UNIVERSITY OF MUMBAI

Bachelor of Engineering

Mechanical Engineering

Third Year (Sem. V & VI) and Final Year (Sem. VII & VIII)

Revised Syllabus (REV- 2012) w. e. f. Academic Year 2014 - 15 and 2015-2016 respectively

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

Deans Preamble

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

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

Semester based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande
Dean,
Faculty of Technology,
Member - Management Council, Senate, Academic Council
University of Mumbai, Mumbai

Chairman Preamble

Engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

As the Chairman, Board of Studies in Mechanical Engineering of University of the Mumbai, I am happy to state here that, the Program Educational Objectives were finalized in a brain storming session, which was attended by more than 20 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Mechanical Engineering. The Program Educational Objectives finalized for the undergraduate program in Mechanical Engineering are listed below;

1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals.
2. To prepare the Learner to use modern tools effectively in order to solve real life problems.
3. To prepare the Learner for a successful career in Indian and Multinational Organisations and to excel in their Postgraduate studies.
4. To encourage and motivate the Learner in the art of self-learning.
5. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process.

In addition to the above, 2 to3 more program educational objectives of their own may be added by affiliated Institutes.

In addition to Program Educational Objectives, for each course of undergraduate program, objectives and expected outcomes from the point of view of a learner are also included in the curriculum to support the philosophy of outcome based education. I strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stake holders.

Dr. S. M. Khot

Chairman, Board of Studies in Mechanical Engineering, University of Mumbai

B. E. Mechanical-(Semester VII)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
MEC701	Machine Design -II	4	2	4	1	5
MEC702	CAD/CAM/CAE [&]	4	2	4	1	5
MEC703	Mechanical Utility Systems	4	2	4	1	5
MEC704	Production Planning and Control	4	2	4	1	5
MEE701X	Elective- I	3	2	3	1	4
MEP701	Project- I	--	6[#]	--	3	3
Total		**19**	**16**	**19**	**8**	**27**

Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
MEC701	Machine Design- II	20	20	20	80	03	25	25	150
MEC702	CAD/CAM/CAE[&]	20	20	20	80	03	25	25	150
MEC703	Mechanical Utility Systems	20	20	20	80	03	25	--	125
MEC704	Production Planning and Control	20	20	20	80	03	25	25*	150
MEE701X	Elective -I	20	20	20	80	03	25	--	125
MEP701	Project- I	--	--	--	--	--	50	--	50
Total		**--**	**--**	**100**	**400**	**--**	**175**	**75**	**750**

[&] Common with Automobile Engineering *** Only ORAL examination based on term work and syllabus**

B. E. Mechanical-(Semester VIII)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
MEC801	Design of Mechanical Systems	4	2	4	1	5
MEC802	Industrial Engineering and Management	4	2	4	1	5
MEC803	Refrigeration and Air Conditioning	4	2	4	1	5
MEE802X	Elective- II	3	2	3	1	4
MEP802	Project- II	--	12[#]	--	6	6
Total		**15**	**20**	**15**	**10**	**25**

Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
MEC801	Design of Mechanical Systems	20	20	20	80	03	25	25	150
MEC802	Industrial Engineering and Management	20	20	20	80	03	25	--	125
MEC803	Refrigeration and Air Conditioning	20	20	20	80	03	25	25	150
MEE802X	Elective -II	20	20	20	80	03	25	--	125
MEP802	Project- II	--	--	--	--	--	50	100	150
Total		**--**	**--**	**80**	**320**	**--**	**150**	**150**	**700**

* Only ORAL examination based on term work and syllabus

# indicates work load of Learner (Not faculty) in VII and VIII semester for Project

Project –I and II: Students groups and load of faculty per week
Project Groups: Students can form groups with minimum 2 (Two) and not more than 4 (Four)
Faculty Load : In semester VII 1/2 hour per week per project group
In semester VIII 1 hour per week per project group
Each faculty is permitted to take (guide) maximum 4 (Four) project groups.

Course codes	**Elective I**	Course codes	**Elective II**
MEE7011	Product Life Cycle Management (PLM)	MEE8021	Micro Electro Mechanical Systems (MEMS)
MEE7012	Power Plant Engineering [&]	MEE8022	Renewable Energy Sources
MEE7013	Energy Management	MEE8023	Project Management [&]
MEE7014	Supply Chain Management [&]	MEE8024	Business Process Reengineering
MEE7015	Computational Fluid Dynamics [&]	MEE8025	Cryogenics
MEE7016	Advanced Turbo Machinery	MEE8026	Automobile Engineering
MEE7017	Piping Engineering	MEE8027	Process Equipment Design
MEE7018	Emission and Pollution Control	MEE8028	Alternative Fuels
MEE7019	Operations Research	MEE8029	Enterprise Resource Planning
MEE70110	Total Productive Maintenance (TPM)	MEE80210	World Class Manufacturing [&]
MEE70111	Robotics	MEE80211	Nanotechnology
MEE70112	Digital Prototyping for Product Design –I	MEE80212	Digital Prototyping for Product Design –II

[&] Common with Automobile Engineering

Course Code	Course/Subject Name	Credits
MEC801	**Design of Mechanical Systems**	**4+1**

Objectives

1. To study system concepts and methodology of system design.
2. To study system design of various systems such as snatch block, belt conveyors, engine system, pumps and machine tool gearbox.

Outcomes: Learner will be able to…

1. Design material handling systems such as hoisting mechanism of EOT Crane, belt conveyors.
2. Design engine components such as cylinder, piston, connecting rod and crankshaft from system design point of view.
3. Design pumps for the given applications.
4. Prepare layout of machine tool gear box and select number of teeth on each gear.

Modules	Detailed Content	Hrs.
01	Methodology & Morphology of design. Optimum design, System concepts in design.	**04**
02	Design of Hoisting mechanism: Design of Snatch Block assembly including Rope selection, Sheave, Hook, Bearing for hook, cross piece, Axle for sheave and shackle plate, Design of rope drum, selection of motor with transmission system.	**10**
03	Design of belt conveyors-- Power requirement, selection of belt, design of tension take up unit, idler pulley.	**06**
04	Engine Design (Petrol & Diesel): Design of Cylinder, Piston with pin and rings, Connecting Rod & Crank Shaft with bearings.	**10**
05	**Design of pump :** **Design of main components of gear pump:** 1. Motor selection 2. Gear design 3. Shaft design and bearing selection 4. Casing and bolt design 5. Suction and delivery pipe. **Design of main components of centrifugal pump:** 1.Motor selection 2. Suction and delivery pipe 3.Design of Impeller, Impeller shaft, 4. Design of Volute casing.	**10**
06	Design of gear boxes for machine tool applications (Maximum three stages and twelve speeds): Requirements of gear box, determination of variable speed range, graphical representation of speeds, structure diagram, ray diagram, selection of optimum ray diagram, estimation of numbers of teeth on gears, deviation diagram, layout of gear box.	**08**

Term Work

Term work shall comprise of

1. Exercises on the above topics in the form of design calculations with sketches and or drawings.
2. Design and detailed assembly drawing (Computer aided drawing on **A- 3 size sheets**) of minimum two design problem, from the module 2, 3 and 5.
3. **Course project**: There will be a course project where the students will be able to apply and integrate the knowledge gained during the course. The projects will be developed by teams of Two to Four students and will consist of design of any system studied during the course.

The distribution of term work marks shall be as follow:

- Exercises & Drawing Sheets : 15 Marks
- Course Projects : 05 Marks
- Attendance (Theory & Practical) : 05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Note

Use of standard design data books like PSG Data Book , Design Data by Mahadevan, Engine Design data book by Kale & Khandare are permitted at the examination and shall be supplied by the college.

Internal Assessment

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

Practical/Oral Examination

Students will be given small task of design which may be the part of term work, which will be assessed by examiners and oral examination.

