RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)
RV Vidyaniketan Post, Mysuru Road
Bengaluru – 560059

Scheme and Syllabus of I to IV Semesters

(Autonomous System of 2018 Scheme)

Master of Technology (M.Tech)
in
POWER ELECTRONICS

DEPARTMENT OF

ELECTRICAL AND ELECTRONICS ENGINEERING

VISION

Leadership in Quality Technical Education, Interdisciplinary Research & Innovation, with a Focus on Sustainable and Inclusive Technology

MISSION

1. To deliver outcome based Quality education, emphasizing on experiential learning with the state of the art infrastructure.
2. To create a conducive environment for interdisciplinary research and innovation.
3. To develop professionals through holistic education focusing on individual growth, discipline, integrity, ethics and social sensitivity.
4. To nurture industry-institution collaboration leading to competency enhancement and entrepreneurship.
5. To focus on technologies that are sustainable and inclusive, benefiting all sections of the society.

QUALITY POLICY

Achieving Excellence in Technical Education, Research and Consulting through an Outcome Based Curriculum focusing on Continuous Improvement and Innovation by Benchmarking against the global Best Practices.

CORE VALUES

Professionalism, Commitment, Integrity, Team Work and Innovation

RV COLLEGE OF ENGINEERING®

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Scheme and Syllabus of I to IV SEMESTER

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Master of Technology (M.Tech)
in
POWER ELECTRONICS

DEPARTMENT OF
ELECTRICAL AND ELECTRONICS ENGINEERING

DEPARTMENT OF
ELECTRICAL AND ELECTRONICS ENGINEERING

VISION

Promotion of technical excellence in Electrical and Electronics Engineering by offering programs to produce Engineers with dynamic well rounded personalities adaptable to ever increasing demands of emerging technologies involving analytical and practical skills, with commitment to research and development

MISSION

- To provide technical education that combines rigorous academic study and the excitement of innovation enabling the graduates to engage in lifelong learning which is essential to improve performance continuously and excel in their career.
- To establish research and development centre of repute so as to encourage active participation with industry by faculty and students to take on practical problems of industry and to provide feasible solutions.
- To establish tie-ups with institutions of national and international repute and to foster building up of a wide knowledge base to keep in tune with ever increasing demands of technologies

PROGRAMME OUTCOMES (PO)

M.Tech in Power Electronics graduates will be able to:

- PO1 Able to independently carry out research /investigation and development work to solve practical problems in Power Electronics
- PO2: Able to write and present a substantial technical report/document
- PO3: Able to demonstrate a degree of mastery over Power Electronics at a level higher than the requirements in bachelor program of Electrical Engineering
- PO4: Integrate Power Electronics with other domains to facilitate collaborative inter-disciplinary research
- PO5: Acquire professional integrity and ethics, understand the responsibility for sustainable development of the society
- PO6: Understand and demonstrate management skills with commitment to lifelong learning ,assess and evaluate the economic feasibility, work effectively as a leader and a team member.

ABBREVIATIONS

Sl. No.	Abbreviation	Acronym
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	SEMESTER End Examination
5.	CE	Professional Elective
6.	GE	Global Elective
7.	HSS	Humanities and Social Sciences
8.	CV	Civil Engineering
9.	ME	Mechanical Engineering
10.	EE	Electrical & Electronics Engineering
11.	EC	Electronics & Communication Engineering
12.	IM	Industrial Engineering & Management
13.	EI	Electronics & Instrumentation Engineering
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	TE	Telecommunication Engineering
17.	IS	Information Science & Engineering
18.	BT	Biotechnology
19.	AS	Aerospace Engineering
20.	PY	Physics
21.	CY	Chemistry
22.	MA	Mathematics
23.	MCA	Master of Computer Applications
24.	MST	Structural Engineering
25.	MHT	Highway Technology
26.	MPD	Product Design & Manufacturing
27.	MCM	Computer Integrated & Manufacturing
28.	MMD	Machine Design
29.	MPE	Power Electronics
30.	MVE	VLSI Design & Embedded Systems
31.	MCS	Communication Systems
32.	MBS	Bio Medical Signal Processing &Instrumentation
33.	MCH	Chemical Engineering
34.	MCE	Computer Science & Engineering
35.	MCN	Computer Network Engineering
36.	MDC	Digital Communication
37.	MRM	Radio Frequency and Microwave Engineering
38.	MSE	Software Engineering
39.	MIT	Information Technology
40.	MBT	Biotechnology
41.	MBI	Bioinformatics

CONTENTS

RV COLLEGE OF ENGINEERING®, BENGALURU - 560059
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DEPARTMENT OF ELECTRICAL ENGINEERING
M.Tech in POWER ELECTRONICS

FIRST SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Credits**
1	18 MAT11A	Applied Mathematics	MAT	4	0	0	**4**
2	18MPE12	Power Converters-I	EE	4	0	1	**5**
3	18MPE13	Control of AC – DC drives	EE	4	0	1	**5**
4	18HSS14	Professional(Soft) Skills Development	HSS	0	0	0	**0**
5	18MPE1AX	Elective Group-A	EE	4	0	0	**4**
6	18MPE1BX	Elective Group-B	EE	4	0	0	**4**
Total number of Credits				**20**	**0**	**2**	**22**
Total Number of Hours / Week				**20**	**0**	**4**	**24**

SECOND SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Credits**
1	18 MPE 21	Power Converters-II	EE	4	0	1	**5**
2	18 MPE 22	Modelling and Simulation of Power Electronic Systems	EE	4	0	0	**4**
3	18 IEM 23	Research Methodology	HSS	3	0	0	**3**
4	18MPE24	Minor Project	EE	0	0	2	**2**
5	18MPE2CX	Elective Group-C	EE	4	0	0	**4**
6	18MPE2DX	Elective Group-D	EE	4	0	0	**4**
7	18XXX2GX	Global Elective-G	RES BoS	3	0	0	**3**
Total number of Credits				**22**	**0**	**3**	**25**
Total Number of Hours / Week				**22**	**0**	**6**	**28**

SEMESTER : I		
GROUP A: PROFESSIONAL ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1.	18MPE1A1	Advanced Control Systems
2.	18MPE1A2	Intelligent Control Techniques
3.	18MPE1A3	Embedded Systems
GROUP B: PROFESSIONAL ELECTIVES		
1.	18MPE1B1	Power Quality Problems and Mitigation
2.	18MPE1B2	Power System Harmonics
3.	18MPE1B3	Smart Grid-Technology, Analysis and Applications
SEMESTER : II		
GROUP C: PROFESSIONAL ELECTIVES		
1.	18MPE2C1	EMC in Power Electronics
2.	18MPE2C2	PWM Techniques
3.	18MPE2C3	DSP Applications to Drives
GROUP D: PROFESSIONAL ELECTIVES		
1.	18MPE2D1	Converters for Solar and Wind Systems
2.	18MPE2D2	Hybrid Electric Vehicles
3.	18MPE2D3	Flexible AC Transmission System

GROUP G: GLOBAL ELECTIVES				
Sl. No.	**Host Dept**	**Course Code**	**Course Title**	**Credits**
1.	CS	18CS2G01	Business Analytics	3
2.	CV	18CV2G02	Industrial & Occupational Health and Safety	3
3.	IM	18IM2G03	Modeling using Linear Programming	3
4.	IM	18IM2G04	Project Management	3
5.	CH	18CH2G05	Energy Management	3
6.	ME	18ME2G06	Industry 4.0	3
7.	ME	18ME2G07	Advanced Materials	3
8.	CY	18CHY2G08	Composite Materials Science and Engineering	3
9.	PY	18PHY2G09	Physics of Materials	3
10.	MA	18MAT2G10	Advanced Statistical Methods	3

THIRD SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Credits**
1	18MPE31	Programmable Logic Controller and SCADA	EE	4	0	1	**5**
2	18MPE32	Internship	EE	0	0	5	**5**
3	18MPE33	Major Project : Phase-I	EE	0	0	5	**5**
4	18MPE3EX	Professional Elective-E	EE	4	0	0	**4**
Total number of Credits				**8**	**0**	**11**	**19**
Total Number of Hours/Week				**8**	**0**	**22**	**30**

FOURTH SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Credits**
1	18MPE41	Major Project : Phase-II	EE	0	0	20	**20**
2	18MPE42	Technical Seminar	EE	0	0	2	**2**
Total number of Credits				**0**	**0**	**22**	**22**
Total Number of Hours / Week				**0**	**0**	**44**	**44**

SEMESTER: III		
GROUP E: PROFESSIONAL ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
4.	18MPE3E1	Digital System Design
5.	18MPE3E2	High Voltage DC Transmission
6.	18MPE3E3	Nanomaterials and Devices

SEMESTER : I					
APPLIED MATHEMATICS (Theory) (Common to MPE, MBT, MBI, MCH, MST, MHT, MPD, MMD, MCM)					
Course Code	**:**	**18MAT11A**		**CIE Marks**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**100**
Hours	**:**	**52L**		**SEE Duration**	**3 Hrs**

Unit-I	**10 Hrs**
STATISTICS Method of least squares, fitting of straight line, linearization of nonlinear laws, curve fitting by polynomials, correlation, coefficient of correlation, lines of regression, Spearman rank correlation.	
Unit –II	**10 Hrs**
PROBABILITY DISTRIBUTIONS Introduction to probability, Random variables-discrete and continuous random variables, important measures and moment generating functions, Standard distributions-Binomial, Exponential, Normal and Gamma distributions.	
Unit –III	**10 Hrs**
SYSTEM OF LINEAR EQUATIONS AND EIGEN VALUE PROBLEMS System of linear equations-LU decomposition and Gauss-Jordan method, Eigen value problems–bounds on eigen values, Power method and Inverse Power method, Eigen values and eigen vectors of real symmetric matrices-Jacobi method.	
Unit –IV	**11 Hrs**
NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS Boundary value problems (BVP's)–finite difference method for linear and nonlinear problems, Shooting method and Galerkin method. Finite differences-implicit and explicit scheme, Finite difference methods for parabolic, elliptic and hyperbolic partial differential equations, Finite element method and simple problems.	
Unit –V	**11 Hrs**
CONCEPTS OF ENGINEERING OPTIMIZATION Engineering applications of optimization, statement of an optimization problem-design vector, design constraints, constraint surface, objective function and objective function surface. Multivariable optimization with inequality constraints-Kuhn-Tucker conditions, Constraint qualification, Genetic operators, Neural-Network-based Optimization. Optimization of Fuzzy systems.	

Course Outcomes

After going through this course the student will be able to:

CO1	Identify and interpret the fundamental concepts of statistics, distributions, linear algebra, differential equations and optimization arising in various fields engineering.
CO2	Apply the knowledge and skills of statistical/numerical/optimization techniques to solve problems of least squares, probability distributions, linear equations, eigen value problems and differential equations.
CO3	Analyze the physical problem to establish statistical/mathematical model and use appropriate method to solve and optimize the solution.
CO4	Distinguish the overall mathematical knowledge gained to demonstrate the problems of least squares, probability distributions, linear equations, eigen value problems, differential equations and optimization arising in practical situations.

Reference Books

1	Theory and Problems of probability, Seymour Lipschutz and Marc lars Lipson, 2nd Edition, Schaum's Outline Series, ISBN: 0-07-118356-6.
2	Introductory method of numerical analysis, S. S. Sastry, 4th Edition,2009,, Prentice-Hall India Pvt. Ltd, ISBN : 81-203-1266-X.
3	Numerical methods for scientific and engineering computation ,M K Jain, S. R. K. Iyengar, R. K. Jain, 6th Edition,2012, New Age International Publishers, ISBN-13: 978-81-224-2001-2.
4	Engineering Optimization Theory and Practice, Singiresu S. Rao, 3rd Edition, New Age International (P)Ltd., ISBN: 81-224-1149-5.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: I						
POWER CONVERTERS-I (Theory and Practice)						
Course Code	**:**	**18MPE12**		**CIE Marks**	**:**	**100+50**
Credits: L:T:P	**:**	**4:0:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**52L+26P**		**SEE Duration**	**:**	**3 + 3 Hrs**

Unit-I	
Power Semiconductor Devices: working principle, characteristics (static & dynamic) of Power Diodes, Schottky diodes, SiC diodes, GaN diode. Structure, physics of operation, characteristics (static & dynamic) of Thyristors, MOSFET, IGBT,	**10 Hrs**
Unit – II	
Gate drive circuits and Protection, Operating Limitations and Safe operating Areas of Thyristors, MOSFET, IGBT .Working Principle GTOs. Choppers: Analysis of Step down, step up, step up-down choppers, Classification and Analysis of choppers	**10 Hrs**
Unit -III	
Line Commutated Converters: Phase control, single phase and three phase semi controlled & fully controlled bridge converter, expression of output voltage/current interms of fourier series, power factor improvement methods, effect of source inductance, twelve pulse converter, design of converter circuits	**10 Hrs**
Unit –IV	
Inverters: Principle of operation, performance parameters, single phase bridge inverters and three phase inverters, current source inverter, comparison between VSI & CSI. **Output Voltage Control of Inverters:** Single/multiple pulse, modified SPWM methods, PWM unipolar, bipolar switching and harmonic spectrum analysis for single phase and three phase inverters, third harmonic PWM, harmonic reduction and elimination.	**10 Hrs**
Unit –V	
AC Voltage Controllers: Principle of on-off control, phase control: single and 3 phase controllers – Design and analysis with R and R-L loads. Single phase and 3 phase dual converter. **Multilevel Inverters:** Introduction, types, diode clamped multi-level inverters, features & applications, capacitor clamped multilevel inverter, cascaded H-bridge multilevel inverter, multilevel inverters for hybrid converter- mixed level hybrid, asymmetric hybrid and soft switched multilevel inverters, super-lift multilevel inverters Introduction to matrix converters	**12 Hrs**

UNIT VI Lab Component	**2Hrs/Week**

1. Analysis of static and dynamic characteristic of Power Diodes, Schottky diodes, SiC diodes, Thyristors
2. Design and Simulation of DC-DC Converters step-down, step-up, step up/down.
3. Performance analysis of DC-DC Converters step-down, step-up, step up/down.
4. Design and Simulation of single phase fully controlled and semi-controlled converter for RL load for continuous & discontinuous current mode
5. Performance testing of single phase fully controlled and semi-controlled converter for RL load for continuous & discontinuous current mode
6. Simulation Study of effect of source inductance on the performance of single phase fully controlled converter
7. Experimental Study of effect of source inductance on the performance of single phase fully controlled converter
8. Performance analysis of three phase fully controlled and semi-controlled converter for RL load for continuous & discontinuous current mode
9. Performance analysis of single phase bridge inverter for RL load and voltage control by single pulse width modulation
10. Design and Performance analysis of single phase bridge inverter for RL load and voltage control by sinusoidal pulse width modulation using a modern design tool.
11. Diode clamped multilevel inverter

Course Outcomes **After completing the course, the students will be able to:**	
CO1:	Understand the concepts of various converters, choppers inverters, multi-level inverters, matrix converters and ac regulators.
CO2:	Explain, evaluate and simulate converter, inverter and ac regulator topologies for a given application.
CO3:	Analyze the operations with waveforms of various converters, choppers inverters, multi-level inverters, matrix converters and ac regulators. Also choose appropriate control techniques and converters.
CO4:	Design PWM controller, various converters, inverters and ac regulators.
Reference Books	
1	Fundamentals of Power Semiconductor Devices, B. JayantBaliga, 1st Edition, 1995, International Thompson Computer Press, ISBN:9780387473130.
2	Power Electronics Converters, Applications, and Design, Ned Mohan, Tore M. Undeland, William P. Robbins, 3rd Edition, 2011, Wiley India Pvt Ltd, ISBN: 978-0-471-22693-2
3	Power Electronics, Circuit Devices and Applications, M. H. Rashid, 3rd Edition, 2003, Prentice Hall Publisher, ISBN-10: 0131011405
4	Power Electronics, M D Singh, K B Khanchandani, 2nd Edition, 2012, Mc. Graw Hill, ISBN 9780070583894

