

UNIVERSITY OF MUMBAI



Bachelor of Engineering

Automobile 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 to 3 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. Automobile-(Semester VII)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned					
		Theory	Pract.	Theory	Pract.	Total			
AEC701	Chassis Body Engineering	3	2	3	1	4			
AEC702	CAD/CAM/CAE ^κ	4	2	4	1	5			
AEC703	Automotive Design	4	2	4	1	5			
AEC704	Product Design and Development	4	2	4	1	5			
AEE701X	Elective I	3	2	3	1	4			
AEP701	Project I	--	6 [#]	--	3	3			
Total		18	16	18	8	26			
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract./oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test2	Avg.					
AEC701	Chassis Body Engineering	20	20	20	80	03	25	25	150
AEC702	CAD/CAM/CAE ^κ	20	20	20	80	03	25	25	150
AEC703	Automotive Design	20	20	20	80	03	25	25*	150
AEC704	Product Design and Development	20	20	20	80	03	25	--	125
AEE701X	Elective I	20	20	20	80	03	25	--	125
AEP701	Project I	--	--	--	--	--	50	--	50
Total		--	--	100	400	--	175	75	750

^κ Common with Mechanical Engineering * Only ORAL examination based on term work and syllabus

B. E. Automobile-(Semester VIII)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned					
		Theory	Pract.	Theory	Pract.	Total			
AEC801	Autotronics	4	2	4	1	5			
AEC802	Vehicle Dynamics	4	2	4	1	5			
AEC803	Vehicle Maintenance	4	2	4	1	5			
AEE802X	Elective II	3	2	3	1	4			
AEP802	Project II	--	12 [#]	--	6	6			
Total		15	20	15	10	25			
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract./oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
AEC801	Autotronics	20	20	20	80	03	25	25	150
AEC802	Vehicle Dynamics	20	20	20	80	03	25	--	125
AEC803	Vehicle Maintenance	20	20	20	80	03	25	25	150
AEE802X	Elective II	20	20	20	80	03	25	--	125
AEP802	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 – ½ an 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 Code	Elective I	Course Code	Elective II
AEE7011	Power Plant Engineering &	AEE8021	Noise Vibrations & Harshness
AEE7012	Supply Chain Management &	AEE8022	Vehicle Safety
AEE7013	Tribology	AEE8023	World Class Manufacturing &
AEE7014	Computational Fluid Dynamics &	AEE8024	Knowledge Management
AEE7015	Automotive Embedded Systems	AEE8025	Project Management &
AEE7016	Industrial Robotics	AEE8026	Artificial Intelligence
AEE7017	Transportation Management Motor Industry	AEE8027	Virtual Reality

& Common with Mechanical Engineering

Course Code	Course/Subject	Credits
AEC701	Chassis and Body Engineering	3+1

Objectives

1. Understand fundamentals of Vehicle Body design
2. Study different vehicle structural design and their requirements.
3. Study Vehicle Aerodynamics.
4. Design vehicle body structures

Outcomes: Learner will be able to.....

1. Design and implement knowledge practically of Vehicle structures.
2. Develop efficient and safe designs with consideration of all constraints.

Module	Detailed Contents	Hrs.
01	<p>Fundamental aspects of Vehicle Bodies</p> <p>1.1 Chassis and structure types: Open, Semi integral and Integral bus structure. Frames: functions and types of frames, Loads on frames, Load distribution of structure.</p> <p>1.2 Classification of motor vehicle, Location of power plant, Location of different chassis components,</p> <p>1.3 Terminology and overview of structural surface types, history and Overview of structural types. Basic concept of design.</p> <p>1.4 Vehicle body materials and their selection: Detail study of materials used in vehicle body building (Steel sheet, timber, plastics, FRP, GRP etc, properties of materials-Corrosion anticorrosion methods, scalation of paint and painting process)</p>	8
02	<p>Vehicle body styles</p> <p>2.1 Car Body Details: Types: Saloon, Convertibles, Limousine, Estate van, racing and sports car. Visibility: regulations, driver's visibility, test for visibility, Methods of improving visibility and space in cars. Safety: safety design, safety equipments for car. Car body construction, Front assembly, Roof Assembly, Under floor, bonnet etc.</p> <p>2.2 Bus Body Details: Types, mini bus, single Decker, double Decker, two levels, split level and articulated bus. Bus Body Lay Out: Floor height, engine location, entrance and exit location, seating dimensions. Constructional details: Frame construction, Double skin construction-Types of metal section used-Regulations-Conventional and Integral type construction.</p> <p>2.3 Commercial Vehicle Body Details: Types of bodies, flat platform, drop side, fixed side, tipper body, tanker body, light construction vehicle body types, Dimensions of driver seat in relation to control, Driver cabin design.</p>	8
03	<p>Vehicle Aerodynamics: Objectives, Vehicle drag and types, various types of forces and moments, Effects of forces and moments, side wind effects on forces and moments, various body optimization techniques for minimum drag .Calculation of drag.</p>	6

04	Ergonomics and Preliminary Design 3.1 Design and requirement of Driver, Passenger and child seat. 3.2 Drawing of the preliminary design-Vehicle Body Weight Analysis, Calculation of C.G for Vehicle, Vehicle Weight Distribution and Master Model. 3.3 Overall Criteria for Vehicle Comparison: Design, Running costs, Overall Design Efficiency.	6
05	Body Loads 5.1 Loads on Vehicles: Bending, Torsion, Lateral and Braking and Acceleration Load Cases, Shear Panel Method 5.2 Calculation of loading cases Static loading case, Asymmetric loading case, Longitudinal loads, Side Loads, Calculation of different cases.	4
06	Strength of Vehicle Body Elements 6.1 Thin Walled Structures-General Principle, Torsion, Torsion centre, Forces in End Load Carrying Members. Effect of Holes, Spot welded joints. 6.2 Latest Trends in Design, Manufacturing and Materials.ULSAB Design, Tailored blanks. Manufacturing Process: Hydro forming tubular, Sheet Stamping	4

List of Experiments

1. Structural Analysis of Chassis Frame using CAD Software for different sections (C-section, I-section, L-section, O-section, Hat section, Tubular section etc)
2. Mini Project: Containing a 3D Model of Chassis or Body or combination of both (Min 2 Max 4 Students per Group)
3. Industrial Visit

Term Work

Term work shall consist of experiments from the list, 6 assignments based on complete syllabus, industrial visit report and a mini project report

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

- Laboratory work (Experiments) : **05 marks**
- Mini project : **05 marks**
- Assignment: **05 marks**
- Industrial 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.

Practical/Oral examination

1. Practical examination duration is 2 hours.
2. Practical examination shall be based structural analysis and mini project mentioned in the term work.
3. The distribution of marks for practical/oral examination shall be as follows:
 - i. Practical performance: 15 marks
 - ii. Oral: 10 marks
4. Evaluation of practical examination to be done based on the experiment performed and the output of the experiments during practical examination.
5. 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. John Fenton, "Vehicle Body Layout & Analysis", Hutchinson, London.
2. J Powloski, "Vehicle Body Engineering", Business Books Ltd., London.
3. J.G. Giles, "Body Construction and Design", Vol. 6. Iife Books/Butterworth & Co. London
4. P. L. Kohli, "Automotive Chassis & Body", Papyrus Publishing House, New Delhi.
5. John Fenton, "Handbook of Automotive Body Construction and Design Analysis" Professional Engineering Publishing.

Course Code	Course/Subject Name	Credits
AEC702	CAD/CAM/CAE^{&}	4+1

& Common with Mechanical Engineering

Objectives

1. To introduce new and exciting field of Intelligent CAD/CAM/CAE with particular focus on engineering product design and manufacturing.
2. To develop a holistic view of initial competency in engineering design by modern computational methods.

Outcome: A learner will be able to....

1. Identify proper computer graphics techniques for geometric modelling.
2. Transform, manipulate objects and store and manage data.
3. Prepare part programming applicable to CNC machines.
4. Use rapid prototyping and tooling concepts in any real life applications.
5. Identify the tools for Analysis of a complex engineering component.

Modules	Details	Hrs.
01	Computer Graphics and Techniques for Geometric Modeling Computer Graphics: Two dimensional computer graphics, vector generation, the windowing transformation, Three dimensional Computer graphics, viewing transformation, Homogeneous coordinates, Perspective projection, Hidden line removal & hidden surface removal algorithm, light & shade ray tracing. The parametric representation of geometry, Bezier curves, Cubic Spline curve, B-Spline curve, parametric representation of line, circle, ellipse & parabola. Constructive solid geometry (CSG), Boundary Representation (B-Rep), Wire Frame Modeling, Solid Modeling, Surface Modeling, Parametric Modeling, feature based modeling, Feature recognition, Design by feature.	08
02	Transformation, Manipulation & Data Storage 2D & 3D Transformations (Translation, Rotation, & Scaling & Magnification), Concatenations, Matrix representation, Problems & object oriented programming on Transformations. Object transformation, mirror transformation, Artificial Intelligence in Design & Manufacturing, Representation of Knowledge, and Knowledge base Engineering.	08
03	NC & CNC Technology Tape coding & format, Manual Part Programming, Computer Aided Part Programming, CNC functions & advantages, DNC, adaptive Control, CNC programming concepts, Trends & new developments in NC, Part programmers job, functions of a post processor, NC part programming languages, Elements of a APT language, The Macro Statement in APT, NC programming with interactive graphics. Constructional details of CNC machines, Feed back devices- Velocity & displacement, Machining Centers and its types, Automated Material Handling & storage Systems like Robots, AGVs and AS/RS etc.	08
04	Computer Aided Engineering (CAE) Fundamentals of computer aided engineering, CAE includes mass property calculations, kinematic analysis and animation (movement, visualization, simulation and FEA). Case study based on modeling and analysis of structural, thermal/fluid, and dynamic (vibration analysis) system. Parameter optimization.	08