The distribution of marks for oral-practical examination shall be as follows:

Design Task …… 15 marks
Oral …… 10 marks

1. Evaluation of practical/oral examination to be done based on the performance of design task.
2. Students work along with evaluation reportto be preserved till the next examination

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1) Shigley J.E. and Mischke C.R., "Mechanical Engineering Design", McGraw Hill Pub. Co. Ltd.
2) M.F.Spotts – 'Mechanical design analysis' Prentice Hall Inc.
3) Bhandari V.B., "Design of Machine Elements", Tata McGraw Hill Pub. Co. Ltd.
4) Black P.H. and O. Eugene Adams, "Machine Design", McGraw Hill Book Co. Inc.
5) "Design Data", P.S.G. College of Technology, Coimbatore.
6) I.S. : 2825 Code for unfired pressure vessels.
7) Johnson R.C., "Mechanical Design Synthesis with Optmisation Applications", Von-Nostrand-Reynold Pub.
8) Dieter G.E., "Engineering Design", McGraw Hill Inc.
9) S.K. Basu and D.K. Pal – 'Design of machine tools', Oxford and IBH Pub. Co.
10) N.K.Mehta – 'Machine tool design' Tata McGraw Hill Pub. Co.
11) S.P. PATIL – 'Mechanical System Design' JAICO students Ed., JAICO Publishing House, Delhi
12) Rudenko – 'Material Handling Equipment' M.I.R. publishers, Moscow

Course Code	Course/Subject Name	Credits
MEC802	**Industrial Engineering and Management**	**4+1**

Objectives

1. To introduce the students to the concept of integration of various resources and the significance of optimizing them in manufacturing and allied Industries.
2. To acquaint the students with various productivity enhancement techniques.
3. To introduce the concepts of various cost accounting and financial management practices as applied in industries.

Outcomes: The learner will be able to**…**

1. Illustrate the need for optimization of resources and its significance in manufacturing industries, in order to enhance overall productivity.
2. Develop capability in integrating knowledge of design along with other aspects of value addition in the conceptualization and manufacturing stage of various products.
3. Demonstrate the concept of value analysis and its relevance.
4. Manage and implement different concepts involved in methods study and understanding of work content in different situations.
5. Describe different aspects of work system design and facilities design pertinent to manufacturing industries.
6. Identify various cost accounting and financial management practices widely applied in industries.

Modules	Detailed contents	Hrs.
01	**Introduction to Industrial Engineering.** History and contribution, Industrial engineering approach, techniques of industrial engineering, objectives of industrial engineering, system approach to industrial engineering, definition and concept of productivity, productivity measurements, factors influencing productivity and productivity improvement techniques.	**06**
02	**Value Engineering and Value Analysis:** Distinction between value engineering & value analysis and their significance. Steps in value engineering & analysis and Check lists.	**05**
03	**Work study:** Method study, micro-motion study and principles of motion economy. Work measurement: time study, work sampling, standard data, PMTS; MOST.	**10**
04	**Work system design:** Introduction to ergonomics and its scope in relation to work. Outline of the discipline of anatomy, physiology and psychology, with respect to ergonomics building blocks such as anthropometry and biomechanics. Job evaluation, merit rating, incentive schemes, wage administration and business process reengineering.	**08**
05	**5.1 Facility Design:** Facility location factors and evaluation of alternate locations; types of plant layout and their evaluation; computer aided layout design techniques; assembly line balancing; materials handling systems. 5.2 **Concepts of Group Technology and cellular manufacturing**	**09**

06	**6.1 Cost accounting:** Elements of cost, cost sheet, job costing and marginal costing. **6.2 Financial management:** Methods of depreciation, time value of money and techniques for evaluation of capital investments. Introduction to financial statements only.	**10**

Term Work

Term work shall consist of

1. One seminar presentation on a topic selected from the syllabus, with its significance explained as in a live situation in the industry, as applicable.
2. Assignments: On topics drawn from syllabus [At least 1 assignment per module].
3. Course Project: One Case study on value analysis of a live component from industry in a group of not more than 3 students.

The distribution of marks for term work shall be as follows:

- Laboratory work (Experiment/ programs and journal): 10 marks
- Course Project: 10 marks
- Attendance (Theory and Practical): 05 marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal Assessment

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Introduction to Work study, ILO, Geneva, and Oxford & IBH Pub. Co. Pvt. Ltd.
2. Ergonomics at Work, Murrell.
3. Plant Layout and Material Handling, James M. Apple, John Wiley & Sons.
4. Facility Layout and Location – An Analytical Approach, Richard L. Francis & John A. White, Prentice Hall.
5. Production Systems Planning Analysis & Control, James L. Riggs, John Wiley & Sons.
6. Modern Production / Operations Management, Elwood S. Buffa, Rakesh K. Sarin, John Wiley & Sons.
7. Production Planning and Control, Samuel Elion.
8. Production and Operations Management, Joseph G. Monks

Course Code	Course/Subject Name	Credits
MEC803	**Refrigeration and Air Conditioning**	**4+1**

Objectives

1. To study working and operating principles of Vapour Compression and Vapour Absorption system
2. To study components of refrigeration and air conditioning systems
3. To Design air conditioning systems using cooling load calculations.

Outcomes: Learner will be able to…

1. Discuss fundamental refrigeration and air conditioning principles
2. Identify and locate various important components of the refrigeration and air conditioning system
3. Illustrate various refrigeration and air conditioning processes using psychometric chart
4. Design and analyze complete air conditioning system

Module	Detailed Contents	Hrs.
01	**Introduction to Refrigeration:** Methods of refrigeration, First and Second Law applied to refrigerating machines, Carnot refrigerator, Carnot heat pump, unit of refrigeration, Co-efficient of Performance, Energy Efficiency Ratio (EER), BEE star rating **Air refrigeration systems:** Bell Colemon cycle, applications. **Aircraft air refrigeration systems:** Need for aircraft refrigeration, Simple, Bootstrap including evaporative cooling, Reduced ambient, Regenerative air cooling system, Comparison of these systems based on DART rating.	08
02	**Vapor Compression Refrigeration System:** Simple vapor compression cycle, Effect of liquid subcooling & superheating, effect of evaporator and condenser pressures, methods of subcooling, use of P-h charts, Actual VCR cycle, Two stage VCR cycle with Water intercooler, flash intercooler & liquid sub-cooler, multi-evaporators at different temperatures with individual/compound compressors and individual/multiple expansion valves. Types of condensers, evaporators, expansion devices and Compressors. Use of enhanced surface tubes in Heat Exchangers. Cooling tower: Types of cooling towers, tower approach, tower range, tower efficiency, tower losses, tower maintenance. **Refrigerants**- Desirable properties of refrigerants, ASHRAE numbering system for refrigerants. Thermodynamic, Chemical and Physical properties. Secondary refrigerants, ODP and GWP, Montreal protocol and India's commitment, Recent substitutes for refrigerants.	12
03	**Vapor Absorption Refrigeration.** Importance of VAR system, COP of ideal VAR system, Amonia-water VAR system, Lithium Bromide – Water VAR system, Single and double effect, Electrolux refrigeration system. Solar VAR system. **Nonconventional Refrigeration Systems** : Thermoelectric Refrigeration, Thermoacoustic Refrigeration, Vortex Tube Refrigeration	06

04	**Psychrometry** Need for air conditioning, Principle of psychromerty, Psychrometric properties, chart and processes, air washers, requirements of comfort air conditioning, summer and Winter Air conditioning.	05
05	**Design of air conditioning systems** Different Heat sources,- Adiabatic mixing of two air streams, Bypass factor, sensible heat factor, RSHF, GSHF, ERSHF, Room apparatus dew point and coil apparatus dew point, Ventilation and infiltration, Inside and Outside Design condition, Cooling Load estimation , Introduction to Unitary Products viz. Room/Split and Packaged Air Conditioners, Introduction to recent developments viz. Variable Refrigerant Flow systems, VAV control systems, Inverter Units. Human Comfort, Thermal exchange of body with environment, Effective temperature, Comfort chart, Comfort zone.	08
06	**Duct Design and Applications** Friction chart for circular ducts. Equivalent diameter of a circular duct for rectangular ducts, Static pressure regain and equal pressure drop methods of duct design,Factors considered in air distribution system, Air distribution systems for cooling & heating, Controls – LP/HP cutoff, Thermostats, Humidistats, Interlocking control, Electronic Controllers. Applications Refrigeration & A/C Ice plant – food storage plants – diary and food processing plants, Food preservation ,Freeze Drying, A/c in textile ,printing pharmaceutical industry and Hospitals , Liquefaction of LNG, Liquefaction of gases (cryogenics), Deep sea water air-conditioning.	09

List of Experiments

1. Study of domestic refrigerator along with wiring diagram
2. Study of the procedure of leak detection, evacuation and charging of refrigerant
3. Trial on window air conditioner or Air Conditioning Test Rig
4. Trial on water cooler or Refrigeration Test Rig
5. Trial on cooling tower
6. Study of humidification and dehumidification, heating and cooling, mixing of two air streams.
7. Report on different protocols to regulate global warming
8. Visit report- Refrigeration establishment like Cold storage plant or ice plant or air-conditioning plant
9. Steady state Simulation of VCR system with developed code or any analytical software

Term Work

Term work shall consist of minimum **six** experiments, assignments consisting numerical based on above syllabus, at least 3 numerical from each module.

