UNIVERSITY OF MUMBAI

Bachelor of Engineering

Automobile Engineering

Third Year (Sem. V)

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)

Program Structure for B E Automobile Engineering
T. E. Automobile-(Semester V)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
AEC501	I C Engines[&]	4	2	4	1	5
AEC502	Metrology and Quality Engineering	4	2	4	1	5
AEC503	Production Process-III[&]	4	2	4	1	5
AEC504	Theory of Machines- II[&]	4	2	4	1	5
AEC505	Heat Transfer[&]	4	2	4	1	5
AEL5O1	Business Communication and Ethics[#]	-	2[$]+2	-	2	2
Total		**20**	**14**	**20**	**7**	**27**

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.					
AEC501	I C Engines[&]	20	20	20	80	03	25	25	150
AEC502	Metrology and Quality Engineering	20	20	20	80	03	25	25	150
AEC503	Production Process-III[&]	20	20	20	80	03	25	--	125
AEC504	Theory of Machines- II[&]	20	20	20	80	03	25	--	125
AEC505	Heat Transfer[&]	20	20	20	80	03	25	25*	150
AEL5O1	Business Communication and Ethics[#]	--	--	--	--	--	50	--	50
Total		**--**	**--**	**100**	**400**	**--**	**175**	**75**	**750**

[$] Theory for entire class to be conducted **[#] Common with all engineering program**

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

Course Code	Course/Subject Name	Credits
AEC501	**Internal Combustion Engines[&]**	**4+1**

[&]Common with Mechanical Engineering

Objectives

1. Study of air standard and actual engine cycles.
2. Study of SI and CI engine components and processes involved
3. Study and analysis of engine performance characteristics and engine emissions

Outcomes: Learner will be able to…

1. Differentiate SI and CI engines
2. Identify and explain working of engines components/systems
3. Plot and analyze engine performance characteristic
4. Perform exhaust gas analysis and comment on adverse implications on environment

Module	Detailed Contents	Hrs.
01	**Introduction** Heat engines; Internal and external combustion engines; Classification of I.C. Engines; Cycle of operations in four strokes and two-stroke IC engines and their comparative study; Scavenging and scavenging blowers, Air standard cycles and Fuel air cycles, Variable specific heat and its effects, Dissociation and other losses, Actual cycles, Deviation of actual engine cycle from ideal cycle	06
02	**Spark Ignition Engines** **A. Carburators and fuel injection system in S I Engines :** Theory of carburetion, Simple carburetor, Essential parts of modern carburetor, Types of carburators, Types of fuel injection systems in S I engines, Continuous injection system, Timed injection system, Electronic Fuel-Injection systems (EFIs), Advantages and disadvantages of SI engine fuel injection system **B. Ignition Systems :** Spark Plug and its requirements, Battery, Magneto, Electronic ignition systems **C. Combustion :** Combustion phenomenon in SI Engines, Ignition delay, Flame propagation, Pressure-Crank angle diagram, Abnormal combustion, Auto ignition, Detonation and Knocking, Factors affecting combustion and detonation, Types of combustion chambers	12
03	**Compression Ignition Engines** A. **Fuel Injection Systems :** Types i.e. Air injection systems, Airless/solid injection systems, Common rail, individual pump, distributor and unit injector etc, Injection pumps, Fuel injector, Types of nozzle, Electronically controlled unit fuel injection system, C I Engine Governors: necessity and characteristics B. **Combustion :** Combustion phenomenon in C I engines, Stages of combustion, Delay period, Knocking, Pressure-Crank angle diagram, Factors affecting combustion and knocking, Types of combustion chambers	12
04	**Engine lubrication :** Types of lubricants and their properties, SAE rating of lubricants, Types of lubrication systems **Engine Cooling:** Necessity of engine cooling, disadvantages of overcooling, Cooling systems and their comparison: Air cooling, Liquid cooling **Supercharging/Turbo-charging:** Objectives, Effects on power output and engine efficiency, Methods, Types, Limits	08