Scheme of Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Scheme of Continuous Internal Evaluation (CIE): Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Continuous Internal Evaluation (CIE): Practical (50 Marks)
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE): Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Total marks: 100+50=150

Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

SEMESTER : I						
CONTROL OF AC – DC DRIVES (Theory and Practice)						
Course Code	**:**	**18MPE13**		**CIE Marks**	**:**	**100+50**
Credits L:T:P	**:**	**4:0:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**52L+26P**		**SEE Duration**	**:**	**3+3 Hrs**

Unit-I	
Fundamentals of Drives: **Dynamics of Electric drives:** Fundamentals of torque equations, speed torque conventions and multi-quadrant operations, drive parameters, components of load torque, classification of load torques, steady state stability, load equalization. **Selection of motor power ratings:** Thermal model of motor for heating and cooling, classes of motor duty, determination of moto ratings, **Electrical drives:** advantages, parts of electric drives, choice of electrical drives, status of DC AC drives.	**10 Hrs**
Unit – II	
DC Drive fundamentals: **DC Motor drives: DC motors and their performance, starting, braking, speed control.** **Converter Control of DC Drives:** Analysis of series and separately excited DC motor with single phase and three phase converters operating in different modes and configurations. **Chopper Control of DC Drives:** Analysis of series and separately excited DC motors fed from different choppers for both time ratio control and current limit control, four quadrant control.	**10 Hrs**
Unit –III	
Modelling of AC machines for Drives: **AC Machines for drives:** Introduction, Induction machines, rotating magnetic field, torque production, equivalent circuit, torque speed curve, variable voltage operation, variable frequency and V/F operation, drive operating regions, variable stator current operation, effect of harmonics, dynamic d-q model. synchronous machines, wound field machine, synchronous reluctance machine, permanent magnet machine, variable reluctance machines.	**10 Hrs**
Unit –IV	
Control and estimation of Induction machine drives: Introduction, Induction motor control with small signal model, scalar control, open loop v/f control, Current fed inverter control: Independent current and frequency control. Vector or field-oriented control, d c drive analogy, equivalent circuit and phasor diagram, principles of Vector control, direct or feedback vector control, flux vector estimation: voltage model. Indirect or feed forward vector control, direct torque and flux control,	**10 Hrs**
Unit –V	
Control and estimation of synchronous motor drives: Introduction, sinusoidal SPM machine drives, open loop v/f self-control model, absolute position encoder, optical analog resolver with decoder, vector control (field weakening mode), synchronous reluctance machine drives, trapezoidal SPM machine drives: drive operation with inverters, torque speed curve, machine dynamic model, drive control, Torque pulsation, extended speed operation, switched reluctance motor drives.	**12 Hrs**

UNIT VI Lab Component	**2 Hrs/Week**

1. Performance Analysis of single phase fully controlled converter fed separately excited DC motor for continuous current mode.
2. Performance Analysis of single phase semi controlled converter fed separately excited DC motor for continuous current mode.
3. Performance analysis of three phase fully controlled converter fed separately excited DC motor for continuous current mode.
4. Performance analysis of Chopper fed DC drive system with armature current in continuous current mode

5. Performance analysis of single phase fully controlled and dual converter fed separately excited DC motor for continuous and discontinuous current mode using simulation 6. Performance analysis of 4- quadrant chopper fed DC drive system using simulation 7. Speed control of single phase induction motor using V/F control 8. Speed control of three phase induction motor using V/F control 9. Simulation of Speed control of three phase induction motor using Static Cramer Control 10. Simulation of Speed control of three phase SPM machine from stator side 11. Simulation of Speed control of BLDC motor 12. Simulation of Regenerative Braking for 3- phase Induction motor

Course Outcomes **After completing the course, the students will be able to:**	
CO1:	Understand the specifications, selection and design techniques of drive system for a given applications.
CO2:	Modelling and Building and electric drive system as per given specifications.
CO3:	Simulate and build control modules for closed loop operation of an electric drive system
CO4:	Analyze the issues related to effect of harmonics and external disturbances of electric drives.
Reference Books	
1	Fundamentals of Electric drives, Gopal K Dubey, 2nd Edition, 2010, Narosa publisher, ISBN: 978-81-7319-428-3
2	Modern Power electronics and AC Drives, Bimal K Bose, 1st Edition, 2001, PHI publication, ISBN-13: 978-0130167439.
3	Power Electronics and Variable frequency drives, Bimal.K. Bose, Wiley student Edition, 2000, Wiley Publishers Distributors, New Delhi,. ISBN No: 9788126529346
4	Power Electronics in Motor Drives: Principles, Application and Design, Martin Brown, 1st Edition, 2010, Gazelle Distribution Publisher, ISBN:978-0905705897

Scheme of Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Scheme of Continuous Internal Evaluation (CIE): Theory (100 Marks)
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Scheme of Semester End Examination (SEE): Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Total marks: 100+50=150

Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

SEMESTER : I						
PROFESSIONAL SKILL DEVELOPMENT (Common to all Programs)						
Course Code	**:**	**18HSS14**		**CIE Marks**	**:**	**50**
Credits L: T: P	**:**	**0:0:0**		**SEE Marks**	**:**	**Audit Course**
Hours	**:**	**24 L**				

Unit – I	**03 Hrs**

Communication Skills: Basics of Communication, Personal Skills & Presentation Skills – Introduction, Application, Simulation, Attitudinal Development, Self Confidence, SWOC analysis.
Resume Writing: Understanding the basic essentials for a resume, Resume writing tips Guidelines for better presentation of facts. Theory and Applications.

Unit – II	**08 Hrs**

Quantitative Aptitude and Data Analysis: Number Systems, Math Vocabulary, fraction decimals, digit places etc. Simple equations – Linear equations, Elimination Method, Substitution Method, Inequalities.
Reasoning – a. **Verbal** - Blood Relation, Sense of Direction, Arithmetic & Alphabet.
b. **Non- Verbal reasoning** - Visual Sequence, Visual analogy and classification.
Analytical Reasoning - Single & Multiple comparisons, Linear Sequencing.
Logical Aptitude - Syllogism, Venn-diagram method, Three statement syllogism, Deductive and inductive reasoning. Introduction to puzzle and games organizing information, parts of an argument, common flaws, arguments and assumptions.
Verbal Analogies/Aptitude – introduction to different question types – analogies, Grammar review, sentence completions, sentence corrections, antonyms/synonyms, vocabulary building etc. Reading Comprehension, Problem Solving

Unit – III	**03 Hrs**

Interview Skills: Questions asked & how to handle them, Body language in interview, and Etiquette – Conversational and Professional, Dress code in interview, Professional attire and Grooming, Behavioral and technical interviews, Mock interviews - Mock interviews with different Panels. Practice on Stress Interviews, Technical Interviews, and General HR interviews

Unit – IV	**03 Hrs**

Interpersonal and Managerial Skills: Optimal co-existence, cultural sensitivity, gender sensitivity; capability and maturity model, decision making ability and analysis for brain storming; Group discussion(Assertiveness) and presentation skills

Unit – V	**07 Hrs**

Motivation: Self-motivation, group motivation, Behavioral Management, Inspirational and motivational speech with conclusion. (Examples to be cited).
Leadership Skills: Ethics and Integrity, Goal Setting, leadership ability.

Course Outcomes
After going through this course the student will be able to:

CO1	Develop professional skill to suit the industry requirement.
CO2	Analyze problems using quantitative and reasoning skills
CO3	Develop leadership and interpersonal working skills.
CO4	Demonstrate verbal communication skills with appropriate body language.

Reference Books

1.	The 7 Habits of Highly Effective People, Stephen R Covey, 2004 Edition, Free Press, ISBN: 0743272455
2.	How to win friends and influence people, Dale Carnegie, 1st Edition, 2016, General Press, ISBN: 9789380914787
3.	Crucial Conversation: Tools for Talking When Stakes are High, Kerry Patterson, Joseph Grenny, Ron Mcmillan 2012 Edition, McGraw-Hill Publication ISBN: 9780071772204
4.	Ethnus, Aptimithra: Best Aptitude Book, 2014 Edition, Tata McGraw Hill ISBN: 9781259058738

Phase	**Activity**
I	After the completion of Unit 1 and Unit 2, students are required to undergo a test set for a total of 50 marks. The structure of the test will have two parts. Part A will be quiz based, evaluated for 15 marks

	and Part B will be of descriptive type, set for 50 Marks and reduced to 35 marks. The total marks for this phase will be 50 (15 + 35).
II	Students will have to take up second test after the completion Unit 3, Unit 4 and Unit 5. The structure of the test will have two parts. Part A will be quiz based evaluated for 15 marks and Part B will be of descriptive type, set for 50 Marks and reduced to 35 marks. The total marks for this phase will be 50 (15 + 35).
FINAL CIE COMPUTATION	
Continuous Internal Evaluation for this course will be based on the average of the score attained through the two tests. The CIE score in this course, which is a mandatory requirement for the award of degree, must be greater than 50%. The attendance will be same as other courses.	

SEMESTER: I						
ADVANCED CONTROL SYSTEMS (Professional Elective-A1)						
Course Code	**:**	**18MPE1A1**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours:	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I	
Digital Control Systems: Review of difference equations and Z - transforms, sampled data systems: ideal sampler, sample and hold operations, Z- transfer function (Pulse transfer function), pulse transfer functions and different configurations for closed loop discrete-time control systems. Z - Transforms analysis of sampled data systems.	**10 Hrs**
Unit – II	
Mapping between the s-plane and the z-plane, stability analysis of closed loop systems in the z-plane Stability analysis (Jury's Stability Test and Bilinear Transformation), State model for continuous time and discrete time systems, Solutions of state equations(for both continuous and discrete systems), Discretization of continuous time state equations	**10 Hrs**
Unit –III	
Concepts of controllability and observability (for both continuous and discrete systems), design of state feedback controllers via pole placement, design of full and reduced order state observers and design of servo systems using pole placement technique. (for both continuous and discrete systems), full order and reduced order observers (for both continuous and discrete systems), dead beat control by state feedback	**10 Hrs**
Unit –IV	
Optimal control problems using state variable approach, state regulator and output regulator, Linear regulator problem: matrix Riccati equation and its solution, concepts of model reference control systems, adaptive control systems and design.	**12 Hrs**
Unit –V	
Non Linear Control Systems: Characteristics of nonlinear systems, Singular points, stability of nonlinear systems - phase plane analysis and describing function analysis, Lyapunov's stability criterion, Popov's criterion.	**10 Hrs**

Course Outcomes

After completing the course, the students will be able to:

CO1:	Identify, Formulate and obtain transfer function models, solve discrete control engineering problems, use the techniques, tools and skills related to discrete signals to solve complex control engineering problems.
CO2:	Apply the concepts of state space, controllability and observability, pole placement technique, optimal & adaptive control and Liapunov stability.
CO3:	Analyze and obtain state space models, solution of state equation, state feedback controllers and observers, stability of linear nonlinear systems using phase plane and linear & nonlinear Liapunov method.
CO4:	Assess and design of state feedback controllers and observers, using pole placement for continuous and discrete systems.

Reference Books

1	Digital Control & State Variable Methods, M. Gopal, 4th Edition, 2012, McGraw Hill Education, ISBN: 9780071333276.
2	Modern Control Engineering, Ogata. K., 5th Edition, 2010, PHI, ISBN: 9788120340107.
3	Discrete Time Control Systems, Ogata K, 2nd Edition, 2011, PHI, ISBN: 9788120327603.
4	Control Systems Engineering, Nagarath and Gopal, 2012, New Age International Publishers, ISBN: 9788122420081.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: I						
INTELLIGENT CONTROL TECHNIQUES IN DRIVES (Professional Elective-A2)						
Course Code	**:**	**18MPE1A2**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I	
Fuzzy Logic Systems: Introduction to fuzzy logic, fuzzy Vs crisp set, linguistic variables, membership functions, fuzzy sets and operations on crisp sets and fuzzy sets, Fuzzy relations, operations on fuzzy relation, Cartesian Product of Relation.linguistic variables, fuzzy if then rules, compositional rule of inference, Fuzzy Rule Base and Approximate Reasoning	**10 Hrs**
Unit – II	
Fuzzy Logic Control: Basic concept of fuzzy logic control, relationship to PI, PD and PID control, design of FLC: determination of linguistic values, construction of knowledge base, inference engine, tuning, fuzzification, De-fuzzification methods. Fuzzy Inference Systems (FIS), Construction and Working Principle of FIS, Mamdani FIS models, Takagi-Sugeno-Kang (TSK) fuzzy models and concept of Adaptive Fuzzy control, Examples applicable to Drives.	**10Hrs**
Unit –III	
Neural network: Fundamental Concept, history and development of neural network principles, Biological Neural Network, Comparison Between Biological Neuron and Artificial Neuron ,Important Terminologies of ANN.Basic Models and Advantages of Neural Networks **Learning methods:** types of learning, supervised, unsupervised, reinforced learning, knowledge representation and acquisition, **Theory, architecture and learning algorithm of neural network models**: McCulloc model, Hopfield model, Perceptron Network, Back propagation network	**10 Hrs**
Unit –IV	
Neural Networks for feedback Control: Identification of system models using neural networks, Model predictive control, feedback linearization and model reference control using neural networks, Neural Network Reinforcement Learning Controller, Radial basis function neural networks, Basic learning laws in REF nets, Recurrent back propagation, CMAC networks and ART networks, Kmeans clustering algorithm. Kohnen's feature maps, pattern recognition & mapping, Examples applicable to Drives.	**12 Hrs**
Unit –V	
Hybrid algorithms: Neuro-fuzzy systems, ANFIS and extreme-ANFIS, derivative free optimization methods, **Genetic algorithms** :- introduction, principle of natural selection, Flow chart of simple genetic algorithm, GA operators and parameters. particle swarm optimization, Solution of typical control problems. **Case studies on Application to Electrical Drives**.	**10 Hrs**

Course Outcomes **After completing the course, the students will be able to**	
CO1:	Explain the concepts ANN and Fuzzy Logic
CO2:	Analyze the techniques involved in ANN and fuzzy logic applications
CO3:	Design and model hybrid system with ANN and FL or independent system
CO4:	Application of techniques in modern industrial drives and power electronics system

Reference Books	
1	Principles of Soft Computing, Dr. S. N. Sivanandam and Dr. S. N. Deepa, 2nd Edition, 2008, WILEY publication, ISBN: 9788126527410
2	Fuzzy Logic – Intelligence, Control and Information, John Yen and Reza Langari, 3rd Edition, 2009, Pearson Education Inc, ISBN 978-81-317-0534-6
3	Neural Networks – A Comprehensive Foundation, Simon Haykin, 2nd Edition, 1998, PH Publisher, ISBN978-81-203-2373-5
4	Fuzzy Logic with Engineering Applications, Timothy J. Ross., 3rd Edition, 2011, John Wiley and Sons, ISBN 978-0-470-74376-8