The distribution of marks for term work shall be as follows:

- Laboratory work **: 10 marks**
- Assignments : **10 marks**
- Attendance (Theory and Practical) **: 05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal Assessment

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

Practical/Oral examination

1. Practical examination shall be conducted in a group of not more than 5 students. Examination shall be based on actual trials performed during the semester. Students are expected to actually take reading and plot the performance characteristics and comment.
2. Examiners are expected to evaluate results of each group and conduct oral based on the curriculum of the course.
3. The distribution of marks for practical/oral examination shall be as follows:
    i. Practical performance …… 15 marks
    ii. Oral …… ……. .10 marks
4. Students work along with evaluation report to be preserved till the next examination

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Refrigeration and air-conditioning – C P Arora, *TMH*
2. Principles of refrigeration – R J Dossat, *Willey Eastern Publication*
3. Refrigeration and air-conditioning – W F Stoker and J W Jones, *TMH*
4. Modern Air-conditioning practice – C P Arora, *TMH*
5. Refrigeration and air-conditioning- Manohar Prasad, *New Age Int (P) Ltd.*
6. Basic Refrigeration and air-conditioning- P.Ananthanarayana, TMH
7. ASHRAE Handbook of Fundamentals
8. ASHRAE Handbook of Systems
9. ASHRAE Handbook of Equipment
10. ISHRAE Air Conditioning Handbook
11. ISHRAE Refrigeration Handbook

Course Code	Course/Subject Name	Credits
MEE8021	**Micro Electro Mechanical Systems (MEMS)**	**3+1**

Objectives

1. To acquaint with micro electro mechanical systems.
2. To study fabrication methodology, modelling and simulation and characterization techniques of MEMS system

Outcomes: Learner will be able to…

1. Illustrate working and importance of MEMS system
2. Describe fabrication methodology of MEMS system
3. Illustrate Modeling and Simulation Techniques of MEMS system
4. Describe Characterization Techniques of MEMS system

Module	Details	Hrs.
01	**Introduction to MEMS & Applications** • Introduction to Micro-Electro-Mechanical Systems, • Applications and Materials, • Advantages & Disadvantages of Micro-sensors, and micro-actuators.	03
02	**Sensors and Actuators in Micro-domain** • Concept of Sensors & Actuators, • Sensing & Actuation Principles: Mechanical Sensing, Capacitive, • Electrostatic, Electromagnetic, Piezo Resistive, Piezo Electric, Thin Films, Shape Memory Alloys • Comb Drive Actuation & Sensing. Micro-mechanisms, Air-Bag Sensors, Chemical Sensors • Sensors & Actuators for Automotive, Biomedical, Industrial applications • Design of sensor and actuator for few applications such as automobile accelerometer, bimetallic temperature sensor, etc.	06
03	**Fabrication Methods** Microfabrication Methods (VLSI Techniques) • Positive and Negative Photoresists, • Bulk Micromachining, • Surface Micromachining, • Etching (Isotropic and Anisotropic), • Deposition techniques such as CVD (Chemical Vapor Deposition),Metallization Techniques. 3D High Aspect Ratio Techniques • LIGA,AMANDA, • Microstereolithography, • IH-Process, • X-Ray Techniques, • Ion-beam Lithography, Bulk Lithography (layer-less 3D microfabrication)	09
04	**Modelling and Simulation Techniques** • Scaling Laws, Governing Equations • Modelling of Mechanical Structures via classical methods, Newtons Laws, Thermal Laws, Fluid Flow Analysis • Micro-mechanism modelling and analysis techniques : Lumped Parameter Modelling and Distributed Parameter Modeling • Modelling of Micro-channel as heat exchanger, accelerometers, microhinges, compound microstructures. • Numerical Methods used for MEMS analysis.	08

05	**Characterization Techniques** **Topography Methods** (Optical, Electrical and Mechanical Methods) • Microscopy, STM (Scanning Tunneling Microscopes), • SEM (Scanning Electron Microscopes), AFM (Atomic Force Microscopes) **Mechanical Structure Analysis** • Deformation & Vibration Measurement Techniques (Piezo resistive and piezo electric) **Interferometry Techniques,** • ESPI (Electronic Speckle Pattern Interferometry), • Laser Techniques, Laser Doppler Vibro-meters, **Fluid, Thermal and Chemical Techniques** • Fluid Flow Pattern Analysis, Electro-chemical Analysis, • PIV Techniques • Spectroscopy	06
06	**Introduction to Nanotechnology** • CNT (Carbon Nano Tubes) Applications, its properties, and Fabrication Method, • Nano-mechanical Systems (NEMS), • Nano-tribology, & nano-indentation techniques, • Domestic and Industrial Applications of nanotechnology	04

Term Work

Term work shall consist of 06 design based assignment (one assignment on each module) and two case studies of MEMS.
(Design based assignment shall encourage use of recent literature for the development of MEMS or microstructure.)

The distribution of marks for term work shall be as follows:

- Assignments : 15 Marks
- Case studies : 05 Marks
- Attendance (Theory & Practical's) : 05 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal Assessment

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Julian W. Garden, Vijay K. Varadan and Osama O. Awadelkarim “Microsensors MEMS and Smart devices”, John Wiley and sons, Ltd.
2. NadimMulaf and Kirt Williams, “An Introduction to Microelectromechanical systems Engineering”, Artech House.
3. NicolaeLobontiu and Ephrahim Garcia, “Mechanics of Microelectromechanical systems”, Kluwer Academic Publication.
4. Stanley Wolf and Richard Tauber, “Silicon Processing for the VLSI era Volume -1 Technology”, Lattice press.
5. Vijay K. Varadan, K.J.Vinoy and S. Gopalkrishnan, “Smart Material Systems and MEMS: Design and Development Methodologies”, John Wiley and sons Ltd.
6. Bhushan, “Springer Handbook of Nanotechnology”, Springer Inc.

Course Code	Course/Subject Name	Credits
MEE 8022	**Renewable Energy Sources**	**3+1**

Objectives

1. Study working principles of various renewable energy sources and their utilities
2. Study economics of harnessing energy from renewable energy sources

Outcomes: Learner will be able to…

1. Demonstrate need of different renewable energy sources and their importance
2. Calculate and analyse utilization of solar and wind energy
3. Illustrate design of biogas plant
4. Estimate alternate energy sources India

Module	Detailed Contents	Hrs.
01	**Introduction to Energy Sources**: Renewable and non-renewable energy sources, energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements Global and National scenarios, Prospects of renewable energy sources.	04
02	**Solar Energy**: Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length. flat plate collectors, concentrating collectors, Solar air heaters-types, solar driers, storage of solar energy-thermal storage, solar pond , solar water heaters, solar distillation, solar still, solar cooker, solar heating & cooling of buildings, photo voltaic - solar cells & its applications.	06
03	**Wind Energy**: Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of Aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations.	08
04	**Energy from Biomass**: Biomass conversion technologies, Biogas generation plants, classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of bio gas, utilization of biogas.	06
05	**Geothermal Energy**: Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dry rock, magma. Advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India. **Energy from the ocean**: Ocean Thermal Electric Conversion (OTEC) systems like open cycle, closed cycle, Hybrid cycle, prospects of OTEC in India. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy	08
06	**Energy Management**: Energy economics, energy conservation, energy audit, general concept of total energy system, scope of alternative energy system in India.	04

List of Experiments

1. Demonstration of solar collector for air/water heating
2. Visit to wind farm/biogas plant

Term Work

Term work shall consist of experiments from the list, 5 assignments covering maximum portion of the syllabus and a report on factory visit

