organizational setting and culture. • Utilize the behavioral skill sets learnt, in working with different people, teams & groups within the national and global environment. • Apply the acquired techniques, knowledge and integrate it within the engineering/ non engineering working environment emerging as future engineers and managers.	

Module	Detailed Contents	Hrs
01	**Introduction to HR:** Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	5
02	**Organizational Behavior (OB) :** Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues, Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness, Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. Case study	7

03	**Organizational Structure & Design:** Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	6
04	**Human resource Planning:** Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. Training & Development: Identification of Training Needs, Training Methods	5
05	**Emerging Trends in HR :** Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment, Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
06	**HR & MIS:** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

<u>Assessment</u>:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

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4. Only Four question need to be solved.

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. SubbaRao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Subject Code	Subject Name	Credits
ILO2025	**Professional Ethics and Corporat Social Resonsibility (CSR)**	**03**
Course Objectives	• To understand professional ethics in business • To recognized corporate social responsibility	
Course Outcomes	Learner will be able to… • Understand rights and duties of business • Distinguish different aspects of corporate social responsibility • Demonstrate professional ethics • Understand legal aspects of corporate social responsibility	

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

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examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

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4. Only Four question need to be solved.

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

Subject Code	Subject Name	Credits
ILO2026	**Research Methodology**	**03**
Course Objectives	• To understand Research and Research Process • To acquaint students with identifying problems for research and develop research strategies • To familiarize students with the techniques of data collection, analysis of data and interpretation	
Course Outcomes	Learner will be able to… • Prepare a preliminary research design for projects in their subject matter areas • Accurately collect, analyze and report data • Present complex data or situations clearly • Review and analyze research findings	

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts:** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology, Need of Research in Business and Social Sciences , Objectives of Research, **Issues** and Problems in Research, Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	**10**
02	**Types of Research:** Basic Research, Applied Research, Descriptive Research, Analytical Research, Empirical Research, Qualitative and Quantitative Approaches	**08**
03	**Research Design and Sample Design :** Research Design – Meaning, Types and Significance, Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**08**
04	**Research Methodology :** Meaning of Research Methodology, Stages in Scientific Research Process **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f**. Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	**08**
05	**Formulating Research Problem:** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research:** Preparation of the report on conclusion reached, Validity Testing & Ethical Issues, Suggestions and Recommendation	**04**

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R., 1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2^{nd}ed), Singapore, Pearson Education

Subject Code	Subject Name	Credits
ILO2027	**IPR and Patenting**	**03**
Course Objectives	• To understand intellectual property rights protection system • To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures • To get acquaintance with Patent search and patent filing procedure and applications	
Course Outcomes	Learner will be able to… • understand Intellectual Property assets • assist individuals and organizations in capacity building • work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting	

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement **Indian Scenario of IPR:** Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:** Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	06
04	**Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publicationetc, Time frame and	07

	cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
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4. Only Four question need to be solved.

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield,2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph&Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. LousHarns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. PrabhuddhaGanguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar andmohdIqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. KompalBansal and PraishitBansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, PritiMathur, AnshulRathi**,** IPR: Drafting,Interpretation of Patent Specifications and Claims**,** New India Publishing Agency

14. Vivien Irish, 2005,Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Subject Code	Subject Name	Credits
ILO2028	**Product Life Cycle Management**	**03**
Course Objectives	• To familiarize with digital business concept • To acquaint with E-commerce • To give insights into E-business and its strategies	
Course Outcomes	The learner will be able to ….. • Identify drivers of digital business • Illustrate various approaches and techniques for E-business and management • Prepare E-business plan	

Module	Detailed content	Hours
1	**Introduction to Digital Business:** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business-** Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce: E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06
3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system, **Application Development:** Building Digital business Applications and Infrastructure	06
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business, Security Threats to e-business - Security Overview, Electronic Commerce Threats, Encryption, ryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	**M Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-en OECD Publishing

Subject Code	Subject Name	Credits
ILO2029	**Environmental Management**	**03**
Course Objectives	• Understand and identify environmental issues relevant to India and global concerns • Learn concepts of ecology • Familiarise environment related legislations	
Course Outcomes	• Learner will be able to… • Understand the concept of environmental management • Understand ecosystem and interdependence, food chain etc. • Understand and interpret environment related legislations	

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks

3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management, **T V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Subject Code	Subject Name	Credits
PEDL201	Laboratory - III	01

Course Objectives: Design and implementation of closed loop control of various power electronic topologies based on the subjects taught. Suggested list is given below.