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: I						
EMBEDDED SYSTEMS FOR POWER ELECTRONICS (Professional Elective-A3)						
Course Code	**:**	**18MPE1A3**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I	
ARM Processor: Background of ARM and ARM Architecture, Overview of the Cortex-M3, Registers, Operation Modes, The Built-In Nested Vectored Interrupt Controller, The Memory Map, The Bus Interface, The MPU, The Instruction Set, Interrupts and Exceptions	**10 Hrs**
Unit – II	
Cortex-M3 Basics: Registers, Operation Mode, Exceptions and Interrupts, Vector Tables, Stack Memory Operations, Reset Sequence	**10 Hrs**
Unit –III	
Instruction Sets: Assembly Basics., Instruction Descriptions, Useful Instructions in the Cortex-M3, Memory Systems, Memory Maps, Memory Access Attributes, Default Memory Access Permissions, Bit-Band Operations Unaligned Transfers, Exclusive Accesses, Endian Mode Basic Cortex-M3 Programming using C	**10 Hrs**
Unit –IV	
PIC Microcontrollers: Overview of PIC 18 family, PIC Architecture, PIC Assembly Language Programming, RISC Architecture in PIC	**11 Hrs**
Unit –V	
Instruction Sets and Programming: Call, Branch ad Time Delay Loop, PIC18 Time Delay and Instruction Pipe Lining, Arithmetic, Logic Instructions and Programming	**11 Hrs**

Course Outcomes **After completing the course, the students will be able to:**	
CO1:	Gain understanding about the embedded system as a whole and its hardware and software components
CO2:	Analyze popular CPU architectures used in embedded systems such as ARM,PIC and writing assembly language programming.
CO3:	Apply embedded software design and modelling in power electronic circuits
CO4:	come up with high level design of an embedded system from both hardware and software perspective
Reference Books	
1	The Definitive Guide to the ARM Cortex-M3, Joseph Yiu, 2nd Edition. 2009, Elsevier Publisher, ISBN: 9789351071754,
2	PIC Microcontroller, Muhammad Ali Mazidi, Rolin D. McKinlay , 1st Edition, 2007, Prentice Hall Publisher, ISBN-13: 978-0131194045,
3	Embedded Systems: Introduction to ARM Cortex™-M3 Microcontroller, Jonathan W Valvano , Volume1,. 2012,CreateSpace Independent Publishing Platform, ISBN-13: 978-1477508992
4	Microcontroller and Embedded System, Er. Vikrant Vij , 1st Edition, 2011, Laxmi Publications; ISBN-13: 978-9381159019

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: I						
POWER QUALITY PROBLEMS AND MITIGATION (Professional Elective-B1)						
Course Code	**:**	**18MPE1B1**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I	
Power Quality: Introduction, State of the Art on Power Quality, Classification of Power Quality Problems, Power Quality definitions, Power Quality Standards and Monitoring, Numerical Examples **Loads That Cause Power Quality Problems:** Introduction, Nonlinear Loads, Classification of Nonlinear Loads, Power Quality Problems Caused by Nonlinear Loads, Analysis of Nonlinear Loads, Modeling, Simulation, and Performance of Nonlinear Loads, Grounding techniques, Numerical Examples.	**10 Hrs**
Unit – II	
Passive Power Filters – Introduction to Passive Power Filters , Classification, Principle of Operation , Analysis and Design , Modeling, Simulation, and Performance , Limitations , Parallel Resonance of Passive Filters with the Supply System and Its Mitigation , Numerical Examples	**10 Hrs**
Unit –III	
Active Shunt Compensation: Introduction, State of the Art on DSTATCOMs, Classification of DSTATCOMs, Principle of Operation and Control of DSTATCOMs, Analysis and Design of DSTATCOMs, Modelling, Simulation, and Performance of DSTATCOMs, Numerical Examples	**10 Hrs**
Unit –IV	
Active Series Compensation: Introduction, State of the Art on Active Series Compensators, Classification of Active Series Compensators, Principle of Operation and Control of Active Series Compensators, Analysis and Design of Active Series Compensators, Modelling, Simulation, and Performance of Active Series Compensators, Numerical Examples	**11 Hrs**
Unit –V	
Unified Power Quality Compensators: Introduction, State of the Art on Unified Power Quality Compensators, Classification of Unified Power Quality Compensators, Principle of Operation and Control of Unified Power Quality Compensators, Analysis and Design of Unified Power Quality Compensators, Modeling, Simulation, and Performance of UPQCs	**11 Hrs**

Course Outcomes
After completing the course, the students will be able to:

CO1:	Explain the various power quality problems and identify the causes of PQ disturbances in a system
CO2:	Model and Simulate Active series, shunt and unified compensators
CO3:	Analyze and design controllers for various compensators
CO4:	Compute the level of PQ disturbance and design a suitable compensator for a system

Reference Books

1	Power Quality Problems and Mitigation Techniques, Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, 1st Edition, 2015, John Wiley Publisher, ISBN: ISBN: 978-1-118-92205-7
2	Power Quality Enhancement Using Custom Power Devices, Arindam Ghosh and Gerard Ledwich, 1st Edition, 2002, Kluwer Academic Press, ISBN 1-4020-7180-9
3	Power Quality, C. Sankaran , 2002,, CRC Press, ISBN 0-8493-1040-7
4	Understanding Power Quality Problems: Voltage Sags and Interruptions,Math H.J. Bollen, 1st Edition, 1999, Wiley India Pvt Ltd Publisher, **ISBN-13:** 978-8126530397

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: I						
POWER SYSTEM HARMONICS (Professional Elective-B2)						
Course Code	**:**	**18MPE1B2**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I	
Fundamentals of Harmonics: Introduction, Examples of harmonic waveforms, characteristics of harmonics in power systems, measurement of harmonic distortion, power in passive elements, calculation of passive elements, resonance, capacitor banks and reactive power supply, capacitor banks and power factor correction, bus voltage rise and resonance, harmonics in transformers. **Harmonics in Power system:** Introduction, sources of harmonics, transformers, rotating machines, fluorescent and CFL lights, static var compensators, cycloconverters. Single phase controlled rectifiers, three phase converters.	**10 Hrs**
Unit – II	
Effects of Harmonic Distortion on Power System: Introduction, thermal losses in a harmonic environment, harmonic effects on power system equipment: capacitor banks, transformers, rotating machines, protection, communication and electronic equipment. **Mitigation of Power system Harmonics:** Introduction, Passive harmonic filters : Tuned, De-tuned filters; Active Filters – Shunt and series; Hybrid filters	**10 Hrs**
Unit –III	
Limits of Harmonic Distortion: Introduction, voltage harmonic distortion limits, current harmonic distortion limits. IEEE 519-1992 standards for Harmonics **Modelling of System Components for harmonic studies:** Introduction, impedance in the presence of harmonics, skin effect, modelling of the high voltage grid, generator modelling, modelling of shunt capacitor banks, series capacitor banks, load models, induction motor modelling. **Transformer Modelling:** Introduction, modelling of two winding transformers, phase sequence admittance matrices, transmission of voltage and current across two winding transformers, transmission matrices and phase admittance matrix, modelling of three and four winding	**10 Hrs**
Unit –IV	
Modelling of Transmission lines/Cables: Introduction, skin effect, modelling of power lines, Line's series impedance, mutual coupling between conductors, mutually coupled lines, line's shunt capacitance, surge impedance and velocity of propagation, line's series impedance and shunt capacitance – single phase equivalents, the transmission (ABCD) matrix, the admittance matrix, conversion between the transmission and admittance matrices, the nominal pi model – single phase equivalent, the equivalent pi model – voltage and current the line, line losses, the equivalent pi model – single phase equivalent, variations in the network's short circuit capacity, examples – the nominal and equivalent models	**12 Hrs**
Unit –V	
Power in presence of harmonics : Active ,reactive distortion and apparent powers – definitions and computation. PF in the presence of harmonics – true PF, Displacement PF and Distortion PF **Harmonic Studies :** Harmonic Analyser; Calculation of harmonics through spread sheet; Design of filter with practical considerations; location of filters , Case studies of effects of harmonics.	**10 Hrs**

Course Outcomes
After completing the course, the students will be able to

CO1:	Discuss the sources and effects of harmonics in a given power system
CO2:	Compute the harmonic indices and distortion of power in the system
CO3:	Model various components for harmonic studies
CO4:	Design passive and active filters to meet the IEEE 519-1992 standards

Reference Books

1	Power System Harmonics, George J Wakileh , 1st Edition, 2014, Springer Reprint, ISBN 978-3-540-42238-9
2	Power System Harmonic Analysis, Jos Arrillaga, Bruce C. Smith, Neville R. Watson, Alan R. Wood, 1st Edition, 2014, Wiley Reprint, ISBN 0-470-85129-5

3	Power System Harmonics, J. Arrillaga, N.R. Watson, 2nd Edition, 2003, Wiley Publisher, ISBN: 978-0-470-85129-6
4	Harmonics – Causes, effects and Control, White Paper, usa.siemens.com/lv-drives

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: I						
SMART GRID-TECHNOLOGY, ANALYSIS AND APPLICATIONS (Professional Elective-B3)						
Course Code	**:**	**18MPE1B3**		**CIE Marks: 100**	**:**	**100**
Credits: L:T:P	**:**	**4:0:0**		**SEE Marks: 100**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration: 3Hrs**	**:**	**3 Hrs**

Unit-I	
INTRODUCTION- Definition, Objectives, Early Smart Grid initiatives, Overview of the technologies required for the Smart Grid, smart grid from customers view, Issues of energy management in smart grids **INFORMATION AND COMMUNICATION TECHNOLOGIES:** Dedicated and shared communication channels, Switching techniques, Communication channels, Layered architecture and protocols	**10 Hrs**
Unit-II	
COMMUNICATION TECHNOLOGIES FOR SMART GRID: Communication technologies, Standards for information exchange, control decentralization, Interoperability and connectivity, future internet for smart grids **INFORMATION SECURITY FOR THE SMART GRID**-Encryption and decryption, Authentication, Digital signatures, Cyber security standards	**10 Hrs**
Unit-III	
SMART METERING AND DEMAND-SIDE INTEGRATION: Need for demand response and new regulations**,** Smart meters ,An overview of the hardware used, Communications infrastructure and protocols for smart metering, Demand-side integration **DISTRIBUTION AUTOMATION EQUIPMENT:** Substation automation equipment, Faults in the distribution system, Voltage regulation **TRANSMISSION SYSTEM OPERATION:** Data sources, Energy management systems, Wide area applications, Visualization techniques	**12 Hrs**
Unit-IV	
DISTRIBUTION MANAGEMENT SYSTEMS: Data sources and associated external systems, Modeling and analysis tools, Applications, **ARCHITECTURE AND RECONFIGURATION :** New structure of distribution grids, planning : Long term and short term, Reconfiguration to reduce power losses	**10 Hrs**
Unit-V	
Micro Grids : Micro Grid configurations, Renewable energy generation, Fault current limiting, Shunt and Series compensation in microgrids with renewable soruces, **ENERGY STORAGE:** Energy storage technologies and case studies, technological challenges with penetration of electric vehicles **STANDARDIZATION OF SMART GRIDS –** Issues, regulations and current status	**10 Hrs**

Course Outcomes **After completing the course, the students will be able to:**	
CO1:	Explain the evolution of the smart grid and the different components of a smart grid
CO2:	Critically evaluate the ICT options and choose the appropriate one for a given grid
CO3:	Design and propose reconfiguration strategies for the smart distribution network
CO4:	Assess and propose changes in metering, storage and regulation to implement smart grid technology

Reference Books	
1	Smart Grid: Technology and applications, Ekanayake J., Jenkins N., Liyanage K., Wu, J., Yokoyama A., 1st Edition, 2012, Wiley Publications, ISBN 978-0-470-97409-4
2	Smart Grids, Nouredine Hadjsaid and Jean-Claude, 1st Edition, 2012, Wiley Publications, ISBN – 978-1-84821-261-9
3	Smart Grid: Fundamentals of Design and Analysis, James Momoh, 1st Edition, 2012, Wiley-IEEE Press, ISBN: 978-0-470-88939-8
4	Smart Grids – Fundamentals and Technologies in Electricity Networks, Bernd M. Buchholz , 1st Edition, 2016, Springer Vieweg Publisher, ISBN-13: 978-3662525265

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
POWER CONVERTERS-II (Theory and Practice)						
Course Code	**:**	**18MPE21**		**CIE Marks**	**:**	**100+50**
Credits: L:T:P	**:**	**4:0:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**45L+26P**		**SEE Duration**	**:**	**3+3 Hrs**

Unit-I	
Non isolated dc-dc converters: Comparison of linear and switch mode power converter. Analysis and Design Buck, Boost, Buck-boost, Cuk and SEPIC converters in continuous and discontinuous modes. Interleaved converters. High boost converter.	**09 Hrs**
Unit-II	
Isolated DC-DC Converters: Principle of operation, Analysis and Design of isolated DC- DC converters Flyback, Forward, Push Pull, Half Bridge and Full bridge topologies in continuous and discontinuous current mode operation. Bidirectional converters.	**09 Hrs**
Unit-III	
Resonant Converters: Introduction to soft switching, comparison between zero voltage and zero current switching, classification, ZVS, ZCS converters, series resonant, parallel resonant and series-parallel resonant converter topologies: analysis and design.	**09 Hrs**
Unit-IV	
Design of magnetic: Design of magnetic components-inductors and transformers. **Modelling of converters**- small signal modelling, State space average modelling of non isolated converters.	**09 Hrs**
Unit-V	
Closed loop Control of DC-DC converters: Basic control techniques: Voltage control, current control, Design of type 2 and type 3 error amplifiers. Stability analysis of converters. PWM ICs for DC-DC Converters.	**09 Hrs**
UNIT VI Lab Component	
1. Design and Simulation of DC-DC Converters step-down, step-up, step up/down. 2. Design and practical implementation of two and four quadrant choppers. 3. Design ,Simulation and testing of non-isolated converter for RL load for continuous & discontinuous current mode(Cuk, SEPIC) in open loop and closed loop, 4. Design, Simulation and testing of isolated converter for RL load for continuous & discontinuous current mode) in open loop and closed loop. 5. Design, simulation and testing of series resonant converter.	