The distribution of marks for term work shall be as follows:

- Laboratory work (Experiments) **:** **05 marks**
- Assignments : **10 marks**
- Visit report: **05 marks**
- Attendance (Theory and Practical) **:** **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal Assessment

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Non-conventional energy sources by G.D. Rai, Khanna Publishers
2. Solar Energy: Principles of Thermal Collection and Storage by S,P Sukhatme, Tata McGraw Hill
3. Solar Engineering of Thermal processes, J.A.Duffie and W.A.Beckman, 2nd edition, John Wiley, New York, 1991.
4. Fuel Cells by Bockris and Srinivasan; McGraw Hill.
5. Solar Energy: Fundamentals and Applications by H.P. Garg& Jai Prakash, Tata McGraw Hill.
6. Wind Power Technology, Joshua Earnest, PHI Learning, 2014
7. Non Conventional Energy Resources by S. Hasan Saeed and D. K. Sharma, S. K. Kataria& Sons.
8. Renewable Energy Sources, J W Twidell& Anthony D. Weir. ELBS Pub.
9. Energy Conversion Systems, R D Begamudre, New Age International (P) Ltd., Publishers, New Delhi ,2000.
10. Principles of Solar Engineering, D.Y.Goswami, F.Kreith and J.F.Kreider, Taylor and Francis, Philadelphia, 2000.
11. Solar Photovoltaics: Fundamentals, Technologies and Applications, C S Solanki, 2nd Edition, PHI Learning, 2013
12. Biomass Regenerable Energy, D. D. Hall and R. P. Grover, John Wiley, New York,1987.
13. Wind and Solar Power Systems, Mukund R Patel, CRC Press, 1999.
14. Wind Energy Explained: Theory, Design and Application, J F Manwell, J.C.McGowan, A.L.Rogers, John Wiley and Sons, May 2002.
15. Magneto Hydrodynamics by Kuliovsky and Lyubimov, Addison.

Course Code	Course/Subject Name	Credits
MEE8023	**Project Management[&]**	**3+1**

[&] Common with Mechanical Engineering

Objectives

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To apprise the students with the project management lifecycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to..

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference.

Module	Details	Hrs.
01	**Project Management Foundations** Definition of project management, project manager and project. Project types, project phases and knowledge areas.	**04**
02	**Initiating Projects** How to get a project started; Your project sponsor and creating charter; The project team and team dynamics; running meetings	**06**
03	**Planning Projects** Project estimating and scheduling techniques. PERT, CPM, GANTT chart. Introduction to any one project scheduling software.	**08**
04	**Planning Projects** Risk planning methods; Cost planning; Communication plan and Final project plan.	**04**
05	**Executing Projects** 5.1 Team management; communicating and engaging with all stakeholders of the projects. **Controlling Projects** 5.2 Earned Value Management techniques for measuring your work completed; Using milestones for measurement; change requests and scope creep. Keeping up with the project, Updating the project, Project Issues management and Dealing with troubled projects.	**08**
06	**Closing the Project** Customer acceptance; completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	**06**

Term Work

Term work shall consist of,

1. Assignments: On topics drawn from syllabus [At least 1 assignment per module].
2. One scheduling exercise on any project management software where writing WBS and Scheduling on PMIS software for a simple project or a Case Study on project selection/ risk management.
3. Case Studies (at least 2 with inferences).

The distribution of marks for term work shall be as follows:

- Assignments: **10** marks
- Scheduling on PMIS software: **10** marks
- Attendance (Theory and Practical): **05** marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal Assessment

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Project Management and Control,Narendra Singh; Himalaya Publishing House
2. Preparation, Appraisal, Budgeting, Implementing and Review, Prasanna Chandra TMGH
3. Project Management: A managerial approach, Jack Meredith & Samuel Mantel, Wiley India, 7th Ed.
4. Project Management, Dennis Lock, Gower Publishing England, 9th Ed.
5. Project Management, Gido Clements & Cengage Learning.
6. Project Management, Gopalan, Wiley India
7. Projects- Planning, Analysis, Selection, Financing, Implementation and Review, Prasanna Chandra, TMGH

Course Code	Course/Subject Name	Credits
MEE8024	**Business Process Reengineering (BPR)**	**3+1**

Objectives

1. To understand the role and need of Business Process Reengineering in an organization.
2. To develop an insight as to how BPR tool/techniques are used strategically for business excellence and for the betterment of an organization.

Outcomes: Learner will be able to..

1. Demonstrate the use of BPR practices in an organization to enhance its competitiveness and overall productivity.
2. Identify the need and when to implement BPR in an organization.
3. Develop an understanding of how BPR helps in aspects like customer focus, innovation and quality management in various organizations.

Module	Details	Hrs.
01	Introduction to BPR: Concept, Philosophy of BPR, Fundamental tenets of BPR, Benefits & pitfalls of BPR, myths of BPR and Drivers of BPR.	**05**
02	Process reengineering framework: Opportunity assessment, planning the process re-engineering project. Organizing for process reengineering.	**05**
03	3.1 Process analysis and design: a) Process analysis (b) Process design. 3.2 Planning and implementing the transition: Planning the transition, implementing the transition, tracking and measuring process performance.	**05**
04	Tools and techniques used in BPR: Case tools, Work flow systems, Imaging technology, Floware, Business design facility tools, and Change management tools. BPR in Manufacturing industry, BPR &ERP.	**08**
05	BPR implementation methodology, Success factors of BPR and Barriers to BPR. Risk and Impact measurement.	**06**
06	Change management in BPR: Introduction, Nature, process of change, Management of Change in BPR. Strategic aspects of BPR.	**07**

Term Work

Term work shall consist of assignments (at least one assignment per module), case discussion (at least 3) covering a cross section of strategic advantages to be gained by applying BPR tools and techniques and a seminar presentation based on the topics mentioned in syllabus.

The distribution of marks for term work shall be as follows;

- Assignments: **10** marks
- Seminar/ case discussion: **10** marks
- Attendance (Theory and Practical): **05** marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal Assessment

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Process Re-engineering: The Key to Achieving Breakthrough Success, Lon Roberts, Amer Society for Quality.
2. Business Process Reengineering: Breakpoint Strategies for Market Dominance, Henry J. Johansson, Patrick McHugh, A. John Pendlebury, William A. Wheeler, Wiley.
3. Business Process Reengineering, R Radhakrishnan, S. Balasubramanian, PHI.
4. Business Process Reengineering And change management, B R Dey, Wiley.
5. Organizational transformation through BPR,Sethi, King, Pearson.
6. Business Process Management, Second Edition: Practical Guidelines to Successful Implementations, Johan Nelis, John Jeston, oxford.
7. Business Process Change,Paul Harmon, Morgn Kaufmann.
8. A Practical Guide to Business Process Re-Engineering, Mike Robson, Philip Hllah, Gower.

Course Code	Course/Subject Name	Credits
MEE8025	**Cryogenics**	**3+1**

Objectives

1. Study fundamental concepts of cryogenics
2. Study gas liquefaction and purification
3. Study operating in low temperature

Outcomes: Learner will be able to…

1. Explain historical developments in cryogenic systems
2. Describe gas liquefaction and purification systems/methods
3. Analyze system parameters and performance

Module	Detailed Contents	Hrs.
01	**Introduction to cryogenic systems** – Chronology of cryogenic technology & Present areas involving cryogenic engineering. **Low temperature properties of engineering materials**:-Mechanical, thermal and magnetic properties of cryogenic fluids	04
02	**Gas Liquefaction systems:** System performance parameters, Thermodynamically ideal systems, Liquefaction systems for Neon, Hydrogen & Helium, critical components of liquefaction systems. **Gas purification methods**:-Refrigeration purification, Physical adsorption.	06
03	**Cryogenic Refrigeration system**: Ideal Refrigeration systems, **Refrigerators for temperatures above 2K**:-Joule-Thomson refrigeration system, Expansion engine refrigeration system, Philips refrigerator, V-M refrigerator, Gifford-McMahon refrigerator, Regenerators, **Refrigerators for temperatures below 2K**:-Magnetic cooling, Magnetic refrigeration system	08
04	**Measurement systems for low temperature:** Introduction, Metallic resistance thermometer, semiconductor resistance thermometer, Thermocouples, Constant-volume gas thermometer, vapour pressure thermometer	06
05	**Liquid Level Measurement**: Hydrostatic gauges, Electric resistance gauges, Thermodynamic liquid level gauge	04
06	**Application of Cryogenics:** Cryogenic Fluid Storage systems, Insulations, Importance of vacuum technology in cryogenics, Application of cryogenics system, superconducting devices, Space Technology, Cryogenics in Biology and Medicine.	08

List of Experiments

1. Study of gas liquefaction and purification systems
2. Study of cryogenic refrigeration systems
3. Study of cryocoolers
4. Case study on applications of cryogenics
5. Visit report to gas liquefaction plant

Term Work

Term work shall consist of experiments from the list, 3 assignments covering maximum portion of the syllabus.