Module	Detailed content	Lab. Sessions
1	**Design and Simulation (Any two)** • Power factor improvement in rectifiers • Control of power sharing between two DC-DC converters • Multilevel Inverter • Grid synchronization of renewable energy based converter/inverter system and control of active power • Variable frequency or Vector control of induction motor • Development of virtual instrumentation software interface for power electronics hardware through suitable VI software	08
2	**Experimentation** • Variable frequency or Vector control of induction motor • PLC Controlled Drives	04

Term work: Term work consists of performing 08 practical mentioned as above. Final certification and acceptance of the term work ensures satisfactory performance of laboratory work

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners

Subject Code	Subject Name	Credits
PEDL202	Laboratory - IV	01

Course Objectives: Study basics of DSP programming and various control strategies implementation through DSP in power electronic based system. Suggested list of experiments are given below.

Module	Detailed content	Lab. Sessions
1	**Write program in DSP/ Microprocessor (any four)** • Generation of sine wave • Sense a non-sinusoidal voltage/current and find out harmonic content in it • Generation of Sine-PWM signals • Implementation of dq reference transformations • Implementation of Harmonic Oscillator • PLL implementation	06
2	**DSP Controlled Applications (An y Three)** • Closed loop control of DC-DC converter • Power factor correction in converters • LED lamp intensity control • Solar PV based converter / inverter system • Speed control of BLDC / PMSM motor • Communication System protocol implementation	06

Term work: Term work consists of performing 08 practical mentioned as above. Final certification and acceptance of the term work ensures satisfactory performance of laboratory work

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners

Subject Code	Subject Name	Credits
PEDS301	Seminar	03

Guidelines for Seminar:

- Seminar should be based on thrust areas in Electrical Engineering.
- Students should undergo literature survey and identify the topic of seminar and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the topic and compile the report in standard format and present in front of Panel of Examiners appointed by the Head of the Department/Institute of respective Program.
- Seminar assessment should be based on following points:
  - Quality of Literature survey and Novelty in the topic.
  - Relevance to the specialization
  - Understanding of the topic
  - Quality of Written and Oral Presentation

IMPORTANT NOTE:

1. Assessment of Seminar will be carried out by a pair of Internal and External examiner. The external examiner should be selected from approved panel of examiners for Seminar by University of Mumbai, OR faculty from Premier Educational Institutions/Research Organizations such as IIT, NIT, BARC, TIFR, DRDO, etc. OR a person having minimum Post-Graduate qualification with at least five years' experience in Industries.

2. Literature survey in case of seminar is based on the broader area of interest in recent developments and for dissertation it should be focused mainly on identified problem.

3. At least 4-5 hours of course on Research Methodology should be conducted which includes Literature Survey, Problems Identification, Analysis and Interpretation of Results and Technical Paper Writing in the beginning of 3rd Semester.

Subject Code	Subject Name	Credits
PEDD301/ PEDD401	Dissertation (I and II)	12 + 15

Guidelines for Dissertation

- Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Dissertation I

- Dissertation I should be assessed based on following points
  - Quality of Literature survey and Novelty in the problem
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization
  - Clarity of objective and scope
- Dissertation I should be assessed through a presentation by a panel of internal examiners appointed by the Head of the Department/Institute of respective Program.

Guidelines for Assessment of Dissertation II

- Dissertation II should be assessed based on following points
  - Quality of Literature survey and Novelty in the problem
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization or current Research / Industrial trends
  - Clarity of objective and scope
  - Quality of work attempted
  - Validation of results
  - Quality of Written and Oral Presentation
- Dissertation II should be assessed through a presentation jointly by Internal and External Examiners appointed by the University of Mumbai

Students should publish at least one paper based on the work in reputed International/ National Conference / Refereed Journal.