Course Outcomes
After completing the course, the students will be able to:

CO1:	Understand the working of different converter for continuous and discontinuous operation, modeling
CO2:	Explain and simulate various converters for given parameters
CO3:	Analyze and evaluate performance of various converters with feedback controller.
CO4:	Design with justification various converters with filters and feedback controller

Reference Books

1	Power Electronics Converters, Applications, and Design, Ned Mohan, Tore M. Undeland, William P. Robbins, 3rd Edition, Wiley India Pvt Ltd, 2011. ISBN: 978-0-471-22693-2
2	Power Electronics, Daniel w Hart, 1st Edition, 2014, McGrawHill Education, ISBN-13: 978-0073380674
3	Power Electronics, Circuit Devices and Applications, M. H. Rashid, 3rd Edition, 1998, PHI, ISBN-10: 0131011405
4	Power Electronics Essentials & Applications, L Umanand, 1st Editon, 2013, Willey Publisher, ISBN-978-81-265-1945-3

Scheme of Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Scheme of Continuous Internal Evaluation (CIE): Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Continuous Internal Evaluation (CIE): Practical (50 Marks)
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE): Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Total marks: 100+50=150

Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

SEMESTER: II						
MODELLING AND SIMULATION OF POWER ELECTRONIC SYSTEMS (Theory)						
Course Code	**:**	**18MPE22**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I	
Computer Simulation of Power Electronic Converters and Systems: Challenges in computer simulation, simulation process, Types of analysis, mechanics of simulation, circuit-oriented simulators, equation solvers, comparison of circuit oriented simulators and equation solvers. **Modelling of Systems**: Input-Output relations, differential equations and linearization, state space representation, transfer function representation. **MNA and ST approaches:** Nodal analysis, Modified Nodal analysis, the sparse tableau approach. Non linear circuits The Newton-Raphson Method, computation time, convergence issues, nonlinear circuit equations, Practical limit.	**10 Hrs**
Unit-II	
Introduction to transient simulation Discretization of time, transient analysis, Accuracy and stability, Explicit and Implicit Schemes. **Method for Transient Simulation** Introduction, Numerical methods for solving ODEs, Stability of numerical methods. Stiff equations, Adaptive step size, (excluding compact representation of RK formulas, multistep method, generalised linear multi step method) Transient analysis in circuit simulation, Equivalent circuit approach, and practical aspects.	**10 Hrs**
Unit-III	
Steady state analysis: Direct method for SSW computation, simulation examples, computational efficiency. **DC DC converters**: Simple DC to DC converter, switched mode power converters, more versatile power converters, discontinuous mode of operation in DC to DC converters.	**10 Hrs**
Unit-IV	
Dynamic performance of switched mode power converters Introduction, PWM converter, Average model of the converter, Circuit Averaged model of the converter. Closed loop control of switching converters Introduction, Close loop control, closed loop performance functions	**11 Hrs**
Unit-V	
Advanced topics in Switching converters Current programmed control of DC to DC converters, Soft switching converters.	**11 Hrs**

Course Outcomes
After completing the course, the students will be able to:

CO1:	Analyze performance parameters of various circuits, Power electronic converters and Drives by modelling and simulating with appropriate time steps
CO2:	Solve steady state and transient problems of Power electronic systems
CO3:	Apply numerical techniques to solve ODE using numerical techniques
CO4:	Design, Implement and Analyze open and closed loop systems

Reference Books

1	Simulation of Power Electronic Circuits, M.B.Patil, V.Ramanarayanan, V.T.Ranganathan, 1st Edition, 2013, Narosa Publishing House, ISBN: 978-81-7319-989-9
2	Power Electronics Converters, Applications, and Design, Ned Mohan, Tore M. Undeland, William P. Robbins, 3rd Edition, 2011, Wiley India Pvt Ltd, ISBN : 978-81-265-1090-0
3	Power Electronics Essentials and Applications, L.Umanand, 1st Edition, 2009, John Wiley & Sons, ISBN: 978-81-265-1945-3
4	Power Electronics : Devices, Circuits And Matlab Simulations, Alok Jain, 1st Edition, 2011,Penram International Publishing, ISBN-13: 978-8187972389

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
RESEARCH METHODOLOGY (Common to all programs)						
Course Code	**:**	**18IEM23**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I — **08 Hrs**

Overview of Research

Research and its types, identifying and defining research problem and introduction to different research designs. Essential constituents of Literature Review. Basic principles of experimental design, completely randomized, randomized block, Latin Square, Factorial.

Unit – II — **08 Hrs**

Data and data collection

Overview of probability and data types Primary data and Secondary Data, methods of primary data collection, classification of secondary data, designing questionnaires and schedules.

Sampling Methods: Probability sampling and Non-probability sampling

Unit – III — **08 Hrs**

Processing and analysis of Data

Statistical measures of location, spread and shape, Correlation and regression, Hypothesis Testing and ANOVA. Interpretation of output from statistical software tools

Unit – IV — **08 Hrs**

Advanced statistical analyses

Non parametric tests, Introduction to multiple regression, factor analysis, cluster analysis, principal component analysis. Usage and interpretation of output from statistical analysis software tools.

Unit-V — **07 Hrs**

Essentials of Report writing and Ethical issues

Significance of Report Writing , Different Steps in Writing Report, Layout of the Research Report , Ethical issues related to Research, Publishing, Plagiarism

Case studies: Discussion of case studies specific to the domain area of specialization

Course Outcomes

After going through this course the student will be able to:

CO1	Explain the principles and concepts of research types, data types and analysis procedures.
CO2	Apply appropriate method for data collection and analyze the data using statistical principles.
CO3	Present research output in a structured report as per the technical and ethical standards.
CO4	Create research design for a given engineering and management problem situation.

Reference Books:

1	Research Methodology Methods and techniques by, Kothari C.R., New Age International Publishers, 4th Edition, ISBN: 978-93-86649-22-5
2	Management Research Methodology, Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M.,Pearson Education: New Delhi, 2006. ISBN: 978-81-77585-63-6
3	The Research Methods Knowledge Base, William M. K. Trochim, James P. Donnelly, 3rd Edition, Atomic Dog Publishing, 2006. ISBN: 978-1592602919
4	Statistics for Management, Levin, R.I. and Rubin, D.S., 7th Edition, Pearson Education: New Delhi.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
MINOR PROJECT						
Course Code	**:**	**18MCE24**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**0:0:2**		**SEE Marks**	**:**	**100**
Hours/Week	**:**	**4**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1. Each project group will consist of maximum of two students.
2. Each student / group has to select a contemporary topic that will use the technical knowledge of their program of study after intensive literature survey.
3. Allocation of the guides preferably in accordance with the expertise of the faculty.
4. The number of projects that a faculty can guide would be limited to four.
5. The minor project would be performed in-house.
6. The implementation of the project must be preferably carried out using the resources available in the department/college.

Course Outcomes

After completing the course, the students will be able to:

CO1	Conceptualize, design and implement solutions for specific problems.
CO2	Communicate the solutions through presentations and technical reports.
CO3	Apply resource managements skills for projects.
CO4	Synthesize self-learning, team work and ethics.

Scheme of Continuous Internal Examination

Evaluation will be carried out in 3 phases. The evaluation committee will comprise of 4 members: Guide, Two Senior Faculty Members and Head of the Department.

Phase	Activity	Weightage
I	Synopsys submission, Preliminary seminar for the approval of selected topic and objectives formulation	20%
II	Mid term seminar to review the progress of the work and documentation	40%
III	Oral presentation, demonstration and submission of project report	40%

** Phase wise rubrics to be prepared by the respective departments

CIE Evaluation shall be done with weightage / distribution as follows:

- Selection of the topic & formulation of objectives 10%
- Design and simulation/ algorithm development/ experimental setup 25%
- Conducting experiments/ implementation / testing 25%
- Demonstration & Presentation 15%
- Report writing 25%

Scheme of Semester End Examination (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

- Brief write up about the project 05%
- Presentation / Demonstration of the Project 20%
- Methodology and Experimental results & Discussion 25%
- Report 20%
- Viva Voce 30%

SEMESTER: II						
EMC IN POWER ELECTRONICS (Professional Elective-C1)						
Course Code	**:**	**18MPE2C1**		**CIE Marks**	**:**	**100**
Credits	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I	
Introduction to the EMC: Introduction , Designing for electromagnetic compatibility, EMC regulation, typical noise path and use of network theory Methods of noise coupling, Method of eliminating interferences, MIL-STD explanation. Industrial applications **Cabling:** Capacitive coupling, magnetic coupling, effect of shield on capacitive and magnetic coupling, magnetic coupling between shield and the inner conductor, shielding to prevent magnetic radiation, shielding a receptor against magnetic fields, shield transfer impedance.	**10 Hrs**
Unit-II	
SHIELDING :Near fields and far fields, characteristics and wave impedances, shielding effectiveness, absorption loss, reflection loss, composite absorption and reflection losses, summary of shielding equation, shielding with magnetic material, experimental data. apertures , wave guide below cut off, conductive gaskets, conductive windows, conductive coatings, cavity resonance, grounding of shields	**10 Hrs**
Unit-III	
Grounding: Safety grounds, signal grounds, single point ground systems, multiple ground systems, functional ground layout. Practical low frequency grounding, hard ware grounds, single ground reference for a circular amplified shields, grounding of cable shields, ground loops. Low frequency analysis of common mode choke, high frequency analysis of common mode choke, differential amplifiers, shields grounding at high frequencies, guard shields and guarded meters	**10 Hrs**
Unit-IV	
EMI Circuit Selection And Measurement: Definition of EMI filter parameter, EMI filter circuit, insertion loss **EMI Filter Design**: EMI Filter Design for Insertion Loss, Calculation of Worst – case Insertion Loss, Design Method for Mismatched Impedance Condition, Design Method for EMI Filters with Common – Mode Choke Coils, Damped EMI Filters and Lossy Filter Elements, HF Characteristics of Noise Filter Circuit Elements, EMI Filter Layout.	**11 Hrs**
Unit-V	
Testing for Susceptibility to Power Line Disturbances: Surge Voltages in AC Power Mains, EMC Tests per IEC Specifications, Other EMS Test Methods. **Reduction Techniques for internal EMI**: Conductive Noise Coupling, Electromagnetic Coupling, Electromagnetic Coupling Reduction Methods, Wiring Layout Methods to Reduce EMI Coupling, PCB Design Considerations.	**11 Hrs**

Course Outcomes

After completing the course, the students will be able to:

CO1:	Describing the. Problems of noise by handling noise in shields, ground wires and protective sheaths.
CO2:	Analyzing the cause of problems clearly and comparing the objectiveness between external and internal noise in equipment and reduce its noise content.
CO3:	Evaluating different technologies to handle noise in systems and assessing the total losses with respect to circuits
CO4:	Designing the circuits with different materials to counteract the noise in both hardware and software problems.

Reference Books

1	Noise reduction techniques in electronics systems, Henry .W. Ott, 3rd Edition, 2015, John Wiley publication , ISBN: 978-0-470-18930-6.
2	Electrostatic Damage in Electronics: Devices and Systems, William D Greason, 1986, 4th Edition, John Wiley and sons INC, ISBN:978-0471915394
3	Electromagnetic compatibility in Power Electronics, Laszlo Tihanyi, 1st Edition,1995, Newnes publications, ISBN-0-7803-0416-0
4	Electromagnetic Compatibility in Power Electronics, Eric Laboure, Bertrand Revol, Francois Costa, 1st Edition, 2014, Wiley Publisher:, ISBN: 9781848215047

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
PWM TECHNIQUES FOR CONVERTERS (Professional Elective-C2)						
Course Code	**:**	**18MPE2C2**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I	
Introduction to pulse width modulation (PWM)- Overview of converters and control methods. Purpose of PWM control of converters, Fourier series, Harmonic voltages and their effects. Basic PWM techniques: **Triangle-comparison based PWM**: single pulse. Multiple pulse, SPWM, modified SPWM and phase displacement techniques, Third harmonic injection PWM (THIPWM), Bus-clamping PWM	**10 Hrs**
Unit-II	
Advanced PWM Techniques: Hysteresis band current control PWM, Harmonic Cancellation techniques Concept of space vector, Conventional space vector PWM and bus-clamping PWM, Advanced bus-clamping PWM, Comparison of PWM techniques, Voltage and frequency control of single phase and three-phase inverters.	**10 Hrs**
Unit-III	
Analysis of line current ripple: Transformation from stationary reference frame to synchronously revolving dq reference frame, Volt-second balance and instantaneous error voltage, Calculation of RMS line current ripple, Space vector-based hybrid PWM for reduced line current ripple. Analysis of dc link current, Average and RMS values of dc link current. **Analysis of torque ripple:** Calculation of harmonic torques and RMS torque ripple, Hybrid PWM techniques to reduce ripple torque.	**10 Hrs**
Unit-IV	
Loss Calculations: Practical devices in converters, calculation of switching and conduction loss, PWM techniques for reduced switching loss compensation for dead time and DC voltage regulation. **Effect of inverter dead-time:** Effect of dead-time with continuous modulation and discontinuous modulation.	**11 Hrs**
Unit-V	
Over modulation- Per-phase approach to over modulation, Space vector approach to over modulation, A perspective from the synchronously revolving d-q reference frame. **PWM for multilevel inverters**, Extension of sine-triangle modulation to three-level inverters, Extension of conventional space vector modulation to three-level inverters.	**11 Hrs**

Course Outcomes

After completing the course, the students will be able to:

CO1:	Analyze basic concepts of PWM control method.
CO2:	Analyze basic and explore advance PWM methods for inverters and converters.
CO3:	Evaluate performance parameters like current ripple, torque ripple and losses
CO4:	Design a PWM controller for a given application.

Reference Books

1	Power Electronics: Converter, Applications and Design, Mohan, Undeland and Robbins, 3rd Edition, 2011, Wiley India, ISBN-13: 9781848003170
2	NPTEL materials on 'Pulse width Modulation for Power Electronic Converters'
3	Fundamentals of Power Electronics, Erickson R W, Chapman Hall, 1st Edition, 1997, Springer Publisher, ISBN 0-412-08541-0
4	Power electronics-Principles and Applications, Joseph Vithyahil, , 2017, McGraw Hill Education, ISBN 9780070702394

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit

SEMESTER: II						
DSP CONTROLLERS FOR POWER CONVERTERS (Professional Elective-C3)						
Course Code	**:**	**18MPE2C3**		**CIE Marks: 100**	**:**	**100**
Credits: L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I	
INTRODUTION TO DIGITAL CONTROLLER: Digital Signal Controller (A micro-controller with a DSP engine): Architecture and real time programming in Assembly and Embedded C. Communication Board level: SPI, I2C, System level: RS 232, CAN, MODBUS RTU on RS 485. Introduction to different semiconductor memories: RAM, ROM, NVRAM etc. and their applications. Flash Program Memory, Data EEPROM Memory	**10 Hrs**
Unit-II	
INTRODUCTION TO MICROCHIP DSPIC30F4011 Device overview: Block diagram, I/O pin Descriptions. CPU Architecture: Core Overview, Programmers Model, DSP Engine. Memory Organization: Program Address Space, Data Address Space, Address Generator Units	**10 Hrs**
Unit-III	
Interrupt: Interrupt priority, Interrupt Sequence, External Interrupt Request **I/O Ports:** Parallel I/O ports, Configuring Analog port pins **Timers:** Timer Modules, Timer Gate Operation, Timer Pre-scaler, Timer Interrupt **Capture and Compare Modules:** Capture Event mode, Capture Operation, Compare mode block diagram, compare interrupts	**10 Hrs**
Unit-IV	
Motor Control PWM Module: Block Diagram, Duty cycle comparison, complementary PWM Operation, Dead-Time generators, PWM output and polarity control **Communication Modules: SPI, UART and CAN Modules:** Operating function description, UART module overview, transfer of data ad error handling through UART **ADC Module:** Functional block diagram, conversion operation, configuring analog port pins, programming ADC module, connecting with a DAC chip.	**11 Hrs**
Unit-V	
System Integration (taking an example of a buck converter) (Block Diagram Approach) Control of Buck-Boost DC-DC converter; DSP based control of dual converter fed dc motor **DSP Based Control of Stepper Motors:** Introduction, the Principle of Hybrid Stepper Motor, The Stepper Motor Drive System, The Implementation of Stepper Motor Control System Using DSP	**11 Hrs**

Course Outcomes
After completing the course, the students will be able to:

CO1:	Comprehend different peripherals and architecture & operation of DSP core processor
CO2:	Analyze the functions of peripherals
CO3:	Develop program and demonstrate execution to evaluate the performance of control technique
CO4:	Design suitable control technique for the implementation of DSP to the drives