The distribution of marks for term work shall be as follows:

- Laboratory work (Experiments) **:** **10 marks**
- Assignments : **05 marks**
- Factory visit report: **05 marks**
- Attendance (Theory and Practical) **:** **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal Assessment

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Cryogenics Systems, R. Barron Oxford University Press
2. Cryo-Cooler: Fundamentals Part-I, G. Walker Plenum Press New York
3. Cryo-Cooler: Fundamentals Part-II, G. Walker Plenum Press New York
4. Cryogenic Engineering, T.M.Flynn , Marcel Dekker
5. Cryogenic: Application and progress, A.Bose and P.Sengupta, Tata McGraw Hill
6. Sterling cycle design manual, Martini W. NASA Report, 1978

Course Code	Course/Subject Name	Credits
MEE8026	**Automobile Engineering**	**3+1**

Objectives

1. Study basic principles of actual automobile systems
2. Study important systems in an automobile
3. Study recent and modern trends in automobile sector

Outcomes: Learner will be able to…

1. Demonstrate & explain various systems in an automobile
2. Describe importance and features of different systems like axle, differential, brakes, steering, suspension, wheel and balancing etc.
3. Explain principle of operation, construction and applications of various sensors used in modern automobile

Module	Detailed Contents	Hrs.
01	**Introduction** **Transmissions:** Necessity of gear box, Sliding mesh, Constant mesh, Synchromesh and epicyclic gear box, Overdrives and hydrodynamic torque converter, Trouble shooting and remedies. **Live axle and differential**: Final drive, spiral, bevel, Hypoid and worm drives, Types of live axles, semi, three quarter and full floating axles. Necessity of differential, Conventional and non-slip differential, Trouble shooting and remedies.	05
02	**Brakes** Requirement of brake, Classification of brakes, Mechanical, Hydraulic, Pneumatic, Electro and vaccum brakes. Disc brakes, Braking of front wheel, Rear wheel and four wheel brakes, Brake trouble shooting. Introduction to antilock braking system (ABS). **Steering and Front axles** Steering geometry, Steering requirements, Steering linkages and steering gears, over steer and under steer, Cornering power, Reversibility of steering gears, Types of front axles and their constructions. Trouble shooting and remedies.	06
03	**Suspension** Objects of suspension, Basic requirements, Air suspension and its features, Independent suspension, Forces acting in independent suspension, Sprung and un-sprung mass, Pitching, rolling and bouncing, Shock absorbers. **Wheels and Tyres** Requirements of wheels and tyres, Constructional features, Types of tyres, Inflation Pressure and its importance, Application to ride and stability, Trouble shooting and remedies.	07
04	**Electrical system** Battery: Types of battery, Lead-Acid, Alkaline, ZEBRA, Sodium Sulphur and Swing, Ratings, charging, Maintenance and testing of Lead-Acid battery. **Starting system**: Requirements, Various torque terms used, Starter motor drives; Bendix, Follo through, Barrel, Rubber compression, Compression Spring, Friction Clutch, Overrunning Clutch, Dyer. Starter motor solenoids and switches, Glow plugs. **Alternator:** Principle of operation, Construction, Working, Rectification from AC to DC.	06

05	**Body Engineering** Importance of Body design, Materials for body construction-Styling forms-Coach and bus body style, layouts of passenger cars, Bus and truck bodies. Aerodynamic drag - Aerodynamic lifts and pitching moments, Side force, Yawing moments and rolling moments. **Chassis types and structure types**: Open, Semi integral and integral bus structure.	06
06	**Recent trends in Automobiles** Electronic Control module (ECM), operating modes of ECM (closed loop and open loop) Inputs required and output signals from ECM, Electronic Spark control, Air Management system, Idle speed control. Construction, working & application of temperature sensors, inductive sensors, Position sensors (rotary, linear). Hot wire and thin film air flow sensors, vortex flow/turbine fluid sensors, Optical sensor, Oxygen sensors, Light sensors, methanol sensors ,Rain sensor, New developments in the sensor technology	06

List of Exercises

1. Dismantling and assembly of gear boxes.
2. Dismantling and assembly of brakes.
3. Dismantling and assembly of steering mechanisms.
4. Dismantling and assembly of rear axle and differential.
5. Dismantling and assembly of suspension systems
6. Demonstration of battery charging and starting systems.

Term Work

Term work shall consist of at least 3 exercises from the list with the report, case study presentation covering recent trends in automobile report and a report on automotive factory/service center visit.

The distribution of marks for term work shall be as follows:

- Laboratory work (Exercises) **:** **10 marks**
- Case study: **05 marks**
- Visit report: **05 marks**
- Attendance (Theory and Practical) **:** **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal Assessment

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Automotive Mechanics, William Cruose& Donald L. Anglin, Tata Mcgraw Hill
2. Automotive Mechanics , Joseph Heitner, East-West press pvt .Ltd
3. The Automobile Engineering, T. R. Banga&Nathu Singh, Khanna Publishers
4. The Automobile, Harbans Singh Reyat, S. Chand & Co.
5. Automobile Engineering, R. K. Rajput, Laxmi Publication
6. Basic Automobile Engineering, C.P.Nakra, DhanpatRai Publishing CO.
7. Automobile Engineering, Kirpal Singh Vol I & II, Standard publishers Distributors ,Delhi
8. Automobile Engineering, K. K. Jain & R.B. Asthana, Tata Mcgraw Hill
9. Automotive Mechanics, S. Srinivasan, Tata Mcgraw Hill
10. Automobile Engineering, Vol I & II, R.K. Mohanty, Standard Book House
11. Automobile Electrical and Electronics, Tom Denton
12. Vehicle Body Engineering, J Pawlowski, Century publisher.
13. Computerised Engine Control, Dick King, Delmar publisher.
14. System Approach to Automobile Technology, Jack Erjavec, Cengage Learning
15. Light & Heavy Vehical technology, M. J. Nunney, Elsevier.

Subject Code	Subject Name	Credits
MEE8027	**Process Equipment Design**	**3+1**

Objectives

1. To acquaint with process of designing using codes
2. To study design of process equipment such as pressure vessel, storage tank, heat exchanger etc.

Outcomes: Learner will be able to…

1. Illustrate understanding of process design parameters.
2. Design and develop pressure vessels.
3. Demonstrate capabilities developed for designing storage tank, agitators.