05	Computer Integrated Manufacturing & Technology Driven Practices Introduction, Evolution, Objectives, CIM Hardware and Software, CIM Benefits, Nature and role of the elements of CIM, Identifying CIM needs, Data base requirements of CIM, Role of CAD/CAM in CIM, Obstacles to Computer Integrated Manufacturing, Concept of the future CIM systems, Socio -techno- economic aspects of CIM.	08
06	Rapid Prototyping and Tooling Introduction to RP, Technology Description, Overview of RP, Benefits and Application. RP Processes: Process overviews, STL file Generation, Classes of RP systems: Stereo-lithography Approach (SLA), SLA with photo-polymerization (mathematical modelling of the process), SLA with liquid thermal polymerization, Selective Laser Sintering (SLS), Fused deposition modelling, Laminated object manufacturing, Laser powder forming. Prototype properties: Material properties, colour, dimensional accuracy, stability, surface finish, machinability, environmental resistance, operational properties. RP Applications: Design, Concept Models, Form & fit checking, Functional testing, CAD data verification, Rapid Tooling, Rapid manufacturing, Science & Medicine, RP processes for MEMS, Photolithography, Direct Laser Writer, Bulk Lithography for 3D micro fabrication (Modelling of beam propagation and curing in resin system).	08

List of Exercises

1. Programming for transformations,
2. Solid modeling using any 3D modeling software
3. Part programming and part fabrication on CNC trainer (Turning / Milling)
4. Geometrical optimization of any mechanical component using computer aided engineering concepts.
5. Development of physical 3D mechanical structure using any one of the rapid prototyping processes.
6. Rapid tooling for any one of the engineering or medical applications.

Term Work

Term work shall consist of any three exercises from the above list and a course project in a group of not more than three (3) students on either computer aided engineering or rapid prototyping and tooling

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

- Exercises : **15** marks
- Course Project : **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.

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.

Practical / Oral Examination

Practical examination of 2 hours duration based on any one of the following.

- 1) Programming for Algorithms, transformations.
- 2) Part Programming and machining of components.
- 3) 3D Modeling on software.
- 4) Analysis of component for optimization

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

- | | | |
|-----|------------------------|----------|
| i. | Practical performance: | 15 marks |
| ii. | Oral: | 10 marks |

Evaluation of practical examination to be done based on the experiment performed and the output of the experiments during practical examination.

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. "CAD/CAM Computer Aided and Manufacturing" by Mikell P. Groover and Emory W. Zimmers, Jr., *Eastern Economy Edition*
2. "CAD/ CAM , Theory & Practice" by Ibrahim Zeid, R. Sivasubramanian, *Tata McGraw Hill Publications*
3. "Computer Graphics" by Donald Hearn and M. Pauline Baker, *Eastern Economy Edition*
4. "CAD/CAM Principles, Practice and Manufacturing Management" by Chris McMahon, Jimmie Browne, *Pearson Education*
5. "CAD/CAM/CIM" by P. Radhakrishan, S. Subramanyan, V. Raju, *New Age International Publishers*
6. "CAD/CAM Principles and Applications" by P.N. Rao, *Tata McGraw Hill Publications*
7. "Principle of Computer Graphics" by William .M. Neumann and Robert .F. Sproul, *McGraw Hill Book Co. Singapore.*
8. David L. Goetsch, *Fundamental of CIM technology*, Delmar publication
9. David Bedworth, *Computer Integrated Design and Manufacturing*, *McGraw Hill*,
10. "CNC Machines" by B.S. Pabla and M. Adithan, *New Age International Publishers.*
11. "Numerical Control and Computer Aided Manufacturing" , T.K. Kundra, P.N. Rao, N.K. Tiwari, *Tata McGraw Hill*
12. "CNC Technology and Programming", Krar, S., and Gill, A., *McGraw Hill publishers*
13. "Computer Integrated Manufacturing- An Introduction with Case Studies" by Paul G. Ranky, *Prentice Hall International*
14. "Flexible Manufacturing Systems" by H.K. Shivanand, M.M. Benal, V.Koti, *New Age International Publishers*
15. "Automation, Production Systems and Computer Integrated Manufacturing ", Groover M.P., *Prentice-Hall of India Pvt. Ltd*
16. "Mathematical Elements for Computer Graphics", Rogers D F I and Adams J A, McGraw-Hill.

17. "Computer Integrated Manufacturing Hand Book" by Eric Teicholz, Joel N. Orr, McGraw Hill International Editions
18. "Rapid Prototyping" Chee Kai Chua World Scientific Publishing
19. "Rapid Prototyping: Principles and Applications" Rafiq Noorani, Wiley
20. "Rapid Prototyping: Principles and Applications" C.K. Chua, K.F. Leong, C.S. Lim World Scientific Publishing
21. "Rapid Prototyping and Manufacturing" P. F. Jacobs, Society of Manufacturing Engineers.

Course Code	Course /Subject	Credits
AEC703	Automotive Design	4+1

Objective

1. Provide students with the fundamental knowledge in the field of automotive design.
2. Develop analytical abilities to give solutions to Automotive design problems

Outcome: Learner will be able to...

1. Design automotive component to meet desired needs
2. Apply the fundamental knowledge of Applied Mechanics, Strength of Materials, Engineering Materials and Theory of Machine for actual design problems

Modules	Details	Hrs.
01	Design of Principal parts of I.C. Engines 1. Cylinder and cylinder liner- Material Selection, Design of cylinder 2. Piston, piston rings and piston pin or gudgeon pin- Material Selection, Design considerations, Design calculations 3. Connecting rod with small and big end bearing-forces acting on connecting rod, Design considerations, Design calculations	12
02	Design of Principal parts of I.C. Engines 1.Crank, crankshaft and crank pin 2. Cam shaft and Valve Operating mechanism.	08
03	Design of Clutches and Gear Boxes: single plate, multiple plates, centrifugal clutch, lining material, lever design, sliding mesh, constant mesh, synchromesh gear box, gear ratio and gear shifting lever, sliding mechanism	08
04	Design of Drive train: Design of propeller shaft and U-joints, Design of propeller shaft, criteria, failure theories-joint design, Design of Final drive and differential	08
05	Brakes and Suspension: internal expanding shoe brake, friction lining material, leaf spring, coil spring, materials, suspension system and linkages, independent suspension	06
06	Advanced automotive Body Structures: Emphasis is on body concept for design. Material selection and manufacturing constraints	06

Term Work

Term work shall consists of exercises on the above topics in the form of design calculations with sketches and/ or drawings, Complete design and preparation of drawings for at least four components using CAD Software and Analysis software, Class Assignments and course project where a group of 3 or 4 students shall perform Stress analysis of any machine element using any analysis software like ANSYS/MSC, NASTRAN etc. and submit report as term work

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

- Exercises/Assignment : 10 Marks
- Course Project : 10 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, Mahadevan book is 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.

Oral examination

1. Oral examination shall be conducted based on term work and syllabus content
2. Examiners are expected to give small task or ask questions either to evaluate understanding of basic fundamentals or to evaluate their capability of applying basic theory to practical applications.

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) Machine Design – Khurmi Gupta. S.Chand pub..
- 2) Design of machine elements -- V. B. Bhandari. *Tara Mcgraw Hill Pub.*
- 3) Design of machine elements—Sharma, Purohit, Prentice Hall india publication
- 4) Machine Design by Pandya & shah, Charolar Publishing
- 5) Mechanical Engineering Design – J.E.Shiegly- McGraw hill
- 6) Recommended Design Data Books- PSG, Kalaikathir Achchagam Publishing
- 7) Recommended Design Data Books -Mahadevan,
- 8) Design of machine element – Spotts.
- 9) Design of machine element – V.M.Faires.
- 10) Machine Design – Black Adams- McGraw Hill
- 11) Machine Design – Rashetov- Mir Publication

Course Code	Course/Subject Name	Credits
AEC704	Product Design & Development	4+1

Objectives

1. To understand fundamental product design concepts
2. To understand product design methodologies
3. To understand product design needs and issues in industry

Outcomes: Learner will be able to.....

1. To design the products as per the customer/industry requirements
2. To apply product design tools and techniques

Module	Detailed Contents	Hrs.
01	1. INTRODUCTION 1.1 Introduction to product design. 1.2 Classification/ Specifications of products. 1.3 Product life cycle & Product mix. 1.4 Modern product development process. 1.5 Innovative thinking. 1.6 Morphology of design (7 phases)	08
02	2. CONCEPTUAL DESIGN 2.1 Generation, selection & embodiment of concept. 2.2 Product architecture. 2.3 Significance of Industrial design process. 2.4 Introduction to Design Of Experiments (DOE) for Robust Design, Taguchi Designs.	08
03	3. DESIGN FOR MANUFACTURING AND ASSEMBLY 3.1 Methods of designing for manufacturing & assembly. 3.2 Designs for maintainability. 3.3 Designs for environment. 3.4 Product costing.	10
04	4. DESIGN METHODOLOGIES 4.1 Value engineering and Value analysis. 4.2 Failure Mode Effect Analysis (FMEA) 4.3 Concurrent engineering 4.4 Quality Function Deployment (QFD) 4.5 Reverse engineering	10
05	5. DESIGN FACTORS 5.1 Ergonomics and Aesthetics. 5.2 Anthropometry. 5.3 Man-Machine interaction. 5.4 Concepts of size and texture, color 5.5 Comfort criteria. 5.6 Psychological & Physiological considerations. 5.7 Economic factors.	06
06	6. PRODUCT DESIGN NEEDS AND ISSUES IN INDUSTRY 6.1 Customer needs: types, models and collection of customer needs information, analysis of information, Rapid prototyping, Tools for product design – Drafting / Modeling software, CAM interface. 6.2 Creativity Techniques: Creative thinking, conceptualization, Brain storming, primary design, drawing, simulation, detail design. 6.3 Legal and social issues. Engineering ethics and issues of society related to design of products, Patents & IP Acts. Overview, Disclosure preparation.	06

Term Work

Term work shall consist of minimum six assignments one from each module and Case studies on product design and development

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

- Exercises/Assignment : 10 Marks
- Case studies : 10 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.