Reference Books

1	Microchip Datasheets, Family reference manual, C30 compiler user guide, 2006.
2	Digital Signal Processing:, Steven W Smith, 2nd Edition, 1999, California Technical Publishing, ISBN 0-9660176-7-6
3	Digital Signal Processing and Applications with theC6713 and C6416 DSK by Rulph Chassaing, 1st Edition, 2005, A John Wiley & Sons, Inc., Publication, ISBN: 9780471690078, ISBN: 9780471704072
4	DSP Based Electromechanical Motion Control, Hamid A. Toliyat, Steven G. and Campbell., 1st Edition, 2004, CRC Press. ISBN 9780849319181

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit

SEMESTER: II						
CONVERTERS FOR SOLAR AND WIND SYSTEMS (Professional Elective-D1)						
Course Code	**:**	**18MPE2D1**		**CIE Marks: 100**	**:**	**100**
Credits: L:T:P	**:**	**4:0:0**		**SEE Marks: 100**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration: 3Hrs**	**:**	**3 Hrs**

Unit-I	
Introduction: Wind power development, photovoltaic power development, the grid converter – the key element in grid integration of WT and PV systems. **Power Converters for Solar Energy Systems**: Review of various DC-DC converter (buck, boost, buck-boost, Ćuk and SEPIC) and inverter (VSI & CSI) topologies, selection of inverter, inverter structures derived from H-bridge topology, inverter structures derived from NPC topology, typical PV inverter structures, three-phase PV inverters, introduction to control structures	**10 Hrs**
Unit-II	
Solar Charge Controllers- Need for Balance of Systems (BoS), function and working of charge controller, types of charge controllers, features of charge controller, typical specifications of PWM charge controller. **Grid Requirements for PV:** Introduction, international regulations, Indian grid code for PV integration, response to abnormal grid conditions, power quality, anti-islanding requirements, a grid interactive PV system - phase , frequency matching and voltage consideration – operation of a grid interactive inverter – protection against islanding and reverse power flow – AC modules- introduction to EMI filters and their design. The IEEE Standard 929-2000 for Power Transfer from Inverter to Grid and its issues, requirements of IEC 61727.	**10 Hrs**
Unit-III	
Grid Synchronization in Power Converters: Grid synchronization techniques for single-phase systems, phase detection based on in-quadrature signals, PLLs based in in-quadrature signals and adaptive filtering, the SOGI frequency-locked loop. **Power Converters for WECS**: Three phase AC voltage controllers- AC-DC-AC converters, Grid-Interactive Inverters-matrix converters. Standalone operation of fixed and variable speed wind energy conversion system, Grid connection Issues, Grid integrated PMSG and SCIG Based WECS.	**10 Hrs**
Unit-IV	
Grid Converter Structures for Wind Turbine Systems: Introduction, Indian grid code for wind integration, WTS power configurations, grid power converter topologies, WTS control, connection issues- wind farm and its accessories, and grid related problems – generator control – performance, improvements.	**11 Hrs**
Unit-V	
Grid Synchronization in Three-Phase Power Converters - the three-phase voltage vector under grid faults, the synchronous reference frame PLL under unbalanced and distorted, grid conditions, the Decoupled Double Synchronous Reference Frame PLL (DDSRF-PLL), The Double Second-Order Generalized Integrator FLL (DSOGI-FLL).	**11 Hrs**

Course Outcomes

After completing the course, the students will be able to:

CO1:	Understand the basics of power electronic converters and their integration to the grid
CO2:	Analyze the system to select the proper converter, controller and the filter for the systems.
CO3:	Analysis of controllers appropriate for the PV and wind system integration.
CO4:	Design a grid-connected PV and Wind Energy system that complies with the various standards.

Reference Books

1	Grid converters for photovoltaic and wind power systems, Teodorescu Remus, Marco Liserre, and Pedro Rodriguez, Vol. 29., 2011, John Wiley & Sons, ISBN 0470057513, 9780470057513
2	Photovoltaic Systems: Analysis and Design, Mukerjee AK, Thakur N., 1st Edition, 2011, PHI Learning Pvt. Ltd., ISBN 8120344170, 9788120344174
3	Wind Electrical Systems, S. N. Bhadra, D. Kastha, & S. Banerjee, 7th Edition, 2005, Oxford University Press, ISBN 0195670930, 9780195670936

4	The IEEE Standard 929-2000 for Power Transfer from Inverter to Grid, and The IEC 61727

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit

SEMESTER: II						
HYBRID ELECTRIC VEHICLES (Professional Elective-D2)						
Course Code	**:**	**18MPE2D2**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I	
Introduction: Sustainable Transportation, A Brief History of HEVs, Why EVs Emerged and Failed, Architectures of HEVs, Interdisciplinary Nature of HEVs, State of the Art of HEVs, Challenges and Key Technology of HEVs. Vehicle Basics, Basics of the EV, HEV, Plug-In Hybrid Electric Vehicle (PHEV) and Fuel Cell Vehicles (FCVs). **HEV & PHEV Fundamentals:**Vehicle Model, Vehicle Performance, EV Powertrain Component Sizing, Series Hybrid Vehicle, Parallel Hybrid Vehicle, PHEV Architectures, Equivalent Electric Range of Blended PHEVs, Fuel Economy of PHEVs, Power Management of PHEVs, Component Sizing of EREVs, Component Sizing of Blended PHEVs, Vehicle-to-Grid Technology.	**11 Hrs**
Unit-II	
Motor Drives and Converters for HEVs: A review of AC and DC Motor Drives used in HEV. Regenerative braking; EV, HEV and PHEV battery chargers. **Traction Motors:**Design, Sizing, Thermal Analysis and Modeling. **Series and Parallel Hybrid Drive Train Design:**Operation Patterns, Control Strategies, Sizing of the Major Components, Power Rating Design of the Traction Motor, Power Rating Design of the Engine/Generator, Design of PPS, Design Example.	**11 Hrs**
Unit-III	
Batteries, Ultracapacitors, Fuel Cells, and Controls: Different batteries for EV, Battery Characterization, Comparison of Different Energy Storage Technologies for HEVs, Battery Charging Control, Charge Management of Storage Devices, Flywheel Energy Storage System, Hydraulic Energy Storage System, Fuel Cells and Hybridization of Energy Storages.	**10 Hrs**
Unit-IV	
Management of Energy Storage Systems in EV, HEV and PHEV: Design and Sizing of ESS, Battery Cell Balancing, Battery Management, Management of Vehicle to Grid (V2G), Thermal Management. **Modeling and Simulation of Electric and Hybrid Vehicles:** Fundamentals of Vehicle system modelling, HEV Modeling with ADVISOR, Physics based Modeling and other modelling techniques.	**10 Hrs**
Unit-V	
HEV Component Sizing and Design Optimization: Global Optimization Algorithms for HEV Design, Model-in-the-Loop Design Optimization Process, Parallel HEV Design Optimization Example, Series HEV Design Optimization Examples and Conclusion. **Vehicle Power Management:** Fundamentals of HIL and SIL, Components in HIL and SIL, Advantages of HIL and SIL, Data Acquisition, Monitoring and Control units, Global Description and Analysis for a Vehicle Power Management System.	**10 Hrs**

Course Outcomes
After completing the course, the students will be able to:

CO1:	Understand the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals.
CO2:	Analyze and Evaluate suitable Power Electronics and Electric Propulsion System required for HEVs.
CO3:	Design the different storage technologies appropriate for the required propulsion type using modeling techniques.
CO4:	Design and Implement the HEV propulsion system by comparing different optimization and energy management techniques.

Reference Books

1	Hybrid Electric Vehicle: Principles and Applications with Practical Perspectives, Mi Chris, Masrur A., and Gao D.W., 1st Edition, 2011, Wiley Publisher, **ISBN**:0-824-77653-5

2	Hybrid electric and Fuel Cell Vehicles, Ehsani Mehrdad, GaoYimin, E. Gay Sebastien, Emadi Ali, Modern Electric, 1st Edition, 2005, CRC Press, , **ISBN:***0*-8493-3154-4
3	Vehicle Power Management Modeling, Control and Optimization, Zhang Xi , Mi Chris, 1st Edition, 2011, Springer Publisher, **ISBN:**978-0-85729-735-8
4	Hybrid Electric Vehicles Energy Management Strategies, Onori, Simona, **Serrao**, Lorenzo, Rizzoni**,** Giorgio, 1st Edition, 2016, Springer Brief Publisher, ISBN 978-1-4471-6781-5

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
FLEXIBLE AC TRANSMISSION SYSTEM (FACTS) (Professional Elective-D3)						
Course Code	**:**	**18MPE2D3**		**CIE Marks**	**:**	**100**
Credits: L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I	
Introduction to facts: Review of basics of power transmission networks-control of power flow in AC transmission line- Analysis of uncompensated AC Transmission line Passive reactive power compensation: Effect of series and shunt compensation at the mid-point of the line on power transfer- Need for FACTS controllers- types of FACTS controllers.	**10 Hrs**
Unit-II	
Static var compensator (svc) Configuration of SVC- voltage regulation by SVC- Modeling of SVC for load flow analysis- Modeling of SVC for stability studies-Design of SVC to regulate the mid-point voltage of a SMIB system- Applications: transient stability enhancement and power oscillation damping of SMIB system with SVC connected at the mid-point of the line. Thyristor controlled series capacitors (TCSC) - Concepts of Controlled Series Compensation – Operation, modeling, analysis and control of TCSC.	**10 Hrs**
Unit-III	
Voltage source converter based facts controllers: Static synchronous compensator(STATCOM)- Static synchronous series compensator(SSSC)- Operation of STATCOM and SSSC-Power flow control with STATCOM and SSSC- Modeling of STATCOM and SSSC for power flow and transient stability studies; of Unified Power Flow Controllers(UPFC) - Modeling, Operation and control.	**10 Hrs**
Unit-IV	
Static Voltage and Phase Angle Regulators: Power flow control, TCVR and TCPAR, improvement of transient stability with these. GCSC _ operation, modeling and analysis. Comparison with TCSC, IPFC – Block diagram, operation and comparison with UPFC	**11Hrs**
Unit-V	
Controllers and their co-ordination: Location of FACTS devices, Controller interactions – SVC–SVC interaction - co-ordination of multiple controllers using linear control techniques – Quantitative treatment of control coordination.; Coordination of FACTS with HVDC links	**11 Hrs**

Course Outcomes
After completing the course, the students will be able to:

CO1:	Understand the model and describe operation of different FACTS devices.
CO2:	Select and anlyze FACTS device for a given system.
CO3:	Design controller for various FACTS devices
CO4:	Implement the techniques for the interaction between different FACTS devices and HVDC links

Reference Books

1	Thyristor – Based FACTS Controllers for Electrical Transmission Systems, Mohan Mathur, R., Rajiv. K. Varma, 1st Edition, 2002, IEEE press and John Wiley & Sons, Inc, ISBN:978-0-471-20643-9.
2	FACTS Controllers in Power Transmission and Distribution, K.R.Padiyar, Reprint, 2008, New Age International (P) Ltd. Publishers, New Delhi, ISBN : 978-81-224-3989-2
3	Flexible AC Transmission System, A.T.John, 1st Edition, 1999, Institution of Electrical and Electronic Engineers (IEEE), ISBN: 978-0-85296-771-3
4	Understanding FACTS Concepts and Technology of Flexible AC Transmission System, NarainG.Hingorani, Laszio. Gyugyl, 1st Edition, 2001, Wiley-IEEE Press, ISBN : 978-81-224-3887-2

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: II						
BUSINESS ANALYTICS (Global Elective-G01)						
Course Code	**:**	**18CS2G01**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **08 Hrs**

Business Analytics

Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics.

Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling.

Unit – II **08 Hrs**

Trendiness and Regression Analysis

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

Unit – III **08 Hrs**

Organization Structures of Business analytics

Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, Predictive Analytics, Predicative Modelling, Predictive analytics analysis.

Unit – IV **08 Hrs**

Forecasting Techniques

Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.

Unit –V **07 Hrs**

Decision Analysis

Formulating Decision Problems, Decision Strategies with and without Outcome, Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

Course Outcomes

After going through this course the student will be able to:

CO1	Explore the concepts, data and models for Business Analytics.
CO2	Analyze various techniques for modelling and prediction.
CO3	Design the clear and actionable insights by translating data.
CO4	Formulate decision problems to solve business applications

Reference Books

1	Business Analytics Principles, Concepts, and Applications FT Press Analytics, Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, 1st Edition, 2014, ISBN-13: 978-0133989403, ISBN-10: 0133989402
2	The Value of Business Analytics: Identifying the Path to Profitability,Evan Stubs , John Wiley & Sons, ISBN:9781118983881 |DOI:10.1002/9781118983881, 1st Edition 2014
3	Business Analytics, James Evans, Pearsons Education 2nd Edition, ISBN-13: 978-0321997821 ISBN-10: 0321997824
4	Predictive Business Analytics Forward Looking Capabilities to Improve Business, Gary Cokins and Lawrence Maisel, Wiley; 1st Edition, 2013.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
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Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
INDUSTRIAL AND OCCUPATIONAL HEALTH AND SAFETY (Global Elective-G02)						
Course Code	**:**	**18CV2G02**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

UNIT – I	**7 Hrs**
Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and fire fighting, equipment and methods.	
UNIT – II	**9 Hrs**
Occupational health and safety: Introduction, Health, Occupational health: definition, Interaction between work and health, Health hazards, workplace, economy and sustainable development, Work as a factor in health promotion. Health protection and promotion Activities in the workplace: National governments, Management, Workers, Workers' representatives and unions, Communities, Occupational health professionals. Potential health hazards: Air contaminants, Chemical hazards, Biological hazards, Physical hazards, Ergonomic hazards, Psychosocial factors, Evaluation of health hazards: Exposure measurement techniques, Interpretation of findings recommended exposure limits. Controlling hazards: Engineering controls, Work practice controls, Administrative controls. Occupational diseases: Definition, Characteristics of occupational diseases, Prevention of occupational diseases.	
UNIT – III	**9 Hrs**
Hazardous Materials characteristics and effects on health: Introduction, Chemical Agents, Organic Liquids, Gases, Metals and Metallic Compounds, Particulates and Fibers, Alkalies and Oxidizers, General Manufacturing Materials, Chemical Substitutes, Allergens, Carcinogens, Mutagens, Reproductive Hazards, Sensitizers and Teratogens, Recommended Chemical Exposure Limits. Physical Agents, Noise and Vibration, Temperature and Pressure, Carcinogenicity, Mutagenicity and Teratogenicity. Ergonomic Stresses: Stress-Related Health Incidents, Eyestrain, Repetitive Motion, Lower Back Pain, Video Display Terminals.	
UNIT – IV	**7 Hrs**
Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.	
UNIT – V	**7 Hrs**
Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, over hauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.	

Course Outcomes
After successful completion of this course the student will be able to:

CO1	Explain the Industrial and Occupational health and safety and its importance.
CO2	Demonstrate the exposure of different materials, occupational environment to which the employee can expose in the industries.
CO3	Characterize the different type materials, with respect to safety and health hazards of it.
CO4	Analyze the different processes with regards to safety and health and the maintenance required in the industries to avoid accidents.