Module	Detailed content	Hours
1	**Process Design Parameters** Introduction to Basic process requirement of plants and projects, Importance of codes and standards and their applications. P&ID, Process Data Sheet, PFD and other documents used for designing. Introduction to various design codes required in Process Equipment Design such as; ASME, Section VIII; API; ASTM; TEMA, etc. and their significance. Review of Design pressures, temperatures, design stresses, factor of safety, minimum shell thickness and corrosion allowance, weld joints efficiency, design loading, stress concentration and thermal stresses, failure criteria. Selection of material for process equipment's using ASME Codes.	06
2	**Design of Pressure Vessels** Types of pressure vessels, selection of various parameters for their design Pressure vessel subjected to Internal Pressure: Complete design as per ASME code of Cylindrical and spherical shells. Design of various end closures such as: Flat, Hemispherical, Torrispherical, Elliptical and conical. Design of openings : nozzles and manholes. Design of Flanged joints; Gasket selection and design Design of supports for process vessels. Pressure vessel subjected to External Pressure: Design of shell, heads, nozzles, flanged joints and stiffening rings. Design of Tall Vessels / Tall Columns: Determination of equivalent stress under combined loadings including seismic and wind loads application of it to vertical equipment like distillation column.	08
3	**Vessel Supports** Introduction and classification of supports. Design of skirt support considering stresses due to dead weight, wind load, seismic load and periodic vibration. Design of base plate, skirt bearing plate, anchor bolts. Design of Lug and bracket support.	06
4	**Design of Storage Tanks** Study of various types of storage vessels and applications. Atmospheric vessels, vessels for storing volatile and non-volatile liquids. Various types of roofs used in storage vessels. Manholes, nozzles and mounting design. Design of Rectangular tanks.	06
5	**Heat Exchangers** Heat exchangers: Design of vessels, Design of Shell and Tube Heat Exchanger, Study and design of various types of jackets like plain half coil, channel, limpet coil.	05

6	**Agitator** Study of various types of agitators and their applications. Baffling, Power requirement of agitation. General design of agitator including blades, shaft, blade assembly.	05

List of assignments

1. Explain types of process equipments (static and rotary)
2. Explain inspection and testing requirement for pressure vessel
3. Breifly explain design of storage tank
4. Discuss types of heat exchangers

Design assignment on pressure vessel: Design of shell, formed heads for internal and external pressure, flanges, supports of pressue vessel and preparation of general arrangement drawing and detailed fabrication drawing with bill of materials

Term Work

Term work shall consist of assignments from the list and design of pressure vessel with report containing working drawing.

The distribution of marks for term work shall be as follows:

- Assignment **:** **10 marks**
- Design assignment: **10 marks**
- Attendance (Theory and Practical) **:** **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal Assessment

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Dr. M.V. Joshi, “Process Equipment Design”, Mc-Millan
2. Browell and Young, “Process Equipment Design:, John Wiley
3. B.C. Bhattacharya, “Introduction to Chemical Equipment Design – Mechanical Aspects”, CBS Publications
4. Standard Codes such as: ASME SEC-VIII, Div I & II; ASTM; API; TEMA.

Course Code	Course/Subject Name	Credits
MEE 8028	**Alternative Fuels**	**3+1**

Objectives

1. Study various alternatives for conventional fuel used in SI and CI engines
2. Study electrically driven and solar driven vehicles

Outcomes: Learner will be able to…

1. Identify & explain future trends and development in IC engine fuel
2. Analyze engine performance using blended fuel
3. Explain working of electrical and solar powered vehicle

Module	Detailed Contents	Hrs.
01	Introduction: Working processes in I.C. engine, fuel efficiency, fuel requirement, ignition quality, volatility, sources of fossil fuels, scope of availability of fossil fuels, need for alternative fuels, engine life.	04
02	Alcohols: Sources, methanol & ethanol, production methods, properties of methanol & ethanol as engine fuels, Use of alcohols in S.I. & C.I. engines, performance of methanol & gasoline blends, alcohol diesel emulsions, dual fuel systems, emission characteristics.	06
03	Hydrogen: Properties of hydrogen with respect to its utilization as a renewable forms of energy, sources of hydrogen, production, transportation, storage, application & economics of hydrogen. Fuel Cells: Hydrogen, methanol fuel cells, power rating and performance. Heat dissipation, layout of a fuel cell vehicle.	08
04	Gaseous Fuel: L.P.G., C.N.G., bio-gas, their properties as engine fuels, fuel metering systems, combustion characteristics, effect on performance & emission, cost, safety.	06
05	Bio-Diesels: Jatropa oil, Karanji oil, Neem oil, Rice bran oil, Linseed oil, Sunflower oil, properties, diesel & biodiesel blends, engine performance.	06
06	Electric Vehicles: Layout of an electric vehicles, advantages & limitations, significations, systems components, electronic controlled systems, hybrid vehicles. Solar Power: Solar cells for energy collection, layout of solar powered automobiles	06

List of Experiments

1. Study of physical & chemical properties of fuels
2. Study of Ethanol Production, properties of ethanol as S.I. engine fuel
3. Study of Methanol Production, properties of methanol as C.I. engine fuel
4. Study of fuel cell and fuel cell powered vehicle
5. Trial on SI/CI engine using alternate gaseous fuel
6. Study of solar powered vehicle
7. Layout preparation for Hybrid vehicles.

Term Work

Term work shall consist of minimum 7 experiments from the list, 3 assignments covering maximum portion of the syllabus.

The distribution of marks for term work shall be as follows:

- Laboratory work (Experiments) **:** **10 marks**
- Assignments : **10 marks**
- Attendance (Theory and Practical) **:** **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal Assessment

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Introduction to Internal Combustion Engines, Richard Stone, McMillan, London
2. Internal Combustion Engines, Shyam Agrawal, New Age International
3. Internal Combustion Engines & Air Pollution, Edward F. Obert, Int. Text Book Co., Pennsylvania
4. Internal Combustion Engines, Litchty L. C., McGraw Hill Book Co., New Delhi.
5. Non Conventional Energy Sources, G. D. Rai, Khanna Publications, Delhi
6. H. P. Garg& J. Prakash, "Solar Energy", Tata McGraw Hill Pub. Co. Ltd., Delhi
7. Fuel Cells, Vishwanathan B and M AuliceScibioh, Universities Press, Hyderabad, India, 2006
8. Handbook of Hydrogen Storage: New Materials for Future Energy Storage, Hirscher, Michael, Weinheim : WILEY-VCH Verlag GmbH & Co. KGaA, 2009
9. Hydrogen fuel: Production, transport and storage, Gupta R B, Boca Raton, CRC Press, 2008
10. Energy Conversion Systems, R D Begamudre, New Age International (P) Ltd., Publishers, New Delhi ,2000.
11. Renewable Energy Resources, J. Twidell and T. Weir, Taylor and Francis (special Indian edition), 2006
12. Biofuels from Agricultural Wastes and Byproducts, Hans P. Blaschek, Thaddeus Ezeji, Jürgen Scheffran, Wiley Blackwell, 2010
13. Renewable Energy Engineering And Technology: Principles And Practice,V. V. N. Kishore (Editor), Earthscan Publications (Apr 2009)
14. Biofuels Engineering Process Technology, Caye M. Drapcho, Nghiem PhuNhuan, Terry H. Walker, McGraw Hill, 2008

Course Code	Course/Subject Name	Credits
MEE8029	**Enterprise Resource Planning**	**3+1**

Objectives

1. To help the students acquire the basic understanding of major enterprise wide business processes and their integration through IT enabled applications.
2. To develop a managerial perspective to leverage them for competitive advantage.

Outcomes: Learner will be able to…

1. Demonstrate understanding the role and functions of ERP in carrying out business processes in an industry.
2. Develop the ability to integrate various resources for optimization in the industry as well as for strategic utilization of IT enabled services and functions.
3. Report on the reasons for the success (or failure) of a business strategy in a competitive environment.

Module	Details	Hrs.
01	**Process View of Organization** Introduction to functional areas and business processes, Functional areas and business processes of a very small business, Functional area information systems, Process modeling, Process improvement, ERP workflow tools, Implementing ERP systems, Implementation and change management.	**06**
02	**Approaches to process improvement** Managerial implications of Process Reengineering efforts, Kaizen, Total Quality Management, Implementing new process, Critical success factors of reengineering project and Comparison of different approaches.	**06**
03	**Introduction to Enterprise Resource Planning(ERP)** ERP - Introduction, Evolution of Enterprise applications, Reasons for the growth of the ERP market, Operational advantages of Enterprise Wide Applications, Failure of ERP packages, ERP packages, Enterprise application implementation projects: Rationale for ERP, Enterprise Architecture planning, Selection of an ERP vendor, Advantages of and problems in ERP implementation, Overview of ERP modules, ERP and related technologies.	**08**
04	**ERP – Manufacturing Perspective** Material requirement planning (MRP-I), closed loop MRP, Manufacturing Resource Planning (MRP-II), Distribution Requirements Planning and Product Data Management.	**04**
05	**Supply Chain and CRM Applications** Overview of Supply and demand chain, SCM framework, Advanced planning systems, Introduction to CRM applications and Growth of CRM Applications.	**05**
06	**Introduction to SAP R/3** SAP R/3 basics, Cross-Sectional analysis of other ERP systems with SAP R/3, SAP R/3 Client Server Architecture, Understanding SAP R/3 Business Process Reference Model and Business Process Integration on SAP R/3. Case studies of businesses, implementing IT enabled ERP systems.	**07**

Term Work

Term work shall consist of at least six assignments on concepts, case studies and analysis based on the topics mentioned above.