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. Karl T Ulrich, Steven D Eppinger, "Product Design & Development.", Tata McGraw-Hill New Delhi 2003.
2. David G Ullman, "The Mechanical Design Process." McGrawhill Inc.
3. N J M Roozenberg, J Ekels, N F M Roozenberg "Product Design Fundamentals and Methods", John Willey & Sons 1995.
5. Hollins B & Pugh S "Successful Product Design." Butterworths London.
6. Baldwin E. N. & Neibel B. W. "Designing for Production.", Edwin Homewood Illinois
7. Jones J. C. "Design Methods." Seeds of Human Futures, John Willey New York.
8. Bralla J. G. "Handbook of Product Design for Manufacture, McGrawhill New York.
9. K. Chitale; R.C. Gupta, Product Design and Manufacturing, Prentice - Hall India.
10. Dieter George E., Engineering Design McGraw Hill Pub. Company, 2000.

Course Code	Course/Subject Name	Credits
AEE7011	Power Plant Engineering^{&}	3+1

& Common with Mechanical Engineering

Objectives

1. Study basic working principles of different power plants
2. Study power plant economics

Outcomes: Learner will be able to...

1. Comprehend various equipments/systems utilized in power plants
2. Discuss types of reactors, waste disposal issues in nuclear power plants
3. Illustrate power plant economics

Module	Detailed Contents	Hrs.
01	Introduction: Energy resources and their availability, types of power plants, selection of the plants, review of basic thermodynamic cycles used in power plants.	04
02	Hydro Electric Power Plants : Rainfall and run-off measurements and plotting of various curves for estimating stream flow and size of reservoir, power plants design, construction and operation of different components of hydro-electric power plants, site selection, comparison with other types of power plants.	06
03	Steam Power Plants: Flow sheet and working of modern-thermal power plants, super critical pressure steam stations, site selection, coal storage, preparation, coal handling systems, feeding and burning of pulverized fuel, ash handling systems, dust collection-mechanical dust collector and electrostatic precipitator.	08
04	Combined Cycles: Constant pressure gas turbine power plants, Arrangements of combined plants (steam & gas turbine power plants), re-powering systems with gas production from coal, using PFBC systems, with organic fluids, parameters affecting thermo dynamic efficiency of combined cycles. Problems.	06
05	Nuclear Power Plants: Principles of nuclear energy, basic nuclear reactions, nuclear reactors- PWR, BWR, CANDU, Sodium graphite, fast breeder, homogeneous; gas cooled. Advantages and limitations, nuclear power station, waste disposal.	06
06	Power Plant Economics: Load curve, different terms and definitions, cost of electrical energy, tariffs methods of electrical energy, performance & operating characteristics of power plants- incremental rate theory, input-output curves, efficiency, heat rate, economic load sharing, Problems.	06

List of Experiments

1. Case study report on at least two types of power plants
2. Group presentation (Group shall not be more than 3 students) on topics relevant to syllabus
3. Industrial visit to any power plant

Term Work

Term work shall consist of one case study report and 5 assignments covering maximum syllabus

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

- Case study: **05 marks**
- Industrial visit report: **05 marks**
- Presentation: **05 marks**
- Assignments : **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. Power Plant Engineering, A K Raja, Amit Praksh Shrivastava, Manish Dwivedi, New Age International Publishers
2. Power Plant Familiarization, Manual of Central Training Resources Unit of NTPC India, 1991
3. Power Plant Engineering, 2nd ed, P.K. Nag , Tata McGraw-Hill Pub. Com., New Delhi.
4. Hydro-Electric and Pumped Storage Plants, M G Jog, New Age International Publishers
5. A Text Book of Power Plant Engineering, R.K. Rajput, Laxmi Publications
6. A Course in Power Plant Engineering, Arora, Domkundwar, DhanpatRai & Co.
7. Power Plant Engineering, P.C. Sharma, S.K. Kataria& Sons.
8. Power Plant Engineering, G.R. Nagpal, Khanna Publishers
9. Power station Engineering and Economy by Bernhardt G.A. Skrotzki and William A. Vopat, Tata Mc Graw Hill Publishing Company Ltd., New Delhi
10. Nuclear Energy An Introduction to the Concepts, Systems and Applications of Nuclear Processes, 6th Edition, Raymond L Murray, , ELSEVIER
11. Power Plant Engineering, Manoj Kumar Gupta, PHI Learning
12. Nuclear Power Plant Engineering, James Rust, Haralson Publishing Company
13. Nuclear Power Plants, Edited by Soon Heung Chang, InTech Publishers, 2012
Nuclear Power Plants, Geotge Petridis and DimitriosNicolau, NOVA Publishers

Course Code	Course/Subject Name	Credits
AEE7012	Supply Chain Management^{&}	3+1

& Common with Mechanical Engineering

Objectives

1. To develop an understanding of key drivers of supply chain performance and their inter-relationships with strategy.
2. To impart analytical and problem solving skills necessary to develop solutions for a variety of supply chain management & design problems.
3. To understand the complexity of inter-firm and intra-firm coordination in implementing programs such as e-collaboration, quick response, jointly managed inventories and strategic alliances.

Outcomes: Learner will be able to.....

1. Illustrate the role & functions of supply chain management and its processes.
2. Analyze the flows of material, information and funds in an integrated manner.
3. Evaluate various performance measures of supply chain management.

Module	Detailed Contents	Hrs.
01	Building a Strategic Frame Work to Analyse Supply Chains Supply chain stages and decision phases, Process view of supply chain: Supply chain flows, Examples of supply chains, Competitive and supply chain strategies, Achieving strategic fit: Expanding strategic scope, Drivers of supply chain performance. Framework for structuring drivers: inventory, transportation facilities, information obstacles to achieving fit.	04
02	Designing the Supply Chain Network Distribution Networking: Role, Design, Supply Chain Network(SCN):Role, Factors, Framework for design decisions.	05
03	Materials Management Scope, Importance, Classification of materials, Procurement, Purchasing policies, Vendor development and evaluation. Inventory control systems of stock replenishment, Cost elements, EOQ and its derivative modules.	06
04	Dimensions of Logistics Introduction: A Macro and Micro Dimensions, Logistics interfaces with other areas, Approach to analyzing logistics system, Logistics and systems analyzing: Techniques of logistics system analysis, factors affecting the cost and Importance of logistics.	06
05	Warehouse and Transport Management Concept of strategic storage, Warehouse functionality, Warehouse operating principles, Developing warehouse resources, Material handling and packaging in warehouses, Transportation Management, Transport functionality and principles, Transport infrastructure, transport economics and Pricing. Transport decision making.	07
06	IT in Supply Chain 6.1 IT framework, Customer Relationship Management(CRM),internal Supply chain management, Supplier Relationship Management (SRM) and Transaction Management.Coordination in a Supply Chain 6.2 Lack of supply chain coordination and the Bullwhip effect, Obstacle to Coordination, Managerial levers, Building partnerships and trust. Emerging Trends and Issues 6.3 Vendor managed inventory-3PL-4PL, Reverse logistics: Reasons, Role, Activities; RFID systems: Components, Applications, Implementation; Lean supply chain, Implementation of Six Sigma in supply chain, Green supply chain.	08

Term Work

Term work shall consist of,

1. Assignments: On topics drawn from syllabus [At least 1 assignment per module].
2. Seminar / case study on the modules / trending scenario (current) in industry.

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

Seminar / Case study Presentation & report	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. *Supply Chain Management Strategy, Planning, and operations*, Sunil Chopra and Peter Meindl
2. *Materials Management & Purchasing*, Ammer D.S. Taraporawala
3. *Designing & Managing Supply chain*, David Simchi Levi, Philip Kaminsky & Edith Smichi Levi
4. *Supply Chain Redesign: Transforming Supply Chains into Integrated Value Systems*, Robert B Handfield, Ernest L Nicholas
5. *The Management of Business Logistics: A Supply Chain Perspective*, Coyle, Bardi, Langlely

Course Code	Course/Subject Name	Credits
AEE 7013	Tribology	3+1

Objectives

1. To provide students with the fundamental knowledge in the field of Industrial tribology.
2. To provide basic concepts in the design of automotive lubrication system.
3. To provide knowledge of friction and wear mechanism in automotive system.

Outcome: Lerner will be able to....