Reference Books

1.	Maintenance Engineering Handbook, Higgins & Morrow, SBN 10: 0070432015 / ISBN 13: 9780070432017, Published by McGraw-Hill Education. Da Information Services.
2.	H. P. Garg, Maintenance Engineering Principles, Practices & Management, 2009,S. Chand and Company, New Delhi, ISBN:9788121926447
3.	Fundamental Principles of Occupational Health and Safety, Benjamin O. ALLI, Second edition,2008 International Labour Office – Geneva: ILO, ISBN 978-92-2-120454-1
4.	Foundation Engineering Handbook, 2008, Winterkorn, Hans, Chapman & Hall London. ISBN:8788111925428.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
MODELING USING LINEAR PROGRAMMING (Global Elective-G03)						
Course Code	**:**	**18IM2G03**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**08 Hrs**
Linear Programming: Introduction to Linear Programming problem **Simplex methods:** Variants of Simplex Algorithm – Use of Artificial Variables	
Unit – II	**08 Hrs**
Advanced Linear Programming : Two Phase simplex techniques, Revised simplex method **Duality:** Primal-Dual relationships, Economic interpretation of duality	
Unit – III	**08 Hrs**
Sensitivity Analysis: Graphical sensitivity analysis, Algebraic sensitivity analysis - changes in RHS, Changes in objectives, Post optimal analysis - changes affecting feasibility and optimality	
Unit – IV	**08 Hrs**
Transportation Problem: Formulation of Transportation Model, Basic Feasible Solution using North-West corner, Least Cost, Vogel's Approximation Method, Optimality Methods, Unbalanced Transportation Problem, Degeneracy in Transportation Problems, Variants in Transportation Problems.	
Unit –V	**07 Hrs**
Assignment Problem: Formulation of the Assignment problem, solution method of assignment problem-Hungarian Method, Variants in assignment problem, Travelling Salesman Problem (TSP).	

Course Outcomes
After going through this course the student will be able to:

CO1	Explain the various Linear Programming models and their areas of application.
CO2	Formulate and solve problems using Linear Programming methods.
CO3	Develop models for real life problems using Linear Programming techniques.
CO4	Analyze solutions obtained through Linear Programming techniques.

Reference Books

1	Operation Research An Introduction, Taha H A, 8th Edition, 2009, PHI, ISBN: 0130488089.
2	Principles of Operations Research – Theory and Practice, Philips, Ravindran and Solberg - John 2nd Edition, 2000, Wiley & Sons (Asia) Pvt Ltd, ISBN 13: 978-81-265-1256-0
3	Introduction to Operation Research, Hiller, Liberman, Nag, Basu, 9th Edition, 2012, Tata McGraw Hill ISBN 13: 978-0-07-133346-7
4	Operations Research Theory and Application, J K Sharma, 4th Edition, 2009, Pearson Education Pvt Ltd, ISBN 13: 978-0-23-063885-3.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
PROJECT MANAGEMENT (Global Elective-G04)						
Course Code	**:**	**18IM2G04**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**08 Hrs**
Introduction: Project Planning, Need of Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS), Introduction to Agile Methodology.	
Unit – II	**08 Hrs**
Capital Budgeting: Capital Investments: Importance and Difficulties, phases of capital budgeting, levels of decision making, facets of project analysis, feasibility study – a schematic diagram, objectives of capital budgeting	
Unit – III	**08 Hrs**
Project Costing: Cost of Project, Means of Finance, Cost of Production, Working Capital Requirement and its Financing, Profitability Projections, Projected Cash Flow Statement, Projected Balance Sheet, Multi-year Projections, Financial Modeling, Social Cost Benefit Analysis	
Unit – IV	**08Hrs**
Tools & Techniques of Project Management: Bar (GANTT) chart, bar chart for combined activities, logic diagrams and networks, Project evaluation and review Techniques (PERT) Critical Path Method (CPM), Computerized project management	
Unit-V	**07 Hrs**
Project Management and Certification: An introduction to SEI, CMMI and project management institute USA – importance of the same for the industry and practitioners. PMBOK 6 - Introduction to Agile Methodology, Themes / Epics / Stories, Implementing Agile. **Domain Specific Case Studies on Project Management:** Case studies covering project planning, scheduling, use of tools & techniques, performance measurement.	

Course Outcomes
After going through this course the student will be able to:

CO1	Explain project planning activities that accurately forecast project costs, timelines, and quality.
CO2	Evaluate the budget and cost analysis of project feasibility.
CO3	Analyze the concepts, tools and techniques for managing projects.
CO4	Illustrate project management practices to meet the needs of Domain specific stakeholders from multiple sectors of the economy (i.e. consulting, government, arts, media, and charity organizations).

Reference Books

1	Project Planning Analysis Selection Financing Implementation & Review, Prasanna Chandra, 8th Edition, 2010, Tata McGraw Hill Publication, ISBN 0-07-007793-2.
2	A Guide to the Project Management Body of Knowledge (PMBOK Guide), Project Management Institute, 5th Edition, 2013, ISBN: 978-1-935589-67-9
3	Project Management A System approach to Planning Scheduling & Controlling, Harold Kerzner, 11th Edition, 2013, John Wiley & Sons Inc., ISBN 978-1-118-02227-6.
4	Project Management – Planning and Controlling Techniques, Rory Burke, 4th Edition, 2004, John Wiley & Sons, ISBN: 9812-53-121-1

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
ENERGY MANAGEMENT (Global Elective-G05)						
Course Code	**:**	**18CH2G05**		**CIE**	**:**	**100 Marks**
Credits L: T: P	**:**	**3:0:0**		**SEE**	**:**	**100 Marks**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit-I	**08 Hrs**

Energy conservation:
Principles of energy conservation, Energy audit and types of energy audit, Energy conservation approaches, Cogeneration and types of cogeneration, Heat Exchangers and classification.

Unit-II	**08 Hrs**

Wet Biomass Gasifiers:
Introduction, Classification of feedstock for biogas generation, Biomass conversion technologies: Wet and dry processes, Photosynthesis, Biogas generation, Factors affecting bio-digestion, Classification of biogas plants, Floating drum plant and fixed dome plant their advantages and disadvantages

Unit –III	**08 Hrs**

Dry Biomass Gasifiers :
Biomass energy conversion routes, Thermal gasification of biomass, Classification of gasifiers, Fixed bed systems: Construction and operation of up draught and down draught gasifiers.

Unit –IV	**08Hrs**

Solar Photovoltaic:
Principle of photovoltaic conversion of solar energy, Types of solar cells and fabrication.
Wind Energy:
Classification, Factors influencing wind, WECS & classification.

Unit –V	**07 Hrs**

Alternative liquid fuels:
Introduction, Ethanol production: Raw materials, Pre-treatment, Conversion processes with detailed flow sheet. Gasification of wood: Detailed process, Gas purification and shift conversion, Biofuel from water hyacinth.

Course Outcomes
After successful completion of this course the student will be able to:

CO1	Understand the use alternate fuels for energy conversion
CO2	Develop a scheme for energy audit
CO3	Evaluate the factors affecting biomass energy conversion
CO4	Design a biogas plant for wet and dry feed

Reference Books

1	Nonconventional energy, Ashok V Desai, 5th Edition, 2011, New Age International (P)Limited, ISBN 13: 9788122402070.
2	Biogas Technology - A Practical Hand Book, Khandelwal K C and Mahdi S S, Vol. I & II, 1986, McGraw-Hill Education, ISBN-13: 978-0074517239.
3	Biomass Conversion and Technology, Charles Y Wereko-Brobby and Essel B Hagan, 1st Edition, 1996, John Wiley & Sons, ISBN-13: 978-0471962465.
4	Solar Photovoltaics: Fundamental Applications and Technologies, C. S. Solanki, 2nd Edition, 2009, Prentice Hall of India, ISBN:9788120343863.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
INDUSTRY 4.0 (Global Elective-G06)						
Course Code	**:**	**18ME2G06**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
Introduction: Industrial, Internet, Case studies, Cloud and Fog, M2M Learning and Artificial Intelligence, AR, Industrial Internet Architecture Framework (IIAF), Data Management.	
Unit – II	**08 Hrs**
The Concept of the IIoT: Modern Communication Protocols, Wireless Communication Technologies, Proximity Network Communication Protocols, TCP/IP, API: A Technical Perspective, Middleware Architecture.	
Unit – III	**08 Hrs**
Data Analytics in Manufacturing: Introduction, Power Consumption in manufacturing, Anomaly Detection in Air Conditioning, Smart Remote Machinery Maintenance Systems with Komatsu, Quality Prediction in Steel Manufacturing. Internet of Things and New Value Proposition, Introduction, Internet of Things Examples, IoTs Value Creation Barriers: Standards, Security and Privacy Concerns. Advances in Robotics in the Era of Industry 4.0, Introduction, Recent Technological Components of Robots, Advanced Sensor Technologies, Artificial Intelligence, Internet of Robotic Things, Cloud Robotics.	
Unit – IV	**08 Hrs**
Additive Manufacturing Technologies and Applications: Introduction, Additive Manufacturing (AM) Technologies, Stereo lithography, 3DP, Fused Deposition Modeling, Selective Laser Sintering, Laminated Object Manufacturing, Laser Engineered Net Shaping, Advantages of Additive Manufacturing, Disadvantages of Additive Manufacturing. Advances in Virtual Factory Research and Applications, The State of Art, The Virtual Factory Software , Limitations of the Commercial Software	
Unit –V	**08 Hrs**
Augmented Reality: The Role of Augmented Reality in the Age of Industry 4.0, Introduction, AR Hardware and Software Technology, Industrial Applications of AR, Maintenance , Assembly, Collaborative Operations , Training. Smart Factories: Introduction, Smart factories in action, Importance, Real world smart factories, The way forward. A Roadmap: Digital Transformation, Transforming Operational Processes, Business Models, Increase Operational Efficiency, Develop New Business Models.	

Course Outcomes
After going through this course the student will be able to:

CO1	Understand the opportunities, challenges brought about by Industry 4.0 for benefits of organizations and individuals
CO2	Analyze the effectiveness of Smart Factories, Smart cities, Smart products and Smart services
CO3	Apply the Industrial 4.0 concepts in a manufacturing plant to improve productivity and profits
CO4	Evaluate the effectiveness of Cloud Computing in a networked economy

Reference Books

1	Industry 4.0 the Industrial Internet of Things, Alasdair Gilchrist, Apress Publisher, ISBN-13 (pbk): 978-1-4842-2046-7
2	Industry 4.0: Managing The Digital Transformation, Alp Ustundag, Emre Cevikcan, Springer, 2018 ISBN 978-3-319-57869-9.
3	Designing the industry - Internet of things connecting the physical, digital and virtual worlds, Ovidiu Vermesan and Peer Friess, Rivers Publishers, 2016 ISBN 978-87-93379-81-7

4	The concept Industry 4.0- An Empirical Analysis of Technologies and Applications in Production Logistics, Christoph Jan Bartodziej, Springer Gabler, 2017 ISBN 978-3-6581-6502-4.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
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Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
ADVANCED MATERIALS (Global Elective-G07)						
Course Code	**:**	**18ME2G07**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
Classification and Selection of Materials: Classification of materials. Properties required in Engineering materials, Criteria of selection of materials. Requirements / needs of advance materials.	
Unit – II	**08 Hrs**
Non Metallic Materials: Classification of n on metallic materials, Rubber: Properties, processing and applications. Plastics: Thermosetting and Thermoplastics, Applications and properties. Ceramics: Properties and applications. Adhesives: Properties and applications. Optical fibers: Properties and applications. Composites : Properties and applications.	
Unit – III	**08 Hrs**
High Strength Materials: Methods of strengthening of alloys, Materials available for high strength applications, Properties required for high strength materials, Applications of high strength materials	
Unit – IV	**08 Hrs**
Low & High Temperature Materials Properties required for low temperature applications, Materials available for low temperature applications, Requirements of materials for high temperature applications, Materials available for high temperature applications, Applications of low and high temperature materials.	
Unit –V	**08 Hrs**
Nanomaterials: Definition, Types of nanomaterials including carbon nanotubes and nanocomposites, Physical and mechanical properties, Applications of nanomaterials	

Course Outcomes
After going through this course the student will be able to:

CO1	Describe metallic and non metallic materials
CO2	Explain preparation of high strength Materials
CO3	Integrate knowledge of different types of advanced engineering Materials
CO4	Analyse problem and find appropriate solution for use of materials.

Reference Books

1	The Science & Engineering of Materials, Donald R. Askeland, and Pradeep P. Fulay, 5th Edition, Thomson, 2006, ISBN-13-978-0534553968
2	Nanotechnology, Gregory L. Timp, 1999th Editionmm Springer, 1999 ISBN-13: 978-0387983349
3	Material Science and Metallurgy, Dr. VD Kodgire and Dr. S V Kodgire, 42nd Edition 2018, Everest Publishing House ISBN NO: 81 86314 00 8
4	Processing and Fabrication of Advanced Materials, N Bhatnagar, T S Srivatsan, 2008, IK International, ISBN: 978819077702

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
COMPOSITE MATERIALS SCIENCE AND ENGINEERING (Global Elective-08)						
Course Code	**:**	**18CHY2G08**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**
Unit-I						**08 Hrs**

Introduction to composite materials

Fundamentals of composites – need for composites – Enhancement of properties – Classification based on matrix- Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Constituents of composites, Interfaces and Interphases, Distribution of constituents, Types of Reinforcements, Particle reinforced
composites, Fibre reinforced composites. Fiber production techniques for glass, carbon and ceramic fibers Applications of various types of composites.

Unit – II	**08 Hrs**

Polymer matrix composites (PMC)

Polymer resins – Thermosetting resins, Thermoplastic resins & Elastomers,
Reinforcement fibres-Types, Rovings, Woven fabrics. PMC processes – Hand Layup Processes, Spray up processes – Compression Moulding – Injection Moulding – Resin Transfer Moulding – Pultrusion – Filament winding – Injection moulding. Glass fibre and carbon fibre reinforced composites (GFRP & CFRP). Laminates- Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Mechanical Testing of PMC- Tensile Strength, Flexural Strength, ILSS, Impact Strength- As per ASTM Standard. Applications of PMC in aerospace, automotive industries**.**

Unit -III	**08 Hrs**

Ceramic matrix composites and special composites

Engineering ceramic materials – properties – advantages – limitations – monolithic ceramics
– need for CMC – ceramic matrix – various types of ceramic matrix composites- oxide ceramics – non oxide ceramics – Aluminium oxide – silicon nitride – reinforcements – particles- fibres- whiskers. Sintering – Hot pressing – Cold Isostatic Pressing (CIPing) – Hot isostatic pressing (HIPing). Applications of CMC in aerospace, automotive industries- Carbon /carbon composites – advantages of carbon matrix – limitations of carbon matrix carbon fibre – chemical vapour deposition of carbon on carbon fibre perform. Sol-gel technique- Processing of Ceramic Matrix composites.

Unit –IV	**07 Hrs**

Metal matrix composites

Characteristics of MMC, various types of metal matrix composites alloy vs. MMC, advantages of MMC, limitations of MMC, Reinforcements – particles – fibres. Effect of reinforcement – volume fraction – rule of mixtures. Processing of MMC – powder metallurgy process – diffusion bonding – stir casting – squeeze casting, a spray process,
Liquid infiltration In-situ reactions-Interface-measurement of interface properties- applications of MMC in aerospace, automotive industries.

Unit –V	**08 Hrs**

Polymer nano composites

Introduction and Significance of polymer Nano composites. Intercalated And Exfoliated Nanocomposites. Classification of Nano fillers- nanolayers, nanotubes, nanoparticles. Preparation of Polymer Nano composites by Solution, In-situ Polymerization and melt mixing techniques. Characterization Of polymer nanocomposites- XRD, TEM, SEM and AFM. Mechanical and Rheological properties of Polymer Nano composites. Gas barrier,

Chemical-Resistance, Thermal and Flame retardant properties of polymer nanocomposites.
Optical properties and Biodegradability studies of Polymer nanocomposites, Applications of polymer nano-composites.

Course Outcomes

After completing the course, the students will be able to:

CO1	Understand the purpose and the ways to develop new materials upon proper combination of known materials.