The distribution of marks for term work shall be as follows;

- Lab work (Case Studies: at least 2): **10** marks
- Assignments: **10** marks
- Attendance (Theory and Practical): **05** marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal Assessment

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. *Enterprise Resource Planning,* Alexis Leon, Tata McGraw Hill publication.
2. *Concepts in Enterprise Resource Planning*, Brady, Monk and Wagner, Thomson Learning.
3. *CRM at the speed of Light*, Greenberg, Paul, TMH.
4. *The E-Marketplace: Strategies for success in B2B commerce*, Raisch, Warren D, McGraw Hill inc.2000.
5. *ERP strategy*, Vinod Kumar Garg, Bharat Vakharia and Jaico.

Course Code	Course/Subject Name	Credits
MEE80210	World Class Manufacturing(WCM)[&]	3+1

[&] **Common with Mechanical Engineering**

Objectives

1. To familiarize the students with the concepts of Business excellence and competitiveness.
2. To apprise the students with the need to meet the current and future business challenges.
3. To prepare the students to understand the current global manufacturing scenario.

Outcomes: Learner will be able to..

1. Demonstrate the relevance and basics of World Class Manufacturing.
2. Identify the factors of competitiveness and performance measures based on which, global manufacturing success is bench marked
3. Draw current Status of Indian Manufacturing scenario and design and develop a roadmap to achieve world class manufacturing status.

Module	Details	Hrs.
01	**Historical Perspective** World class organizations: Meaning of world class. Competitiveness and Performance measures. Criteria for world class organizations in Manufacturing. Competing in World markets. Review of frameworks in World Class Manufacturing (WCM). Models for manufacturing excellence: Schonberger, Halls, Gunn & Maskell models and Business Excellence.	05
02	**Benchmark, Bottlenecks and Best Practices** Concepts of benchmarking, Bottleneck & best practices. Best performers, Gaining competitive edge through world class manufacturing, Value added manufacturing, Value Stream mapping, Eliminating different types of waste. Lean Thinking (Toyota Production System), Six Sigma, Theory of Constraints.	07
03	**System and Tools for World Class Manufacturing** Improving Product & Process Design: SQC, Statistical Process Control, Quality Function Deployment (QFD), Seven Basic Quality Tools, FMS, Poka Yoke, 5-S, Optimizing Procurement & stores practices, Total Productive maintenance and Visual Control.	07
04	**HR Dimensions in WCM – WCM Strategy Formulation** 4.1 Adding value to the organization: Organizational learning, techniques of removing Root cause of problems, People as problem solvers, New organizational structures. 4.2 Associates: Facilitators, Teams man ship, Motivation and reward in the age of continuous improvement.	05
05	**Characteristics of WCM Companies** Performance indicators like POP, TOPP and AMBITE systems. Other features of WCM : Supply Chain Management & key issues in SCM, Agile Manufacturing, Green Manufacturing, Role of Information system in WCM, Introduction to Knowledge management, Study of various performance measures in world class organization.	06
06	**Total Quality Management (TQM)** Definition, Understanding quality, Evolution of TQM, Framework for TQM, Commitment and leadership, Customer satisfaction, Employee involvement, Continuous process improvement, Supplier partnership, Performance measures, Formulation and implementation of TQM: Case Study.	06

Term Work

Term work shall consist of at least six assignments on topics drawn from the syllabus [1 assignment per module] and at least 3 case studies and analysis based on the topics mentioned above.

The distribution of marks for term work shall be as follows.

- Assignments: **10** marks
- Lab work (Case Studies: at least 3, with inferences): **10** marks
- Attendance (Theory and Practical): **05** marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal Assessment

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. World Class Manufacturing – Strategic Perspective, Sahay B.S., Saxena K B C and Ashish Kumar, Mac Milan Publications, New Delhi.
2. World Class Manufacturing - The Lesson of Simplicity, Schonberger R. J, Free Press, 1986
3. Management strategy: achieving sustained competitive advantage, Marcus, A. A.,New York: McGraw-Hill/Irwin, 2011.
4. Manufacturing Strategy: Process and Content, Voss C. A., Chapman & Hall, London, 1992.
5. Lean production simplified, Pascal. D., 2nd Edition, Productivity Press, 2007
6. Total Quality Management, Besterfield, D. H., Pearson Education, 1999.
7. Advanced Operations Management, Mohanty R. P., Deshmukh S. G., Pearson Education,2003.
8. "Managing Technology and Innovation for Competitive Advantage", Narayanan V.K, Prentice Hall, 2000.
9. "Making Common Sense Common Practice – Models for manufacturing Excellence", Ron Moore, Butter worth Heinmann.
10. The Toyota Way – 14 Management Principles", Jeffrey K.Liker, Mc-Graw Hill, 2003.
11. "Operations Management for Competitive Advantage", Chase Richard B., Jacob Robert., 11th Edition , McGraw Hill Publications, 2005.

Course Code	Course/Subject Name	Credits
MEE80211	**Nanotechnology**	**3+1**

Objectives

1. To acquaint learner with fundamental multidisciplinary nature of nanotechnology
2. To study applications and implementation of nanotechnology

Outcomes: Learner will be able to…

1. Discuss basics of nanotechnology
2. Identify various nanostructured materials
3. Illustrate characterization techniques and properties of nanomaterials

Modules	Detailed Content	Hrs.
01	**Introduction to Quantum mechanics, Nanostructural Materials and Low dimensional structures:** Basic principles of Quantum mechanics (why and how classical mechanics fails), probability amplitude, wave functions, eigen states and eigen values, Quantum wells, Quantum wires, Quantum dots, Nano clusters and Nano crystals.	**06**
02	**Quantum mechanical application of Nanotechnology:** Quantum well and quantum dot lasers, ultra-fast switching devices, nano magnets for sensors and high density data storage, photonic integrated circuits, long wave length detectors, carbon nanotube, luminescence from porous silicon, spin-tronic devices.	**06**
03	**Nanstructured materials, Zero-Dimensional Nanostructures: Nanoparticals:** Introduction , Nanoparticles through Homogeneous Nucleation, Fundamentals of Synthesis of semiconductor nanoparticles, Synthesis of oxide,nanoparticles, Vapor phase reactions, Solid state phase segregation, Heterogeneous Nucleation and Growth, i.Fundamentals of heterogeneous nucleation, ii.Synthesis of nanoparticles, Kinetically Confined Synthesis of Nanoparticles, i. Synthesis inside micelles or using microemulsions, ii. Aerosol synthesis, iii. Growth homogeneous nucleation, ii.Subsequent growth of nuclei, iii.Synthesis of metallic nanoparticles,iv termination, iv. Spray pyrolysis, v. Template-based synthesis, Epitaxial Core-Shell Nanoparticles. **One-Dimensional Nanostructures: Nanorods and Nanowires :** Introduction, Spontaneous Growth, Evaporation (or dissolution) condensation, Vapor (or solution or solid)–liquid–solid growth, Stress-induced recrystallization, Template-Based Synthesis, Electrochemical deposition, Electrophoretic deposition, Template filling, Electrospinning, Lithography **Two-Dimensional Nanostructures: Thin Film:** Introduction, Fundamentals of Film Growth, Vacuum Science, Physical Vapor Deposition (PVD) i.Evaporation, ii. Molecular beam epitaxy, iii. Sputtering; Chemical Vapor Deposition (CVD), i. Types of chemical reactions, ii. Reaction kinetics, iii. Transport phenomena, iv. CVD methods, v. Diamond films by CVD; Atomic Layer Deposition (ALD), Superlattices, Self-Assembly, Langmuir-Blodgett Films, Electrochemical Deposition, Sol-Gel Films, Solution growth, SILAR films. **Special Nanomaterials and applications:** Introduction; Carbon Fullerenes and Nanotubes: Carbon fullerenes, Fullerene- derived crystals, Carbon nanotubes; Micro and Mesoporous Materials: Ordered mesoporous materials, Random mesoporous materials, Crystalline porous materials (zeolites); Core-Shell Structures: Metal-oxide structures, Metal-polymer structures, Oxide-polymer structures; Organic-Inorganic Hybrids: Class I hybrids, Class II hybrids; Intercalation Compounds; Nanocomposites	**10**