1. apply knowledge of tribology for industrial component design
2. apply design concepts practically for automotive lubrication systems

Module	Detailed Contents	Hrs.
1	Introduction to Tribology Introduction to Tribology, Tribology in design, Tribology in industry, economic aspects of Tribology, lubrication, basic modes of lubrication, lubricants, properties of lubricants-physical and chemical, types of additives, extreme pressure lubricants, recycling of used oils and oil conservation, disposal of scrap oil, oil emulsion. Types of sliding contact bearings, comparison of sliding and rolling contact bearings	06
2	Friction and Wear Friction: Introduction, laws of friction, kinds of friction, causes of friction, friction measurement, theories of friction, effect of surface preparation. Wear: Types of wear, various factors affecting wear, measurement of wear, wear between solids and liquids, theories of wear.	06
3	Hydrodynamic lubrication Theory of hydrodynamic lubrication, mechanism of pressure development in oil film, two-dimensional Reynold,,s equation, infinitely long journal bearing, infinitely short journal bearing, finite bearing Hydrodynamic thrust bearing: Introduction, flat plate thrust bearing, pressure equation, load, center of pressure, friction in tilting pad thrust bearing.	06
4	Hydrostatic Lubrication Hydrostatic lubrication: Basic concept, advantages and limitations, viscous flow through rectangular slot, load carrying capacity and flow requirement of hydrostatic step bearing, energy losses, optimum design of step bearing. Compensators and their actions. Squeeze film lubrication: Introduction, circular and rectangular plates approaching a plane.	06
5	Elasto-hydrodynamic Lubrication and Gas Lubrication Elastohydrodynamic Lubrication: Principle and application, pressure-viscosity term in Reynolds equation, Hertz theory. Ertel- Grubin Equation Gas lubrication: Introduction, merits and demerits, applications. Lubrication in metal working: Rolling, forging, drawing and extrusion. Bearing materials, bearing constructions, oil seals, shields and gaskets	06
6	Surface Engineering Introduction to surface engineering, concept and scope of surface engineering, manufacturing of surface layers, solid surface geometrical, mechanical and physic chemical concepts, superficial -layer, development of concept, structure of superficial layer, general characteristics of superficial layer, obtained by machining, strengthening and weakening of superficial layer.	06

Term Work

Term work shall consist of at least one (1) assignment from each module and a case study or seminar by each student.

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

- Assignments: 10 marks
- Seminar / Case study Presentation & report: 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. Cameron A., "Basic Lubrication Theory", Wiley Eastern Ltd.
2. Shizhu Wen, "Principles of Tribology", Wiley
3. Majumdar, "Introduction to Tribology and Bearings", S.Chand and Company Ltd. New Delhi
4. Fuller D. D., "Theory and Practice of Lubrication for Engineers", John Wiley and Sons
5. Halling J., "Principles of Tribology", McMillan Press Ltd.
- 6.
7. B. Bhushan, B.K. Gupta, "Handbook of tribology: materials, coatings and surface treatments", McGraw-Hill
8. Davis J., "Surface Engineering for corrosion and Wear Resistance", Woodhead Publishing, 2001
9. Tadausz Burakowski, "Surface Engineering of Metals: Principles, Equipments, Technologies", Taylor and Francis

Course Code	Course/Subject Name	Credits
AEE 7014	Computational Fluid Dynamics^{&}	3+1

& Common with Mechanical Engineering

Objectives

1. Study basic principles of modeling a system using software
2. Study grid generation and discretization methods

Outcomes: Learner will be able to...

1. Demonstrate & explain geometrical model of a fluid flow
2. Describe specific boundary conditions and solution parameters

Module	Detailed Contents	Hrs.
01	Introduction: What is CFD, Scope and Application of CFD, Methods of Predictions like Experimental and theoretical, Working of Commercial CFD Softwares, Solution methodology-Preprocessing, Solver, Post processing.	04
02	Mathematical description of Physical Phenomenon: Governing Differential Equations, Meaning of Differential equation, The Continuity Equation, A Momentum equation, The Energy Equation, The General Differential Equation, Boundary Conditions, Initial and Boundary Conditions, Initial and Boundary Value problems	06
03	Grid Generation and Discretization Methods: Structured and unstructured Grids: O-type, H-type, C-type of Structured Grid Generation, Mesh Adaptation. The Nature of Numerical Methods: The Discretization Concept, The Structure of the Discretization Equation. Methods of Deriving the Discretization Equations, Taylor-Series Formulation, Variational Formulation, Method of Weighted Residuals, Control Volume Formulation	08
04	Heat Conduction, Convection and Diffusion: Steady One-dimensional Conduction, Unsteady One-dimensional Conduction, Two and Three-dimensional Situations, Over relaxation and Under relaxation, Steady One-dimensional and Two Dimensional Convection-Diffusion, Unsteady One-dimensional Convection	06
05	Incompressible Fluid Flow: Governing Equations, Stream Function-Vorticity Method, Determination of Pressure for Viscous Flow, The SIMPLE, SIMPLER Algorithm, Introduction to Turbulence Modeling, Basic Theories of Turbulence, The Time-Averaged Equations for Turbulent Flow.	06
06	Finite Volume Methods: FVM solutions to steady one, two and three dimensional diffusion problems and unsteady one and two dimensional diffusion problems, FVM solutions to convection-diffusion problems - one and twodimensional, steady and unsteady; Advection schemes; Pressure velocity coupling	06

List of Experiments

1. Simulate and solve, two problems, each 2-d and 3-d steady and unsteady flows using any commercial CFD package like Ansys-FLUENT, STAR CCM, FLUIDYNE, Ansys-CFX, etc.
2. Write codes for, at least one each, 1-d and 2-d steady conduction with and without source and do the post processing to verify with analytical results
3. Write codes, at least one, for steady, 2-d conduction-advection problems and do the post processing to verify with analytical results

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) : **15 marks**
- Assignments : **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. An introduction to computational fluid dynamics-The finite volume method, Versteeg.H.K. , Malalasekera.W., Prentice Hall
2. Computational Fluid Mechanics and Heat Transfer, Anderson, D.A., Tannehill, I.I., and Pletcher, R.H., Hemisphere Publishing Corporation, New York, USA, 1984.
3. Introduction to Computational Fluid Dynamics, Niyogi P. ,Laha M.K., Chakrabarty S.K., Pearson Education, India.
4. Computational Fluid Flow and Heat Transfer, Muralidhar, K.,andSundararajan,T., Narosa Publishing House ,New Delhi1995.
5. Computer Simulation of flow and heat transfer, Ghoshdasdidar, P. S., Tata McGraw-Hill Publishing Company Ltd., 1998.
6. Finite Element Programming of the Navier Stock Equation, Taylor, C and Hughes J.B., Pineridge Press Ltd.U.K.1981.
7. Computational Techniques for Fluid Dynamics: Fundamental and General Techniques, Fletcher, C.A.J., Springer-Verlag, 1987.
8. Numerical Fluid Dynamics, Bose, T. K., Narosa Publishing House, 1997.

Course Code	Course/Subject Name	Credits
AEE 7015	Automotive Embedded Systems	3+1

Objectives

1. To provide broad introduction to automotive embedded systems
2. To provide a comprehensive overview about existing and future automotive electronic systems.
3. To enable undergraduates to be able to design and apply embedded systems.

Outcomes: Learner will be able to...

1. Ability to design automotive component to meet desired needs.
2. Competence to apply the fundamental knowledge of Applied Mechanics, Strength of Materials, Engineering Materials and Theory of Machine for actual design problems.
3. Develop analytical abilities to give solutions to automotive design problems.

Module	Detailed Contents	Hrs.
01	<p>Introduction</p> <p>Body and convenience electronics, Vehicle power supply controllers and lighting modules, Door control modules</p> <p>Safety electronics: Active safety systems such as ABS, ASR& ESP etc., Passive safety systems such as restrained systems and their associated sensor in an automobile.</p> <p>Power train electronics :Petrol Engine Management,</p> <p>Infotainment electronics: Dashboard /Instrument cluster, car audio, telematics system, navigation system, multimedia systems etc.</p> <p>Cross application technologies:42 volt vehicle power supply system</p>	06
02	<p>Embedded Communications</p> <p>A Review of Embedded Automotive Protocols, Dependable Automotive CAN Networks, Flex Ray Protocol</p>	08
03	<p>Drive By Wire</p> <p>Challenges and opportunities of X by Wire: System and design requirements steer by wire, brake by wire, suspension by wire, gas by wire, power by wire, and shift by wire.</p> <p>Future of automotive Electronics</p>	06
04	<p>Hardware Modules</p> <p>MC9S12XD family features</p> <p>Modes of operation: functional block diagram overview, Programming model Map Overview Pulse width Modulator(PWM)</p> <p>On chip ADC serial communication protocol: SCI,SPI,IIC,CAN</p>	06
05	<p>Software Developments Tools</p> <p>Introduction to HCS12XDT512 Student learning kit & PBMCU(Project board), Introduction to code warrior IDE: editing, debugging simulating simple programs. Flashing code into HCS12XDT512 SLK board and testing</p>	06
06	<p>Integration of Software and Hardware</p> <p>Downloading the software from Host Machine to target Machine, Implementing Application Prototype: Power windows and automotive lighting system</p>	04

Term Work

Term work shall consist of 6 assignments (One on each module) covering maximum portion of the syllabus.

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

- Assignments : **20 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 Electronics By Tom H.Denton
2. Automotive Electrical and Electronic Systems by John F. Kershaw, James D. Halderman / Pearson Education
3. Automotive Embedded System Handbook by Nicolas Navet/CRC PRESS
4. Distributed Automotive Embedded System
5. Embedded System Handbook by Richard Zurawski

Course Code	Course/Subject Name	Credits
AEE 7016	Industrial Robotics	3+1

Objectives

1. To understand basic needs and requirements of robotics in industry.
2. To learn basic kinematics required in designing of robots.
3. To write and embed programs in robots.

Outcomes: Learner will be able to...

1. Appreciate the significance of robot in industry.
2. Design and make the robot for particular industrial problem.

Module	Detailed Contents	Hrs.
01	Fundamentals of Robotics Introduction, Fundamentals of Robot Technology, Programming, and Applications Robot Technology: The Robot and its Peripherals Control Systems and Components, Robot Motion Analysis and Control, Robot End Effectors, Sensors in Robotics, Machine Vision	08
02	Kinematics of robotics. Types of joints and motion, Basic of kinematics in robotics, Inverse kinematics, Balancing of robots	06
03	Robot Programming and Languages Robot Programming on microcontrollers., Robot Languages, Artificial Intelligence	04
04	Robot Applications in Manufacturing Application of robot in processing, assembly and inspection. ASRS(Automatic storage and retrieval system), AGV(Automated guided Vehicles)	06
05	Implementation Principles and Issues Technical issues involved in implementing Robotics, its Safety, Training, Maintenance and Quality	06
06	Social Issues and the Future of Robotics Social and Labor Issues, Robotics Technology of the Future	06

Term Work

Term work shall consist of 6 assignments (one on each module) covering maximum portion of the syllabus.