CO2	Identify the basic constituents of a composite materials and list the choice of materials available
CO3	Will be capable of comparing/evaluating the relative merits of using alternatives for important engineering and other applications.
CO4	Get insight to the possibility of replacing the existing macro materials with nano-materials.
Reference Books	
1	Composite Materials Science and Engineering, Krishan K Chawla, 3rd Edition Springer-verlag Gmbh,2012 , ISBN: 978-0387743646
2	The Science and Engineering of Materials, K Balani, Donald R Askeland, 6th Edition-Cengage, Publishers,2013, ISBN: 13: 978-8131516416
3	Polymer Science and Technology, Joel R Fried , 2nd Edition, Prentice Hall, 2014, ISBN: 13: 978-0137039555
4	Nanomaterials and nanocomposites, Rajendra Kumar Goyal , 2nd Edition, CRC Press-Taylor & Francis, 2010, ISBN: 10-9781498761666, 1498761666

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
PHYSICS OF MATERIALS (Global Elective-09)						
Course Code	**:**	**18PHY2G09**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**
Unit – I						**08 Hrs**
Crystal Structure Discussion of lattice and lattice parameters, seven crystals systems, crystal planes, Miller indices, Interplanar distance, Packing fraction, Structure of different crystals-NaCl and Diamond, Bragg's law, Powder method, Bragg's spectrometer, Qualitative Analysis of Crystal structure using XRD, Reciprocal lattice, Crystal defects-Point, Line, Planar and Volume defects.						
Unit – II						**08 Hrs**

Dielectric Materials

Basic concepts, Langevin's Theory of Polarisation, Types of Polarisation, Dipolar relaxation, Frequency Dependence of total polarization (polarizability as a function of frequency), Qualitative discussion of Internal Field and Claussius Mossotti, Dielectric loss spectrum, Dielectric strength, Dielectric Breakdown, Breakdown mechanisms in solid dielectrics, Applications of Solid Insulating materials in capacitors and Liquid insulating materials in Transformers, Dielectric Heating, Piezoelectricity, Direct and Inverse Piezoelectric effect,

Coupling factor, spontaneous polarization, Piezolelectricty in Quartz, Various piezoelectric materials-PZT, PVDF, Ferroelectricity, Barium titanate, Poling in Ceramics.

Unit – III	**08 Hrs**

Magnetic Materials

Review of Dia, Para and Ferromagnetic materials, Weiss theory of Ferromagnetism, Hysteresis effect, Magnetostriction, Anti-ferromagnetism, Ferrimagnetsim, Soft and Hard magnetic materials, examples and applications in Transformer cores and Magnetic storage devices, Superconductors, properties, Types of Superconductors, BCS theory, High Temperature Superconductors, Applications in Cryotron and SQUID.

Unit – IV	**07 Hrs**

Semiconducting Materials

Semiconductors-Direct and Indirect band gap semiconductors, Importance of Quantum confinement-quantum wires and dots, size dependent properties, Top down approach, Fabrication process by Milling and Lithography, Bottom up approach, fabrication process by vapour phase expansion and vapor phase condensation, Polymer semi-conductors-Photo conductive polymers, Applications.

Unit –V	**08 Hrs**

Novel Materials

Smart materials-shape memory alloys, Austenite and Martensite phase, Effect of temperature and mechanical load on phase transformation, Pseudoeleasticity, Transformation hysteresis, Superelasticity, Characterization technique-Differntial Scanning calorimetry, Preparation technique-spin coating, Nitinol, CuAlNi alloy and applications.

Biomaterials-Metallic, ceramic and polymer biomaterials, Titanium and Titanium alloys, Carbon nanotubes, Graphene- Properties and Applications.

Course Outcomes

After going through this course the student will be able to:

CO1	Apply the principles of Physics in Engineering.
CO2	Apply the knowledge of Physics for material analysis.
CO3	Identify and Analyze Engineering Problems to achieve practical solutions.
CO4	Develop solutions for Problems associated with Technologies.

Reference Books

1.	Solid State Physics, S O Pillai, 6th Edition, New Age International Publishers, ISBN 10-8122436978.
2.	Introduction to Solid State Physics, C.Kittel, 7th Edition, 2003, John Wiley & Sons, ISBN 9971-51-780
3.	Engineering Physics, Dr.M N Avadhanulu, Dr. P G Kshirsagar, S Chand Publishing, Reprint 2015.
4.	The Science and Engineering of Materials, Askeland, Fulay, Wright, Balanai, 6th Edition, Cengage Learning, ISBN-13:978-0-495-66802-2.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of

the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER : II						
ADVANCED STATISTICAL METHODS (Global Elective-G10)						
Course Code	**:**	**18MAT2G10**		**CIE Marks**	**:**	**100**
Credits L: T: P	**:**	**3:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**39L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**07 Hrs**
Sampling Techniques: Concepts of random sampling from finite and infinite populations, Simple random sampling (with replacement and without replacement), Sampling distribution of proportions, Expectation and standard error of sample mean and proportion, Sampling distributions of differences and sums.	
Unit – II	**08 Hrs**
Estimation: Point estimation, Estimator and estimate, Criteria for good estimates - unbiasedness, consistency, efficiency and sufficiency, Method of moment's estimation and maximum likelihood estimation, Confidence intervals-population mean (large sample).	
Unit – III	**08 Hrs**
Tests of Hypothesis: Principles of Statistical Inference, Formulation of the problems with examples. Simple and composite hypotheses. Null and alternative hypotheses. Tests - type I and type II error, Testing of mean and variance of normal population (one sample and two samples), Exact and asymptotic tests of proportions. Chi squared test for goodness of fit (Relevant case studies).	
Unit – IV	**07 Hrs**
Linear Statistical Models: Definition of linear model and types, One way ANOVA and two way ANOVA models-one observation per cell, multiple but equal number of observation per cell (Relevant case studies).	
Unit –V	**09 Hrs**
Linear Regression: Simple linear regression, Estimation of parameters, Properties of least square estimators, Estimation of error variance, Multivariate data, Multiple linear regressions, Multiple and partial correlation, Autocorrelation-introduction and plausibility of serial dependence, sources of autocorrelation, Durbin-Watson test for auto correlated variables.	

Course Outcomes
After going through this course the student will be able to:

CO1	Identify and interpret the fundamental concepts of sampling techniques, estimates and types, hypothesis, linear statistical models and linear regression arising in various fields engineering.
CO2	Apply the knowledge and skills of simple random sampling, estimation, null and alternative hypotheses, errors, one way ANOVA, linear and multiple linear regressions.
CO3	Analyse the physical problem to establish statistical/mathematical model and use appropriate statistical methods to solve and optimize the solution.
CO4	Distinguish the overall mathematical knowledge gained to demonstrate the problems of sampling techniques, estimation, tests of hypothesis, regression and statistical model arising in many practical situations.

Reference Books

1.	Fundamentals of Statistics (Vol. I and Vol. II), A. M. Goon, M. K. Gupta and B. Dasgupta, 3rd Edition, 1968, World Press Private Limited, ISBN-13: 978-8187567806.
2.	Applied Statistics and Probability for Engineers, Douglas C. Montgomery and George C. Runger, 6th Edition, John Wiley & Sons, 2014, ISBN:13 9781118539712, ISBN (BRV):9781118645062.
3.	Fundamentals of Mathematical Statistic-A Modern Approach, S.C. Gupta and V.K. Kapoor, 10th Edition, 2000, S Chand Publications, ISBN: 81-7014-791-3.
4.	Regression Analysis: Concepts and Applications, F. A. Graybill and H. K. Iyer, Belmont, Calif, 1994, Duxbury Press, ISBN-13: 978-0534198695.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SYLLABUS

FOR

SEMESTER III & IV

SEMESTER: III						
Programmable Logic Controller and SCADA (Theory and Practice)						
Course Code	**:**	**18MPE31**		**CIE Marks**	**:**	**100+50**
Credits L:T:P	**:**	**4:0:1**		**SEE Marks**	**:**	**100+50**
Hours	**:**	**52L+26P**		**SEE Duration**	**:**	**3 +3Hrs**

Unit – I **10Hrs**

Programmable Logic Controllers An Overview:
Programmable Logic Controllers ,Parts of a PLC ,Principles of Operation,Modifying the Operation ,PLCs versus Computers,PLC Size and Application.

PLC Hardware Components:
The I/O Section,Discrete,Analog and Special I/O Modules, Typical Discrete and Analog I/O Module Specifications, The Central Processing Unit(CPU), Memory Design,Memory Types, Programming Terminal Devices, Recording and Retrieving Data, Human Machine Interfaces (HMIs)

Unit – II **10Hrs**

Fundamentals of Logic:
The Binary Concept ,AND, OR, NOT and XOR Function, Boolean Algebra , Developing Logic Gate circuits, from Boolean Expressions, Producing the Boolean Equation for a Given Logic Gate Circuit, Hardwired Logic versus Programmed Logic, Programming Word Level Logic Instructions,

Basics of PLC Programming:
Processor Memory Organization, Program Files, Data Files,Program Scan,PLC Programming Languages,Relay-Type Instructions,Instruction Addressing,Branch Instructions,Internal Relay Instructions,Programming Examine If Closed and Examine If Open Instructions,Entering the Ladder Diagram, Modes of Operation.

Unit – III **12Hrs**

Developing Fundamental PLC Wiring Diagrams and Ladder Logic Programs :
Electromagnetic Control Relays, Contactors,Motor Starters,Manually Operated Switches,Mechanically Operated Switches, Output Control Devices,Seal-In Circuits,Latching Relays, Converting Relay Schematics into PLC, Ladder Programs, Writing a Ladder Logic Program, Directly from a Narrative Description

Programming Timers:
Mechanical Timing Relays**,** Timer Instructions,On-Delay Timer Instruction,Off-Delay Timer Instruction, Retentive Timer,Cascading Timers.

Interfacing with different sensors:
Proximity sensors Inductive, capacitive sensors, Photoelectric Sensors and Switches, Encoders, Temperature sensors, position and displacement sensors, pressure sensors.

Unit – IV **10Hrs**

Programming Counters:
Counter Instructions, Up-Counter, One-Shot Instruction,Down-Counter,Cascading Counters, Incremental Encoder-Counter, Applications, Combining Counter and Timer Functions

Program Control Instructions:
Master Control Reset Instruction,Jump Instruction,Subroutine Functions,Immediate Input and Immediate Output Instructions,Forcing External I/O Addresses,Safety Circuitry,Selectable Timed Interrupt ,Fault Routine,Temporary End Instruction,Suspend instruction.

Data Manipulation Instructions:
Data Manipulation, Data Transfer Operations, Data Compare Instructions,Data Manipulation Programs Closed-Loop Control, Math Instructions, Addition Instruction, Subtraction Instruction, Multiplication Instruction Division Instruction.

Unit – V **10Hrs**

SCADA System:
History of Critical Infrastructure Directives, SCADA System Evolution, Definitions and Basic Architecture,

SCADA Evolution, SCADA Definition, SCADA System Architecture, SCADA Applications, Redundancy as a Component of SCADA Security, SCADA System Desirable Properties.

SCADA Systems and its application:

Employment of SCADA Systems for various applications. (The Basic Refining Process, Nuclear Power Generation, The Boiling Water Reactor, The Pressurized Water Reactor, Conventional Electric Power Generation, Water Purification System , Crane Control)

SCADA Protocols:

Evolution of SCADA Protocols, Overview of the OSI Model, TCP/IP Model. MODBUS Model, DNP3 Protocol, UCA 2.0 and IEC61850 Standards, Controller Area Network, Device Net, Control Net , Ethernet/IP, Profibus

UNIT VI **Lab Component**	**2 Hrs / Week**

PLC & AUTOMATION LAB
Lab Component

1. Simulation and verification of operation of relays, switches and pushbuttons using PLC(Usage of Digital I/o Modules)
2. PLC Program on concept of latching and interlocking
3. Interfacing of different Proximity sensors like Capacitive, inductive and infrared sensors to PLC.
4. Speed control of dc motor using PLC(Usage of Analog I/O Modules)
5. Programs on Timers and Counters.
6. Simulation and verification of Starting of Three Phase induction Motors Via Star-Delta Starter.
7. Verification of pneumatic applications using PLC.
8. Speed control of ac servo motor using programmable logic controller.
9. PLC program on Tank filling device simulator(Using Universal Simulator)
10. PLC program on Selective band switch (Using Universal Simulator)
11. Experiments on HMI or SCADA
12. Open Ended Experiment (to be Designed Executed by Students)

Course Outcomes

After successful completion of this course the student will be able to:

CO1: Understand the basic concepts of PLC and SCADA systems.

CO2: Assess the control needs of a process industry and evaluate various options of using PLC or SCADA

CO3: Design and program the PLC to meet a specified control objective

CO4: Build a complete control system through integration of sensor with PLC

Reference Books

1.	Programmable Logic Controllers, Frank D. Petruzella, 4th Edition, 2010 McGraw-Hill Publisher, ISBN 13: 9780073510880
2.	Securing SCADA System, Ronald L. Krutz, 1st Edition, 2015, Wiley Publications, ISBN-10: 9788126557349.
3.	Programmable Logic Controllers, W.Bolton, 4th Edition, 2006, Elsevier ISBN-13: 978-0-7506-8112-4
4.	Programmable Logic Controllers: Programming Methods and Applications, John R. Hackworth and Frederick D. Hackworth Jr., 1stEdition, 2004, Pearson/Prentice Hall, ISBN-9780130607188.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative

methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE(Q+T+A) is 20+50+30=100 Marks.

Scheme of Continuous Internal Evaluation (CIE); Practical (50 Marks)
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the SEMESTER a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Scheme of SEMESTER End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of SEMESTER End Examination (SEE); Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

SEMESTER End Evaluation (SEE): Total marks: 100+50=150

Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)

SEMESTER: III						
INTERNSHIP						
Course Code	**:**	**18MPE32**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**0:0:5**		**SEE Marks**	**:**	**100**
Hours/week	**:**	**10**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1) The duration of the internship shall be for a period of 8 weeks on full time basis after II SEMESTER final exams and before the commencement of III SEMESTER.
2) The student must submit letters from the industry clearly specifying his / her name and the duration of the internship on the company letter head with authorized signature.
3) Internship must be related to the field of specialization of the respective PG programme in which the student has enrolled.
4) Students undergoing internship training are advised to report their progress and submit periodic progress reports to their respective guides.
5) Students have to present the internship activities carried out to the departmental committee and only upon approval by the committee, the student can proceed to prepare and submit the hard copy of the final internship report. However, interim or periodic reports as required by the industry / organization can be submitted as per the format acceptable to the respective industry /organizations.
6) The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.
7) The broad format of the internship final report shall be as follows
    - Cover Page
    - Certificate from College
    - Certificate from Industry / Organization
    - Acknowledgement
    - Synopsis
    - Table of Contents
    - Chapter 1 - Profile of the Organization : Organizational structure, Products, Services, Business Partners, Financials, Manpower, Societal Concerns, Professional Practices,
    - Chapter 2 -Activities of the Department
    - Chapter 3 - Tasks Performed : summaries the tasks performed during 8 week period
    - Chapter 4 – Reflections : Highlight specific technical and soft skills that you acquired during internship
    - References & Annexure

Course Outcomes

After going through the internship the student will be able to:

CO1: Apply engineering and management principles
CO2: Analyse real-time problems and suggest alternate solutions
CO3: Communicate effectively and work in teams
CO4: Imbibe the practice of professional ethics and need for lifelong learning.