	and Nanograined Materials. Molecular Electronics and Nanoelectronics; Nanobots; Biological Applications of Nanoparticles; Catalysis of Gold Nanocrystals; Bandgap Engineered Quantum Devices: Quantum well devices, Quantum dot devices; Nanomechanics; Carbon Nanotube Emitters; Photoelectrochemical Cells; Photonic Crystals and Plasmon Waveguides.	
04	**Synthesis and types of nano particles** Nanocontainers, Nanoshells, Nanohorns, Nanowires, Nanosprings, Nanorods, Nanofilters, Nanopens, Nanopencils, Nanopipettes, Nanopens, Nanoplotter, Nanobalance, Nanobeads, Nanoguitar	**06**
05	**Characterization and Properties of Nanomaterials** Introduction, Structural Characterization, X-ray diffraction (XRD), Small angle X-ray scattering (SAXS), Scanning electron, microscopy(SEM), Transmission electron microscopy (TEM), Scanning probe microscopy (SPM) Gas adsorption. Chemical Characterization, Optical spectroscopy, Electron spectroscopy, Ionic spectroscopy, Physical Properties: Thermal stability and lattice constant, Mechanical properties, Optical properties, Electrical conductivity, Ferroelectrics and dielectrics, Superparamagnetism, Emission spectroscopy, luminescence spectroscopy.	**05**
06	**Application of nano chemistry** Semiconductor and Microelectronics including MEMS, Optical Magnetic including memory, readwrite, flash, bubble memories etc. Mechanical including Nanocomposites, thermal barriers etc.Biomedical including Pharmacology, Virology etc.	**03**

Term Work

Term work shall consist of at least six assignments covering complete syllabus. One group seminar by maximum 3 members in a group on topic relevant to syllabus contents

The distribution of marks for term work shall be as follows:

- Assignments: : **10** marks
- Seminar : **10** marks
- Attendance (Theory & Practical's) : **05** marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal Assessment

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. Introduction to nanotechnology, Charles P Poole Jr and Frank J Owens, Wiely
2. Introduction to Nanosciences and Nanotechnology, Chattopadhyay K K, Banerjee A N, PHI Learning
3. Nanotechnology: The science of small, Shah K A and Shah M A, Wiely
4. Nanotechnology, Rathi R K, S Chand
5. Nano: The essentials Understanding Nanosciences and Nanotechnology, TMH
6. Nanotechnology, Lynn E Foster, Pearson
7. Micromanufacturing and Nanotechnology, Mahalik N P, New Age International
8. Handbook of Nanoscience, Engineering, and Technology, William A Goddard, Donald Brenner, Sergey Edward Lyshevski, Goddard III, CRC Press

Course Code	Course/Subject Name	Credits
MEE80212	**Digital Prototyping for Product Design –II**	**3+1**

Objectives

1. To acquaint learner with basic process of Product engineering and visualization.
2. To study linear and non-linear structural analysis
3. To acquaint with kinematic motion study analysis
4. To study design optimization using simulation

Outcomes: Learner will be able to…

1. Render and animate the appearance and functionality of a product
2. Perform linear and non-linear structural analysis
3. Perform kinematic motion study analysis
4. Design optimization using simulation
5. Cloud-based mechanical simulation

Modules	Detailed Content	Hrs.
01	**Introduction** Digital prototyping process; Introduction to product engineering, Introductions to design changes and Automation. Visualization Extending Design Data	**02**
02	**Product Engineering & Visualization** Designing for change Automating Design and configuration, Design parameters, engineering calculators, Automation using illogic for parts & assemblies, Model relationships,Design visualization throughout product development, Benefits of design visualization, Utilizing Engineering Data throughout Organization. Design approval, Sales and Marketing support & plastic part visualization.	**08**
03	**Simulation & Validation - Linear & Nonlinear Analysis** Role of simulation and validation in product development process. FEM (Theory and requirements) Meshing load and constraints, part material selection and optimization, Linear Structural Analysis Benefits of nonlinear simulation, Theory and requirements, Advanced Meshing, Advanced Material Properties contact types, result reviews. Kinematics role in simulation and optimization	**08**
04	**Kinematics Motion & Mechanical Event** Theory benefits & kinematic requirement: Joints, Forces, Assembly Structure & results. Benefits of combining analysis information, Design Optimization, Motion forces, Component FEA from motion forces, Design optimization, Results	**08**
05	**Design Optimization and Change** Design Changes, Design Optimization; Model Relationships Simulation Results; Manufacturing & service, Leveraging engineering data throughout the organization, Benefits for field service and manufacturing, Story Board, Annotations and Descriptions, Snapshots & Assembly instruction video	**05**
06	**Design Optimization and CFD Analysis** The role of CFD within the product design cycle, CFD Analysis General Theory, Benefits of CFD simulation Model Setup, Meshing Fluid flow loads & Analysis results	**05**

List of Digital Prototyping Projects

1. General engineering calculators and rule based design project
2. Implementation of design changes and rules for automotive seat switches and gears
3. Showcase design visualization of automotive seat
4. General linear component analysis project
5. Automotive single component simulation and validation
6. General nonlinear analysis project
7. General mechanical kinematics motion projects
8. General mechanical event simulation project
9. General design optimization and change workflow projects
10. Automotive cooling airflow or lumbar value study
11. General Cloud-based mechanical simulation

Term Work

Term work shall consist of above projects in group of not more than 2 students and seminar on latest trends/developments in Product Design

The distribution of marks for term work shall be as follows:

- Course Project : **15** Marks
- Seminar : **05** Marks
- Attendance (Theory & Practical's) : **05** Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal Assessment

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

Theory Examination

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

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. K.Otto and K. Wood, Product Design, Pearson Education, 2001.
2. D.G. Ullman, The Mechanical Design Process, McGraw- Hill, 1997
3. Joseph E. Shigley& Larry D. Mitchell, "Mechanical Engineering Design", Fourth Edition, McGraw-Hill International Book Company
4. Design of machine elements -- V. B. Bhandari. Tara Mcgraw Hill Pub.
5. Mastering Autodesk Inventor by Sybex
6. Autodesk Inventor 2012 for Designers by CADCIM Technologies
7. Autodesk Showcase Fundamentals: ASCENT official Training Guide
8. Design of machine elements -- V. B. Bhandari. Tara Mcgraw Hill Pub.
9. Autodesk Simulation Multiphysics ASCENT official training guide
10. Autodesk Student & Educator Learning Center
11. Autodesk SIM 360 Learning resources

Course Code	Course/Subject Name	Credits
MEP701 / MEP802	**Project I/ II**	**3 / 6**

Objective

1. To acquaint with the process of undertaking literature survey/industrial visit and identifying the problem
2. To familiarize the process of solving the problem in a group
3. To acquaint with the process of applying basic engineering fundamental in the domain of practical applications
4. To inculcate the process of research

Outcome: Learner will be able to…

1. Do literature survey/industrial visit and identify the problem
2. Apply basic engineering fundamental in the domain of practical applications
3. Cultivate the habit of working in a team
4. Attempt a problem solution in a right approach
5. Correlate the theoretical and experimental/simulations results and draw the proper inferences
6. Prepare report as per the standard guidelines.

Guidelines for Project

- Students should do literature survey/visit industry/analyze current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem.
- Students should attempt solution to the problem by experimental/simulation methods.
- The solution to be validated with proper justification and report to be compiled in standard format.

Guidelines for Assessment of Project I

- Project I should be assessed based on following points
  - Quality of problem selected
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization
  - Clarity of objective and scope
  - Breadth and depth of literature survey
- Project I should be assessed through a presentation by the student project group to a panel of Internal examiners appointed by the Head of the Department/Institute of respective Programme.

Guidelines for Assessment of Project II

- Project II should be assessed based on following points
  - Quality of problem selected
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization / Industrial trends
  - Clarity of objective and scope
  - Quality of work attempted
  - Validation of results
  - Quality of Written and Oral Presentation
- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Project II should be assessed through a presentation by the student project group to a panel of Internal and External Examiners approved by the University of Mumbai
- Students should be motivated to publish a paper based on the work in Conferences/students competitions