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

- Assignments : **20 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. Robert Shilling, Fundamentals of Robotics-Analysis and control, Prentice Hall of India
2. J.J, Craig, Introduction to Robotics, Pearson Education
3. Fu, Gonzales and Lee, Robotics, McGraw Hill
4. Curtis D. Johnson, Process Control Instrumentation Technology, PHI Publication, Eighth Edition
5. Staughard, Robotics and AI, Prentice Hall of India
6. Grover, Wiess, Nagel, Oderey, Industrial Robotics, McGraw Hill
7. Walfram Stdder, Robotics and Mechatronics,
8. Niku, Introduction to Robotics, Pearson Education
9. Klafter, Chmielewski, Negin, Robot Engineering, Prentice Hall of India
10. Mittal, Nagrath, Robotics and Control, Tata McGraw Hill publications
11. George L Balten Jr., Programmable Controllers , Tata McGraw Hill publication
12. Handbook of Industrial Robotics: Ed. Shimon Y. Nof, John Wiley. ISBN: 9780471177838.

Course Code	Course/Subject Name	Credits
AEE 7017	Transportation Management & Motor Industries	3+1

Objectives

1. To study basic concepts of transport management
2. To study different types of motor insurance

Outcomes: Learner will be able to...

1. To improve existing transport management systems
2. To implement advance techniques in traffic management

Module	Detailed Contents	Hrs.
01	1. Motor Vehicle Act 1.1 Short titles & definitions 1.2 Laws governing to use of motor vehicle & vehicle transport 1.3 Licensing of drivers & conductors 1.4 Registration of vehicle 1.5 State & interstate permits 1.6 Traffic rules, Signals & controls 1.7 Accidents, Causes & analysis 1.8 Liabilities & preventive measures 1.9 Rules & regulations 1.10 Responsibility of driver 1.11 Public & public authorities 1.12 Offences, penalties & procedures 1.13 Different types of forms 1.14 Government administration structure 1.15 Personnel, Authorities & duties 1.16 Rules regarding construction of motor vehicles	04
02	2. Taxation 2.1 Objectives 2.2 Structure & methods of laving taxation 2.3 One time tax 2.4 Tax exemption & tax renewal	08
03	3. Insurance 3.1 Insurance types & significance 3.1.1 Comprehensive 3.1.2 Third party insurance 3.2 Furnishing of particulars of vehicles involved in accident 3.3 MACT (Motor Accident Claims Tribunal) 3.4 Solatium Fund 3.5 Hit & Run case 3.6 Duty of driver in case of accident 3.7 Surveyor & Loss Assessor, Surveyor.s report	04
04	4. Passenger Transport Operation 4.1 Structure of passenger transport organizations 4.2 Typical depot layouts 4.3 Requirements and Problems on fleet management 4.4 Fleet maintenance 4.5 Planning - Scheduling operation & control 4.6 Personal & training-training for drivers & conductors 4.7 Public relations, Propaganda, publicity and passenger amenities 4.8 Parcel traffic.	08

	4.9 Theory of fares-Basic principles of fare charging 4.10 Differential rates for different types of services 4.11 Depreciation & debt charges 4.12 Operation cost and Revenues 4.13 Economics & records	
05	5. Goods Transport Operation 5.1 Structure of goods transport organizations 5.2 Scheduling of goods transport 5.3 Management Information System (MIS) in passenger / goods transport operation 5.4 Storage & transportation of petroleum products	06
06	6. Advance Techniques in Traffic Management 6.1 Traffic navigation 6.2 Global positioning system	06

List of Experiments

1. Organization & Management of Motor Vehicle Department
2. Collection & study of different types of RTO forms.
3. Central Motor Vehicle rules
4. Taxation, Insurance & Permits
5. Study of accidents claims & survey report including post accident procedure
6. Study of depot layouts (passenger & goods transport)
7. Case study of MIS in passenger / goods transports organization
8. Collection & study of goods transport records.
9. Study of vehicle navigation system
10. Advanced traffic control devices

Term Work

Term work shall consist of 8 experiments from the list, 6 assignments (One on each module) 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. Motor Vehicle Act - Government of India Publications
2. Economics of Transport, S.K. Shrivastava
3. Transport Development in India, S. Chand & Co. Pvt. Ltd., New Delhi.

Course Code	Course/Subject Name	Credits
AEC 801	Autotronics	4+1

Objectives

1. To study basic and advance Automotive Electronics systems.
2. To study working of different Automotive Electronics systems and subsystems.
3. To study basic and advance electronics technologies like Battery, Fuel Cell, ECM etc.
4. To have basic idea about how automotive electrical systems are developed.

Course Outcomes: Learner will be able to.....

1. Practically identify different automotive Electronics systems and subsystems.
2. Practically identify and demonstrate Systems like Battery, Alternator, Dynamo, Starter Motors, and Sensors etc.

Module	Detailed Contents	Hrs.
01	<p>1. Battery</p> <p>1.1 Requirement, 1.2 Construction, 1.3 Principle of operation, 1.4 Working of Lead acid, alkaline, Zebra, Sodium Sulphur, Swing, batteries, 1.5 Ratings, 1.6 Charging. 1.7 Maintenance & testing of Lead acid battery.</p> <p>2. Fuel Cells</p> <p>2.1 Introduction of Fuel Cells & fuel used 2.2 Constructions and Operation of proton Exchange membrane 2.3 Alkaline Fuel Cell. 2.4 Medium & high temperature fuel cells, 2.5 Reformers.</p> <p>3. 42-volt technology</p> <p>3.1 Introduction, 3.2 Transition from 12V to 42V electrical system, 3.3 Need of 42V automotive electrical system. 3.4 42V automotive power system, 3.5 Method of controlling 12V system in 42V architecture, 3.6 Present developments in 42 volt technology.</p>	08
02	<p>1. Charging System</p> <p>1.1 Requirements of charging system 1.2 Dynamo 1.2.1 Principle of operation 1.2.2 Construction 1.2.3 Working 1.2.4 Regulators, Combined current & voltage regulator etc.</p> <p>1.3 Alternator 1.3.1 Principle of operation 1.3.2 Construction 1.3.3 Working 1.3.4 Rectification from AC to DC</p> <p>2. Starting system</p> <p>2.1 Requirements of starting system</p>	08

	<ul style="list-style-type: none"> 2.2 Various torque terms used 2.3 Starter motors drives <ul style="list-style-type: none"> 2.3.1 Bendix 2.3.2 Folo through Barrel 2.3.3 Rubber compression 2.3.4 Compression spring 2.3.5 Friction clutch 2.3.6 Overrunning clutch 2.3.7 Dyer 2.4 Starter motor solenoids & switches 2.5 Glow plugs <p>3. Integrated Starter and Alternator</p>	
03	<p>1. Electronic Ignition System</p> <ul style="list-style-type: none"> 1.1 Capacitor Discharge Ignition system 1.2 Distributer less Ignition System 1.3 Direct Ignition System, 1.4 Hall Effect pulse generator 1.5 Inductive pulse generator 1.6 Constant dwell system 1.7 Constant energy system <p>2. Electronic Engine controls</p> <ul style="list-style-type: none"> 2.1 Electronic control module (ECM) 2.2 Operating modes of ECM (closed loop & open loop) 2.3 Inputs required & output signals from ECM 2.4 Electronic spark timing 2.5 Electronic spark control 2.6 Air management system 2.7 idle speed control 	08
04	<p>1. Sensors & Actuators</p> <ul style="list-style-type: none"> 1.1 Automotive Sensors, <ul style="list-style-type: none"> 1.1.1 Thermisters, 1.1.2 Inductive Sensors, 1.1.3 Position Sensors (Rotary, Linear) 1.1.4 Pressure Sensors, 1.1.5 Knock Sensor, 1.1.6 Optical Sensor 1.1.7 Hot wire & thin film air flow sensor, 1.1.8 Turbine fluid flow sensors 1.1.9 Light sensor, 1.1.10 Methanol sensor 1.1.11 Rain sensor operating principles 1.1.12 Oxygen sensor 1.1.13 Application & new developments in sensor technology 1.2 Automotive Actuators <ul style="list-style-type: none"> 1.2.1 Introduction, 1.2.2 Function & operating principle 1.2.3 Construction & working of solenoid actuators, 1.2.4 Relays 1.2.5 Motorized actuators, 1.2.6 Thermal Actuators 1.2.7 Electro hydraulic & Electrochemical Valve actuators, 1.2.8 Application & new developments in the actuators technology. 1.2.9 Stepper motors. 	08

05	<p>1. Automotive Lighting and wiring harness systems.</p> <p>1.1 Lighting</p> <p>1.1.1 Energy demand of lighting system</p> <p>1.1.2 Types of Lamps</p> <p>i. Head lamp: Construction & types. Setting & control</p> <p>ii. Fog Lamp</p> <p>iii. Side Lamp</p> <p>iv. Tail lamp</p> <p>v. Parking lamp</p> <p>vi. Brake warning light</p> <p>vii. Trafficators</p> <p>viii. Blinkers</p> <p>ix. Flashers</p> <p>x. Electronic flasher circuit</p> <p>xi. Instrument panel lights</p> <p>xii. Body interior illumination</p> <p>xiii. Adaptive lighting system.</p> <p>1.1.3 Reflectors: Parabolic, Bifocal, Homifocal, poly-ellipsoidal</p> <p>1.1.4 Gauges: Fuel, Temperature, Oil pressure etc.</p> <p>1.1.5 Accessories: Electric horn, wipers, Fuel pump, Power operated windows.</p> <p>1.2 Wiring</p> <p>1.2.1 Cables</p> <p>1.2.2 Sizes</p> <p>1.2.3 Colors & color codes</p> <p>1.2.4 Connectors</p> <p>1.2.3 Multiplex wiring system</p>	08
06	<p>Introduction to Automotive embedded system and Intelligent vehicle system. Telematics, X by wire, GPS etc.</p>	08

List of Experiments

1. Study of Lead Acid Battery.
2. Study of Fuel Cells.
3. Dismantling, Inspection & assembly of A. C. Generator/Dynamo.
4. Dismantling, Inspection & assembly of Starter motor.
5. Measurement of Temperature using sensor.
6. Measurement of Pressure using sensor.
7. Measurement of Position using sensor.
8. Measurement of Oxygen using sensor.
9. Study of Air Management System under different operating conditions.
10. Study of effect of operating variables on injector's activating Pulses.
11. Study of functioning/working of Idle speed control system.
12. Study of effect of spark advances on the Engine Emissions.
13. Study of Idle Speed Control.
14. Study of Electro-magnetic fuel Injector.