Scheme of Continuous Internal Evaluation (CIE):

The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor. The committee shall assess the presentation and the progress reports in two reviews.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Explanation of the application of engineering knowledge in industries, ability to comprehend the functioning of the organization/ departments,	45%
Review-II	Importance of resource management, environment and sustainabilitypresentation skills and report writing	55%

Scheme for SEMESTER End Evaluation (SEE):
The SEE examination shall be conducted by an external examiner (domain expert) and aninternal examiner. Evaluation shall be done in batches, not exceeding 6 students per batch.

SEMESTER: III						
MAJOR PROJECT : PHASE-I						
Course Code	**:**	**18MPE33**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**0:0:5**		**SEE Marks**	**:**	**100**
Hours/week	**:**	**10**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1. The Major Project work comprises of Phase-I and Phase-II. Phase-I is to be carried out in third semester and Phase-II in fourth semester.
2. The total duration of the Major project Phase-I shall be for 16 weeks.
3. Major project shall be carried out on individual student basis in his/her respective PG programme specialization. Interdisciplinary projects are also considered.
4. The allocation of the guides shall be preferably in accordance with the expertise of the faculty.
5. The project may be carried out on-campus/industry/organization with prior approval from Internal Guide, Associate Dean and Head of the Department.
6. Students have to complete Major Project Phase-I before starting Major Project Phase-II.
7. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory colour for PG circuit Programs and Light Blue for Non-Circuit Programs.

Course Outcomes

After going through this course the students will be able to:

CO1: Conceptualize, design and implement solutions for specific problems.
CO2: Communicate the solutions through presentations and technical reports.
CO3: Apply project and resource managements skills, professional ethics, societal concerns
CO4: Synthesize self-learning, sustainable solutions and demonstrate life-long learning

Scheme of Continuous Internal Examination (CIE)

Evaluation shall be carried out in tworeviews. The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Selection of the topic, Literature Survey, Problem Formulationand Objectives	45%
Review-II	Methodology and Report writing	55%

Scheme for SEMESTER End Evaluation (SEE):

Major Project Phase-I evaluation shall be done by an external examiner (domain expert) and respective guide as per the schedule. Maximum of four candidates per batch shall be allowed to take examination. The batches are to be formed based on specific domain of work.

SEMESTER: III						
DIGITAL SYSTEM DESIGN (Professional Elective-E1)						
Course Code	**:**	**18MPE3E1**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10Hrs**
Review of Digital Logic Design Fundamentals: Development and evolution digital devices, design and verification tools. Abstraction levels of digital system design. Designing of combinational circuits. Design of sequential circuits- Finite State machine; mealy and moore machines. Sequential packages; .	
Unit – II	**10Hrs**
Design Development flow : Overview of PLDs and EDA Software: Introduction of PLDs, general FPGAs devices, Overview of the hardware platform, EDA Tools: Integrated software Environment, creation of design project and HDL codes, test-bench and perform the RTL simulation, RTL Design with HDLs: Combinational circuits design and verification, regular sequential circuits and components, Finite state machine(FSM), Finite State Machine with Datapath (FSMD) code development of FSMD- design examples, CPU design, Algorithmic state machine charts (ASM), code conversion of ASM	
Unit – III	**12Hrs**
Input / Output Modules: UART: Introduction, UART receiving subsystem, Oversampling procedure, Baud rate generator, UART receiver, Interface circuit, UART transmitting subsystem, Overall UART system, Complete UART core, example circuits. PS2: Introduction, PS2 receiving subsystem, Device-to-host communication protocol, Design and code, PS2 keyboard scan code, example circuits. External SRAM: Introduction, Specification of SRAM, Architectural Block diagram, Timing parameters, Timing requirement, Design ASMD chart, Timing analysis	
Unit – IV	**10Hrs**
Customized Hardware and Software: Special-purpose FSMD, general-purpose microcontroller, embedded microcontrollers. Xilinx'sPico Blaze Overview: Overview of Pico Blaze, Internal Architecture, Development flow, Instruction set, Programming model, Instruction format, Interfacing, Interrupt handling, KCPSM3 directives Pico Blaze Assembly Code Development: Development tools-Xilinx's KCPSM3 and PBlazeIDE - Assembler directives, useful code constructs, control structure, subroutine development, example programme and their verification through PBlaze IDE	
Unit – V	**10Hrs**
FPGA Implementation of Digital Circuits: Constraint files development, synthesis and implementation of HDL codes. Generation and downloading of the configuration file to a PLD device; Soft core microcontroller implementation: Picoblaze use in HDL design flow, implementation of programmed processor, development of SOPC.	

Course Outcomes

After successful completion of this course the student will be able to:

CO1: Formulate and solve problems in Sequential and combinational circuits
CO2: Design digital circuits using HDL
CO3: Implement digital systems using FPGA
CO4: Develop design flow for SOPC

Reference Books

1	Digital Design, Mano M. M. and Ciletti M. D., 4th Edition, 2008. Pearson Education, ISBN:9788131714508
2	Digital Systems Design Using VHDL, Charles H Roth Jr., 2nd Edition 1998, PWS Publishing Company, ISBN-13: 978-0-495-66776-6, ISBN: 0-495-66776-5
3	The Design Warrior's Guide to FPGAs – Devices, Tools and Flows, Maxfield C. M., 1st Edition, 2004, Newnes. ISBN-13: 978-0750676045, ISBN-10: 0750676043
4	Fundamentals of Digital Logic with VHDL Design, Brown S. and Vranesic Z., 3rd Edition., 2008, Tata McGraw-Hill Publishing Company Limited., ISBN:9781259025976

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of SEMESTER End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: III						
HIGH VOLTAGE DC TRANSMISSION (ProfessionalElective-E2)						
Course Code	**:**	**18MPE3E2**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I **10Hrs**

HVDC Power Transmission Technology: Historical sketch, existing HVDC projects, Classification of HVDC links, Components of HVDC transmission system, Comparison of AC and DC Transmission, Application of DC Transmission, Modern trends in DC Transmission, Ground Return- advantages and disadvantages. Choice of converter configuration.

Unit – II **10Hrs**

HVDC Converter: Introduction to line commutated converter, analysis of six and twelve pulse converter without overlap. Effect of smoothing reactor,. Two and three level voltage source converter, pulse width modulation. Analysis of converter two and three , three and four valve conduction. Conduction modes. 12 pulse detailed analysis

Unit – III **12Hrs**

Control of Converters And HVDC Link: Converter control characteristics, firing angle control,CEA control, Starting and stopping of DC link, Power control , frequency control. Reactive power control, tap changer control. Control of voltage source converter.

Converter Faults and Protection:

Converter faults, protection against over voltages, over currents in converter station. Surge arrester. Protection against faults in voltage source converter.

Unit – IV **10Hrs**

Smoothing Reactor and DC Line:

Smoothing reactors, effects of corona loss, DC line insulators, Transient over voltages in DC line, protection in DC line. Detection and protection of faults, DC breakers.

Reactive Power Control:

Reactive power control in steady state and transient state. Sources of Reactive power, SVC and STATCOM

Unit – V **10Hrs**

Power Flow Analysis in AC/DC System:

Introduction to DC system model, procedure, inclusion of constraints, Power flow analysis under dynamic conditions, power flow with VSC based HVDC system.

Introduction to stability concepts, analysis of voltage stability in asynchronous AC/DC system.

Multi Terminal DC System: Introduction, type, control and protection.

Course Outcomes

After successful completion of this course the student will be able to:

CO1: Understand the importance of modern long distance transmission technology, and related issues.
CO2: Analyze the control of converter and faults in the system
CO3: Evaluate the power control in AC/DC systems and its modelling
CO4: Design DC reactor, filters and transmission line as per the specifications.

Reference Books

1	Direct current Transmission,Kimbark E.W. Vol 1, Wiley Interscience,1971. ISBN 0471475807, 9780471475804
2	High Voltage Direct Current Power Transmission system- Technology and Systems Interactions, Padiyar K R , 1992, Wiley Eastern Ltd, ISBN-13: 978-1906574772
3	High voltage direct current transmission, Arrillage , 1st Edition, 1983, Peter pregrinus Ltd., London, ISBN 0906048974, 9780906048979
4	High voltage direct current power transmission, Adamson C Hingorani N G, Grraway ltd, London, 1960.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of SEMESTER End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: III						
NANO MATERIALS AND DEVICES (ProfessionalElective-E3)						
Course Code	**:**	**18MPE3E3**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**4:0:0**		**SEE Marks**	**:**	**100**
Hours	**:**	**52L**		**SEE Duration**	**:**	**3 Hrs**

Unit – I	**10Hrs**

Introduction: Nanotechnology: Background and definition of nanotechnology –Types of nanomaterials- Microstructure – Properties – Application in different fields – Reliability issues of MEMS/NEMS. Atomic bonding in solids: Metallic, Ionic, Covalent, Co-ordination/dative bonds; Vander Waals interactions/Electrostatic interactions: Ion pair interactions, solvent effects, Ion-dipole and dipole – dipole interactions, Hydrogen bonding - hydrophobic interactions. MO theory for simple molecules , Size effect of Nanomaterials: Size, shape, density, melting point, wet ability, specific surface area, solid state phase transformation and band gap variation - Quantum confinement, Effect of strain on band gap in epitaxial quantum dots.; .

Unit – II	**10Hrs**

Bonding in Nano-structures: Graphene , Fullerenes , Carbon nanotubes , Bonding in armchair, zigzag and chiral structures , n-m=3q rule , Inorganic nanotubes: Silica nanotubes, boron nitride nanotubes, nanotubes of dichalcogenides and nanotubes of metal oxides, Reactivity on nanosurfaces: Functionalization of carbon nanotubes and Graphene.

Unit – III	**12Hrs**

Nanoscale MOSFETs: Challenges in miniaturization, quantum effects, thin oxides, random dopant fluctuations, tunnelling and subthreshold currents, power density, hot electron effects, fundamental limits of MOS operations, MODFET (Modulation Doped FET), GaN based HEMT (High Electron Mobility Field Effect Transistors).

Unit – IV	**10Hrs**

Molecular Nanoelectronics: Molecular nanowires, organic LEDs, organic FETs, carbon nanotube and grapheme based FETs, Silicon nanowire based FETs, Nano-bioelectronics : DNA based biosensors, protein based biosensors, materials for biosensor applications, quantum dot based bio-imaging, DNA based logic and computing elements

Unit – V	**10Hrs**

Synthesis and characterization of Nanomaterials : Nanomaterials synthesis and applications , Chemical methods : Gas phase synthesis , Liquid phase synthesis , Plasma vapour deposition , Spray synthesis; Extrusion forging, ECAP, Characterization : Description of AFM/FFM and various measurement techniques, TEM.

Course Outcomes

After successful completion of this course the student will be able to:

CO1: Explain structure and bonding of Nanomaterials
CO2: Demonstrate knowledge of nanoelectronic devices and its applications
CO3: Synthesize and characterize nanomaterials
CO4: Use nano materials for industrial applications.

Reference Books

1	Materials Science, M.S.Vijaya,G.Rangarajan, 1st Edition, 2014, Published by McGraw Hill Education (2014) ISBN: 9780070534698
2	Materials Science and Engg., V.Ragavan, 1st Edition, 2015, Published by Prentice-Hall of India Pvt.Ltd, ISBN-10: 9788120350922
3	Nanoelectronics- principles and devices, M. Dragoman and D. Dragoman, 2nd Edition, 2008, Artech House publishers, ISBN-9781596933682.
4	Introduction to Nanotechnology, Charles P. Poole and Frank J. Owens, 1st Edition, 2003, John Wiley & Sons. ISBN-13: 978-0471079354.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

SEMESTER: IV						
MAJOR PROJECT : PHASE II						
Course Code	**:**	**18MPE41**		**CIE Marks**	**:**	**100**
Credits L:T:P	**:**	**0:0:20**		**SEE Marks**	**:**	**100**
Hours/Week	**:**	**40**		**SEE Duration**	**:**	**3 Hrs**

GUIDELINES

1. Major Project Phase-II is continuation of Phase-I.
2. The duration of the Phase-II shall be of 16 weeks.
3. The student needs to complete the project work in terms of methodology, algorithm development, experimentation, testing and analysis of results.
4. It is mandatory for the student to present/publish the work in National/International conferences or Journals
5. The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.

Course Outcomes

After going through this course the students will be able to:

CO1: Conceptualize, design and implement solutions for specific problems.
CO2: Communicate the solutions through presentations and technical reports.
CO3: Apply project and resource managements skills, professional ethics, societal concerns
CO4: Synthesize self-learning, sustainable solutions and demonstrate life-long learning

Scheme of Continuous Internal Examination (CIE)

Evaluation shall be carried out in threereviews. The evaluation committee shall consist of Guide, Professor /Associate Professor and Assistant Professor.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Review and refinement of Objectives, Methodology and Implementation	20%
Review-II	Design, Implementation and Testing	40%
Review-III	Experimental Result & Analysis, Conclusions and Future Scope of Work, Report Writing and Paper Publication	40%

Scheme for SEMESTER End Evaluation (SEE):

Major Project Phase-II SEE shall be conducted in two stages. This is initiated after fulfilment of submission of project report and CIE marks.

Stage-1Report Evaluation

Evaluation of Project Report shall be done by guide and an external examiner.

Stage-2Project Viva-voce

Major Project Viva-voce examination is conducted after receipt of evaluation reports from guide and external examiner.

Both Stage-1 and Stage-2 evaluations shall be completed as per the evaluation formats.

SEE procedure is as follows:

	Internal Guide	External Examiner	TOTAL	
SEE Report Evaluation	100 marks	100 marks		200 marks
			(A)	(200/2) = 100 marks
Viva-Voce	Jointly evaluated by Internal Guide & External Evaluator		(B)	100 marks
			Total Marks	**[(A)+(B)]/2 = 100**

SEMESTER: IV						
TECHNICAL SEMINAR						
Course Code	**:**	**18MPE42**		**CIE Marks**	**:**	**50**
Credits L:T:P	**:**	**0:0:2**		**SEE Marks**	**:**	**50**
Hours/Week	**:**	**4**		**SEE Duration**	**:**	**30 Mins**

GUIDELINES

1) The presentation shall be done by individual students.
2) The seminar topic shall be in the thrust areas of respective PG programs
3) The seminar topic could be complementary to the major project work
4) The student shall bring out the technological developments with sustainability and societal relevance.
5) Each student must submit both hard and soft copies of the presentation along with the report.
6) The reports shall be printed on A4 size with 1.5 spacing and Times New Roman with font size 12, outer cover of the report (wrapper) has to be Ivory color for PG circuit Programs and Light Blue for Non-Circuit Programs.

Course Outcomes

After going through this course the student will be able to:

CO1: Identify topics that are relevant to the present context of the world
CO2: Perform survey and review relevant information to the field of study.
CO3: Enhance presentation skills and report writing skills.
CO4: Develop alternative solutions which are sustainable

Scheme of Continuous Internal Evaluation (CIE): Evaluation shall be carried out in two reviews. The evaluation committee shall consist of Guide, Professor/Associate Professor and Assistant Professor.

The evaluation criteria shall be as per the rubrics given below:

Reviews	Activity	Weightage
Review-I	Selection of Topic, Review of literature, Technical Relevance, Sustainability and Societal Concerns, Presentation Skills	45%
Review-II	Technological Developments, Key Competitors, Report writing	55%

Scheme for SEMESTER End Evaluation (SEE):

The SEE examination shall be conducted by an external examiner and an internal examiner. Evaluation shall be done in batches, not exceeding 6 students per batch.