Term Work

Term work shall consist of minimum 8 experiments from the list, 6 assignments covering maximum portion of the syllabus (one on each module).

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.

Practical/Oral examination

1. Practical examination is based on list of experiments proposed.
2. Demonstration of automobile electronic systems like Battery, Alternator, Dynamo, Starter Motors, Sensors etc
3. Distribution of marks for practical/oral examination shall be as follows:
 - i. Practical performance: 15 marks
 - ii. Oral: 10 marks
4. Evaluation of practical examination to be done based on the experiment performed
5. Students work along with evaluation report to be preserved till the next examination

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. Understanding Automotive Electronics by William B. Ribbens
2. Automobile Electrical & Electronics by Tom Denton.
3. Intelligent Vehicle Technologies by Michel Parent
4. Light weight Electric/Hybrid vehicle design by John Fenton & Ron Hodkinson
5. Computerized engine control by Dick King
6. Automotive electrical equipments by P.L.Kohli
7. Automotive Mechanics by William Crouse and Anglin.
8. Automotive Electronic Hand book by Ronald K. Jurgen
9. Car electronics (Second edition) edited by Shuji Mizutani.

Course Code	Course /Subject Name	Credits
AEC802	Vehicle Dynamics	4+1

Objective

1. To provide students with the fundamental knowledge in the field of automotive dynamics.

Outcome: Learner will be able to.....

1. Ability to design automotive component to meet desired needs.
2. Competence to apply the fundamental knowledge of Applied Mechanics, Strength of Materials, Engineering Materials and Theory of Machine for actual design problems.
3. Develop analytical abilities to give solutions to automotive design problems.

Module	Details	Hrs
1	Fundamentals of vehicle dynamics Road loads, Aerodynamics - Drag, side force, Lift force, Rolling resistance, Total road loads, Ride, Vehicle response properties, Perception of ride. Tyres Tyre construction, Tractive properties, Cornering properties, Camber thrust, Aligning moment, Combined braking and cornering, Conicity and ply steer, Tire vibrations, Tyre properties affecting vehicle rollover	10
2	Suspension systems Fundamental approach to vehicle modeling, Single mass system with two degree of freedom, Theory and problems of double Conjugate points, Motion after the hump, Acceleration for stepped input, Solid axles, Independent suspensions, Anti- Squat and anti- pitch suspension geometry, Equalizing type of suspension, Active suspension, Semi Active.	10
3	Roll Center of suspension linkages, Roll axes and roll angles, Non- Roll layout, No Roll suspensions, Vehicle Rollover Characteristics of on road rollover, Rollover resistance, Anti rollover Braking, Anti- roll bar and its effects Equation of Motion Euler's equation of motion, Inertia tensor axes	08
4	Steering Systems Steering geometry, Front wheel geometry, Steering system forces and moments, Steering system effects, Influence of front wheel drive, Four wheel steering, Steering oscillations, Shimmy & wheel wobble, Jack Knifing of articulated vehicles	07
5	Handling characteristics Steady state cornering, Low speed turning, High speed cornering, Stability derivatives (Derivation and problems), Suspension effect of cornering, Steady state and Transient behavior	07
6	Recent trends in vehicle dynamics Stability Control systems, Introduction of vehicle sensors, Central tyre, inflation systems, Influence of parameters at vehicle rollover, Vehicle dynamics simulations	06

List of Experiments

1. Mathematical modeling of suspension system (Quarter suspension model and half vehicle).
2. Live problem on suspension design of modern vehicle in passenger car segment, heavy vehicle segment etc

Term Work

Term work shall consist of experiments from the list, and minimum 6 assignments covering maximum portion of the syllabus (one on each module).

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. Fundamentals of Vehicle Dynamics By Thomas. D. Gillespie.
2. Multibody Systems Approach to Vehicle Dynamics Mike Blundell and Damian Harty.
3. Mechanics of Road vehicle By Steeds.
4. Mechanics of vehicles By J.J. Taborelc.
5. Automobile suspension and Handling By Colin Campell.
6. Car suspension By Bastow.

Course Code	Course /Subject Name	Credits
AEC803	Vehicle Maintenance	4+1

Objectives

1. To study basics of vehicle maintenance
2. To study maintenance of vehicle systems and subsystems
3. To study different automotive diagnostic tools

Outcomes: Learner will be able to.....

1. Effectively use automotive diagnostic tools in industries.
2. Improve existing vehicle maintenance practices in industries.

Module	Details	Hrs.
1	Types of Maintenance Automotive Engine Diagnosis: Lower End Theory and Service, Upper End Theory and Service, Engine Lubrication Diagnosis and Service, Cooling System Diagnosis	06
2	Electrical System Diagnostic and Service Batteries: Theory Diagnosis, and Service Starting System Diagnosis, and Service Charging Systems Basic Lighting System Diagnosis	10
3	Electrical Accessories Windshield Wiper/Washer Systems , Horns/Clocks/Cigarette Lighter Systems, Sound Systems , Power Lock Systems, Power Windows, Power Seats, Power Mirror System, Rear-Window Defrosters an Heated Mirror Systems, Other Electronic Equipment, Security and Antitheft Devices	06
4	Restraint Systems: Theory, Diagnosis, and Service Seat Belts , Seat Belt Service, Air Bags, Electrical System Components Diagnosis, Servicing the Air Bag System, Other Protection Systems	06
5	Manual transmissions and transaxles Clutch Problem Diagnosis and Service, Diagnosis of Drive Shaft and U-Joint Problems, Transmission/Transaxle Problem Diagnosis and Service, Servicing the Final Drive Assembly and Diagnosing Differential Noises	08
6	Suspension And Steering Systems Tire/Wheel Run out, Tire Replacement, Tire Repair, Installation of Tire/ Wheel Assembly on the Vehicle, Basic Front-Suspension Diagnosis and Service, Manual-Steering Systems and Power-Steering System Diagnosis and service, Alignment Geometry Performing an Alignment on Two wheel drive Four-Wheel-Drive Vehicle Alignment Brakes Drum Brake Inspection, Brake Shoes and Linings, Wheel Cylinder Inspection and Servicing, Drum Parking Brakes. Disc Brake Diagnosis and Service, General Caliper Inspection and Servicing, Rear Disc Brake Calipers, Antilock Brake System Diagnosis and Service	12

	<p>Engine Performance OBD-II Self- Diagnostics, Basic Diagnosis of Electronic Engine Control Systems Using Scan Tool Data, Symptom-Based Diagnosis, Ignition System Diagnosis and Service, Fuel Injection System Diagnosis and Service, Emission Control Diagnosis and Service, EGR System Diagnosis and Service , Catalytic Converter Diagnosis, Air System Diagnosis and Service</p>	
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List of Experiments

1. To perform engine analysis of petrol & diesel engines using a computerized engine analyzer or Auto Master.
2. To perform wheel balancing on a computerized wheel balancer.
3. To find the steering geometry of a vehicle using a computerized wheel aligner
4. Removing and refitting of tyre using an automatic tyre changer.
5. Dismantling, inspection and repairing and assembly of engine components.
6. Experiment on calibration of the fuel injection pump.
7. Study of body repairing and reconditioning methods.

Term Work

Term work shall consist of 7 experiments from the list, and minimum 6 assignments covering maximum portion of the syllabus (one on each module).

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.

Practical/Oral examination

1. Practical examination duration is 2 hours.
2. Examination is based on experiments performed during the semester
3. Distribution of marks for practical/oral examination shall be as follows:
 - i. Practical performance: 15 marks
 - ii. Oral: 10 marks
4. Evaluation of practical examination to be done based on the experiment performed
5. 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. Automotive Technology :A Systems Approach, 5e Jack Erjavec/Delmar Cengage Learning
2. Automotive Mechanics, William Crouse and Donald Anglin /TATA Mc Graw-hill
3. Automotive Technology, Joseph Heitner
4. Automotive Electrical and Electronic Systems by John F. Kershaw, James D. Halderman
5. Automotive Engines: Theory and Servicing by J.D.Halderman & Mitchell/Pearson Education.

Course Code	Course/Subject Name	Credits
AEE 8021	Noise, Vibrations and Harshness	3+1

Objectives

1. To study basic concepts of noise, vibration and harshness and their effects
2. To study various methods of Vibration control
3. To study and analyze sounds and detection of noise from automobiles.

Outcomes: Learner will be able to...

1. Identify and analyze vibrations and noise coming out of automobiles
2. Investigate level of harm caused by noise and harshness and to provide measures to control it.

Module	Detailed Contents	Hrs.
01	1. Basics of Vibrations: 1.1 Basic Concepts 1.2 Mathematical Models 1.3 System characteristics and response 1.4 Single and Multi DOF systems	06
02	2. Vibration control: 2.1 Isolators 2.2 Tuned absorbers 2.3 Untuned viscous dampers 2.4 Applications: single cylinder engines, multi cylinder engine 2.5 Simple rubber engine mounts 2.6 Hydro elastic mounts 2.7 Semi active mounts and active mounts 2.8 Mass elastic models and measurements 2.9 Limits for passenger comforts	08
03	3. Sound & sound measurement: 3.1 Fundamentals of acoustics 3.1.1 General sound propagation 3.1.2 Plane wave propagation 3.1.3 Spherical wave propagation 3.2 Human response to sound – the audible range 3.3 Sound measurement 3.3.1 Instrumentation 3.3.2 Sound level meters 3.3.3 Frequency intensity analyzers 3.3.4 Real time measurements	08
04	4. Automotive noise: 4.1 Automotive noise criteria 4.1.1 Drive by noise test 4.1.2 Noise from stationary vehicles 4.1.3 Interior noise in vehicles 4.2 Automotive noise 4.2.1 Sources and control methods i) Engine noise ii) Transmission noise iii) Intake and exhaust noise iv) Aerodynamic noise v) Tyre noise vi) Brake noise	06

05	5. General noise control principles 5.1 Sound in enclosures 5.2 Sound energy absorption 5.3 Sound transmission through barriers	04
06	6. Harshness 6.1 Causes 6.2 Frequency limits	04

Term Work

Term work shall consist of at the list 6 assignments (one on each module) covering maximum portion of the syllabus.

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

- Assignments : **20 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. Rao S S, "Mechanical Vibrations", Addison Wesley Longman, New Delhi, 1995.
2. Heinz Heisler, "Advanced Engine Technology", SAE 1995.
3. "Automobiles and pollution" SAE Transaction, 1995.
4. Seto, "Mechanical Vibrations ", Schaum Outline Series, McGraw Hill Book Company, New York, 1990.
5. Springer and Patterson, "Engine Emission", Plenum Press 1990.
6. Thomson W T, "Theory of Vibration with Applications", CBS Publishers and Distributors, New Delhi, 1990.
7. Ashok Kumar Mallik, "Principles of Vibration control", Affiliated East-West Press (P) Ltd., New Delhi, 1990.
8. Grover G K, "Mechanical Vibrations ", New Chand and Brothers, Roorkey, 1989.
9. Tse Morse and Hinkle, "Mechanical Vibration", Prentice Hall of India Ltd., New Delhi, 1987.

Course Code	Course/Subject	Credits
AEE 8022	Vehicle Safety	3+1

Objectives

1. To study basic concepts of vehicle safety
2. To study accident reconstruction analysis methods
3. To study different issues in vehicle safety

Outcomes: Learner will be able to.....

1. Understand vehicle design from safety point of view
2. Apply the concepts of accident reconstruction analysis in real world

Module	Detailed Contents	Hrs.
01	Introduction: Introduction to vehicle safety, Basic concepts of vehicle safety, Risk evaluation and communication, Human error control, Universal design The distracted driver, Special design problems (Design for children, handicap, etc)	06
02	Safety Regulations and testing: Vehicle Safety Regulations, Accident Data, Accident Avoidance, Biomechanics and Occupant Simulation, Crash Testing, Vehicle Body Testing, Dynamic Vehicle Simulation Tests, Occupant Protection Pedestrian Protection, Compatibility, Interrelationship among Occupants, Restraint Systems, and Vehicle in Accidents	08
03	Rear Crash Safety: Head Restraint Position during Normal Driving, Study of procedure to evaluate Occupant Interaction with seat in rear crashes, Role of seat in Rear crash safety, Performance criteria for different seats, Ultra high Retention seats, Human and dummy responses for Pendulum impacts to the Back Effectiveness of Self –Aligning Head Restraints in preventing whiplash, Energy absorptions properties of Head Restraints, Introduction to RUPD (Rear under run protection device)	08
04	Accident Reconstruction Analysis: Uncertainty in Measurement and cautions, Tire forces, Straight-line Motion Critical speed from Tire Yaw marks, Reconstruction of Vehicular Rollover Accidents, Analysis of Collisions , Impulse – Momentum Theory, Reconstruction Applications , Impulse Momentum Theory, Crush Energy Frontal Vehicle –Pedestrian Collusion, Photogrammetry for accident constructions	08
05	Working of different Automotive safety systems Recent trends in Automotive safety systems	04
06	Key issues in vehicle safety in India and Abroad	02

List of Experiments:

1. Measurement of Windscreen wiping area for different vehicles.
2. Study of Crash test dummies.
3. Measurement of Eye lids, H Point and R Point.
4. Calibration study of Speedometer and Odometer.
5. Study of Tell Tale Symbols in Indian Cars
6. Industrial Visit

Term Work

Term work shall consist of 5 experiments from the list, 6 assignments covering maximum portion of the syllabus (One on each module).

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

- Laboratory work (Experiments) : **10 marks**
- Assignments : **05 marks**
- Industrial 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 vehicle safety by George Peters and Barbara Peters, CRC Press, 2002.
2. Understanding Automotive electronics by William Ribbens, Newnes, Sixth Edition, 2003.
3. Vehicle Accident Analysis and Reconstruction Methods by Raymond M. Brach and R. Matthew Brach, SAE International, Second Edition, 2011.
4. Role of the seat in rear crash safety by David C. Viano, SAE International, 2002.
5. Automotive Safety Handbook by Ulrich W. Seiffert and Lothar Wech, SAE International, 2007.

Course Code	Course/Subject Name	Credits
AEE 8023	World Class Manufacturing^{&}	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. “Operations Management for Competitive Advantage”, Chase Richard B., Jacob Robert., 11th Edition , McGraw Hill Publications, 2005.

Course Code	Course/Subject Name	Credits
AEE 8024	Knowledge Management	3+1

Objectives

1. To study basic concepts of knowledge management
2. To understand knowledge management tools and techniques

Outcomes: Learner will be able to...

1. Effectively implement knowledge management in organizations
2. Improve existing knowledge management practices in organizations

Module	Detailed Contents	Hrs.
01	Introduction to Knowledge Management: What Is Knowledge Management? Data ,information and knowledge, Types of knowledge, Forces Driving Knowledge Management, Knowledge Management Systems, Knowledge management systems and existing technology	02
02	Principles of Knowledge Management 2.1 Knowledge Management Foundations: Infrastructure, Mechanisms, and Technologies: Knowledge Management Foundations, Knowledge Management Infrastructure, Knowledge Management Mechanisms, Knowledge Management Technologies, Management of Knowledge Management Foundations 2.2 Knowledge Management Solutions: Processes and Systems: Knowledge Management Processes, Knowledge Management Systems, Managing Knowledge Management Solutions 2.3 Organizational Impacts of Knowledge Management: Impact on People, Impact on Processes, Impact on Products, Impact on Organizational Performance	06
03	Knowledge Management Technologies and systems 3.1 Knowledge Application Systems: Systems that Utilize Knowledge: Technologies for Applying Knowledge, Developing Knowledge Application Systems, Types of Knowledge Application Systems, Limitations of Knowledge Application Systems 3.2 Knowledge Capture Systems: Systems that Preserve and Formalize Knowledge: What Are Knowledge Capture Systems? Knowledge, Management Mechanisms to Capture Tacit Knowledge: Using Organization Stories, Techniques for Organizing and Using Stories in the Organization Designing the Knowledge Capture System, Concept Maps, Context-Based Reasoning, Barriers to the Use of Knowledge Capture Systems 3.3 Knowledge Sharing Systems: Systems that Organize and Distribute Knowledge: What Are Knowledge Sharing Systems?, Designing The Knowledge Sharing System, Barriers to The Use of Knowledge Sharing Systems, Specific Types of Knowledge Sharing Systems, Lessons Learned Systems, Communities Of Practices (COP), Expertise Locator Knowledge Sharing Systems, The Role of Ontologies and Knowledge Taxonomies in the Development of Expertise Locator Systems, Shortcomings of Knowledge Sharing Systems 3.4 Knowledge Discovery Systems: Systems that Create Knowledge: Mechanisms to Discover Knowledge: Using Socialization to Create, New Tacit Knowledge, Technologies to Discover Knowledge: Using Data Mining to Create, New Explicit Knowledge, Designing the Knowledge Discovery System, Barriers to the Use of Knowledge Discovery Systems	10

04	4.1 Emergent Knowledge Management Practices 4.2 Factors Influencing Knowledge Management: A Contingency View of Knowledge Management, The Effects of Task Characteristics, The Effects of Knowledge Characteristics, The Effects of Organizational and Environmental Characteristics, Identification of Appropriate Knowledge Management Solutions 4.3 Leadership and Assessment of Knowledge Management: Leadership of Knowledge Management, Importance of Knowledge Management Assessment, Types of Knowledge Management Assessment, Assessment of Knowledge Management Solutions, Assessment of Knowledge, Assessment of Impacts	08
05	The Future of Knowledge Management: Using Knowledge Management as a Decision-Making Paradigm to Address Wicked Problems, Promoting Knowledge Sharing While Protecting Intellectual Property, Involving Internal and External Knowledge Creators, Addressing Barriers to Knowledge Sharing and Creation, KM for innovation	06
06	Case studies in Knowledge Management	04

List of Experiments

1. Case studies on knowledge Management
2. Group seminar (Group shall not be of more than 3 members)

Term Work

Term work shall consist of a case study, report of group seminar, 6 assignments covering maximum portion of the syllabus (one on each module).

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

- Case study: **10 marks**
- Seminar: **05 marks**
- Assignments : **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. Encyclopedia of knowledge management by David Schwartz, publisher : Idea Group Reference
2. Knowledge Management Foundations by Steve Fuller, publisher: Butterworth–Heinemann.
3. KM tools and techniques : practitioners and experts evaluate KM solutions / Madanmohan Rao ,publisher Elsevier Butterworth–Heinemann
4. Knowledge management strategies for business development / Meir Russ, editor. Published by Business Science Reference
5. The Knowledge-Creating Company by Ikujiro Nonaka by Harvard Business Review.
6. The complete guide to knowledge management: a strategic plan to leverage your company's intellectual capital / Edna Pasher and Tuvya Ronen.
7. The Knowledge management Toolkit: Practical Techniques for building a Knowledge management System by Amrit Tiwana/ Pearson Education

Course Code	Course/Subject Name	Credits
AEE 8025	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	Detailed Contents	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
AEE 8026	Artificial Intelligence	3+1

Objectives

1. Introduction to the basic concepts of Artificial Intelligence.
2. To develop the design and programming skills.
3. Implement, evaluate, and compare the performance of various AI Techniques.

Course Outcomes: Learner will be able to

1. Apply the concept in Automobile industry
2. Model and simulate real life problem of Automobile industries.

Module	Detailed Contents	Hrs.
01	<p>AI and Internal Representation Artificial Intelligence and the World, Representation in AI, Properties of Internal Representation, The Predicate Calculus</p> <p>Intelligent Agents: Concept of Rational Agent, Structure of Intelligent agents, Agent Environments.</p> <p>Problem Solving : Solving problems by searching, Problem Formulation, Search Strategies, Uninformed Search Techniques, DFS, BFS, Uniform cost search, Iterative Deepening, Comparing different Techniques, Informed search methods – Best First Search, heuristic functions, Hill Climbing, A*.IDA*. Crypt Arithmetic, Bactracking for CSP</p>	06
02	<p>Programming in LISP or PROLOG Lisps, Typing at Lisp, Defining Programs, Basic Flow of Control in Lisp, Lisp Style, Atoms and Lists, Basic Debugging, Building Up List Structure, More on Predicates, Properties, Pointers, Cell Notation and the Internals (Almost) of Lisp, Destructive Modification of Lists, The for Function, Recursion, Scope of Variables Input/Output, Macros</p>	06
03	<p>Fundamentals Concepts and Models of Artificial Neural Systems Biological Neuron and their Artificial Models, Models of ANN, Learning and Adaptation, Neural Networking Learning Rules. Single-layer Perception Classifiers</p> <p>Multilayer Feed forward Networks : Linearly Nonseparable Pattern Classification, Delta Learning Rule, Feed forward Recall and Error Back-Propagation Training, Learning Factor</p>	06
04	<p>Fuzzy Systems Fuzzy Sets: Fuzzy Relations, Fuzzy Function, Fuzzy Measures, probabilities possibilities. Fuzzy Modeling and applications of Fuzzy Control. Neural and fuzzy machine Intelligence</p>	06
05	<p>Generic Algorithm: Simple generic algorithm, Simulation by hands, similarity templates (Schemata), Mathematical foundations, Schema processing at work, Two armed and k armed Bandit Problem, Building blocks hypothesis, Minimal Deceptive Problem,</p> <p>Computer implementation of generic algorithm, Data structures, Reproduction, Cross over and mutation. Time to response and time to cross mapping objective function to fitness from fitness scaling. Application of generic algorithm. De Jong and Function Optimization. Improvement in basic techniques, Improvement to genetics based machine learning, application of genetic based machine learning</p>	06

06	<p>Data Mining & Information Retrieval</p> <p>Data warehousing & Data Mining. Online Analytic Processing [OLAP]: its architecture and its use. Java implementations, classification trees and exploratory data analysis [EDA].</p> <p>EDA Vs Hypothesis Testing, Computational EDA Techniques, Graphical [Data Visualization], EDA techniques for function fitting, data smoothing, layering, tessellations, contour projections, Verification of results of EDA. Applications & trends in data mining.</p> <p>Case Studies</p>	06
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Term Work

Term work shall consist of, Assignments on each module [At least 1 assignment per module].
The distribution of marks for term work shall be as follows:

- | | |
|---------------------------------------|-----------------|
| 1. Assignments: | 20 marks |
| 2. 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 Artificial intelligence By Eugene Charniak, Drew McDermott Addison Wesley
1. Artificial Neural Networks- B.Yegnanarayana, PHI, 1999.
2. Genetic Algorithms in search, Optimization & Machine Learning by David E Goldberg-Addison wesley
3. Data Mining by Pieter Adriaans and Dolt Zantinge - Pearson Education Asia
4. Data Warehousing in the Real World by Sam Anahory and Dennis Murray.
5. Artificial Intelligence, Elaine Rich, Kevin Knight, S. Nair, McGraw Hill Publishing Company Ltd
6. Principles of Artificial Intelligence – N.J. Nilsson, Tioga Hill, 1992.
7. Artificial Intelligence and Design of Expert Systems – C.F. Luger & W.A. Stubblefeild, Addison-Wesley.
8. Introduction to Data Mining & Knowledge Discovery – Edelstein, Herbert A.
9. Introduction to Artificial Neural Systems – Jacek M. Zurada, Jaico Publishing House, 2001.
10. Neural Network – SimsonHaykin, Macmillan Publication, 1994.
11. Fuzzy Set Theory & its Applications – H.J.Zimmermann, Allied Publishers Ltd, 1996.

Course Code	Course/Subject Name	Credits
AEE8027	Virtual Reality	3+1

Objectives

1. Introduction to the basic concepts of Virtual Reality.
2. To develop the design and programming skills.
3. Implement, evaluate, and compare the performance of various Virtual Reality Techniques

Outcomes: Learner will be able to....

1. Apply the concept in Automobile industry
2. Model and simulate real life problem of Automobile industries.

Module	Detailed Contents	Hrs.
01	<p>Introduction: A short history of early virtual reality, early commercial VR Technology, VR becomes an Industry, The five classical components of VR Systems.</p> <p>Input Devices: Trackers, Navigations and Gesture Interfaces. Three Dimensional Position Trackers: Tracker performance parameters, Mechanical trackers, Magnetic trackers, Ultrasonic trackers, Optical Trackers and Hybrid Inertial Trackers Navigation and Manipulation Interfaces: Tracker based Navigation/Manipulation Interfaces, Trackballs, and three Dimensional Probes Gesture Interfaces: The Pinch Glove, the 5DT Data Glove, the Didjiglove, the Cyberglove</p>	06
02	<p>Output Devices: Graphical, Three Dimensional Sound and Haptic Displays: Graphical Display: The human visual system, personal graphics displays, large volume displays. Sound displays: the human auditory system, the convolvotron, Speaker based three dimensional sound. Haptic Feedback: The human haptic system, Tactile Feedback Interfaces, Force Feedback Interfaces.</p>	06
03	<p>Computing Architectures for Virtual Reality: The Rendering Pipeline: The graphical rendering pipeline, The haptics rendering pipeline. PC Graphics Architectures: PC Graphics Accelerators, Graphics Benchmarks. Work Station Based Architectures: the Sun Blade 1000 Architecture, The SGI Infinite Reality Architecture. Distributed VR Architectures: Multipipeline Synchronization, Colocated rendering Pipelines, Distributed Virtual Environments.</p>	06
04	<p>Modeling: Geometric Modeling: Virtual Object Shape, Object Visual Appearance. Kinematics Modeling: Homogeneous Transformation Matrices, Object Position, Transformation Invariants, Object Hierarchies, viewing the three dimensional words. Physical Modeling: Collision Detection, Surface Deformation, Force Computation, Force Smoothing and Mapping, Haptic Texturing. Behavior Modeling and Model Management: Level of Detail Management, Cell Segmentation.</p>	06
05	<p>Virtual Reality Programming: Toolkits and Scene Graphs. World Toolkit: Model Geometry and Appearance, The WTK Scene Graph, Sensors and Action Functions, WTK Networking, JAVA 3D: Model Geometry and Appearance, Java 3D Scene graph, Sensors and Behaviors, Java 3D Networking, WTK and Java 3D Performance Comparison. General Haptics Open Software Toolkit: GHOST Integration with the Graphics Pipeline, The GHOST Haptic Scene Graph, Collision Detection and response, Graphics and PHANToM</p>	06

	<p>Calibration.</p> <p>Human Factors in Virtual Reality: Methodology and Terminology: Data Collection and Analysis, Usability Engineering Methodology. User Performance Studies: Test bed Evaluation of universal VR Tasks, Influence of System Responsiveness on User Performance, Influence of Feedback Multimodality.</p>	
06	<p>Traditional Virtual Reality Applications: Medical Application of VR: Virtual Anatomy, Triage and Diagnostic and Rehabilitation. Education, Arts and Entertainment: VR in Education, VR and, Surgery the Arts. Entertainment Application of VR. Military VR Application: Army use of VR, VR Application in Navy, Air Force use of VR.</p> <p>Emerging Application of VR: VR Application and Manufacturing: Virtual Prototyping, other VR Application in Manufacturing; Application of VR in Robotics: Robot Programming, Robot Tele operation. Information Visualization: Oil Exploration and Well Management, Volumetric Data Visualization.</p>	06

Term Work

Term work shall consist of, at least one (1) assignments on each module

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

- Assignments: **20** 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. GrigoreBurdea, Philippe Coiffet, “ Virtual Reality Technology” 2nd edition. Wiley India
2. John vince, “Virtual Reality Systems” Pearson Education Asia
3. Understanding Virtual Reality, Sherman, Elsever.

Course Code	Course/Subject Name	Credits
AEP701 / AEP802	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