05	**Engine Testing and Performance:** Measurement of BP, IP, Fuel Consumption, Air flow, BMEP, Performance characteristic of SI and CI Engines, Effect of load and Speed on mechanical, indicated thermal, break thermal and volumetric efficiencies, Heat balance sheet **Exhaust Emissions :** Exhaust gas analysis and methods, necessity, constituents, Air pollution due to engine exhaust, Pollution control devices and EURO, BHARAT standards **Fuels :** SI and CI engine fuels, Rating of fuels, Non conventional fuels: CNG, LPG, Bio-fuels, Hydrogen, Alcohol etc	06
06	**Alternative Potential Engines:** Stratified charge engine, Wankel engine, Free-piston engine, Stirling engine, VCR engine, Dual fuel engines, Multi fuel engines **Modern Trends in I C Engines**	04

List of Experiments

Part A: Study of physical systems in terms of constructional details and functions

1. 2 Stroke and 4 Stroke Engines
2. Carburetor.
3. Ignition system.
4. Fuel injection system.

Part B: Students shall perform at least 5 experiments from the list

1. Morse Test on petrol engine.
2. Speed Test on petrol or/and diesel engine.
3. Load Test on diesel engine (engines).
4. Heat Balance test on diesel or petrol engines.
5. Experimental determination of Air fuel ratio.
6. Exhaust Gas/Smoke analysis of S.I./ C.I. engines
7. Effect of Supercharging on Performance Characteristics of an engine

Term Work

Term work shall consist of minimum 6 experiments from the list out of which 4 must be actual trials on IC Engines and 1 case study/report (in group of not more than 3 students) on latest trends/developments in IC Engines

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

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

Theory Examination

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

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

References

1. Internal Combustion Engines, Willard W.Pulkrabek, Pearson Education.
2. Internal Combustion Engines, Shyam Agrawal, New Age International
3. Internal Combustion Engine, Mathur and Sharma
4. Internal Combustion Engines, Mohanty, Standard Book House
5. Internal Combustion Engine, Gills and Smith
6. Internal Combustion Engines Fundamentals, John B. Heywood
7. Internal Combustion Engines, Gupta H N, 2nd ed, PHI
8. Internal Combustion Engine, V Ganesan - *TataMcGraw Hill*
9. Internal Combustion Engines, Richard Stone - *Palgrave Publication*
10. Internal Combustion Engine, S.L. Beohar
11. Internal Combustion Engine, P.M Heldt.
12. Internal Combustion Engines, V.L. Maleeve
13. Internal Combustion Engine, E.F. Oberi.
14. Internal Combustion Engine, Domkundwar

Course Code	Course/Subject Name	Credits
AEC502	**Metrology and Quality Engineering**	**4+1**

Objectives

1. Study the fundamentals of modem quality concepts and apply statistical techniques.
2. Study fundamentals of inspection methods and systems.
3. Study the principles and operation of precision measurement tools and equipment's used in modern manufacturing.

Outcomes: Learner will be able to…

1. Apply inspection gauge and checking systems.
2. Understand the purpose of critical dimensions in manufacturing.
3. Analyse simple parts for dimensional accuracy and functionality.

Module	Details	Hrs.
01	1.1 Introduction to Metrology, Fundamental principles and definitions, measurement standards / primary and tertiary standards, distinction between precision and accuracy. 1.2 Limits, fits and tolerances, Tolerance grades, Types of fits, IS919, GO and NO GO gauges- Taylor's principle, design of GO and NO GO gauges, filler gauges, plug gauges and snap gauges.	**05**
02	2.1 Comparators: Constructional features and operation of mechanical, optical, electrical/electronics and pneumatic comparators, advantages, limitations and field of applications. 2.2 Principles of interference, concept of flatness, flatness testing, optical flats, optical interferometer and laser interferometer. 2.3 Surface texture measurement: importance of surface conditions, roughness and waviness, surface roughness standards specifying surface roughness parameters- Ra, Ry, Rz, RMS value etc., surface roughness measuring instruments – Tomlinson and Taylor Hobson versions, surface roughness symbols.	**12**
03	3.1 Screw Thread measurement: Two wire and three wire methods, floating carriage micrometer. 3.2 Gear measurement: Gear tooth comparator, Master gears, measurement using rollers and Parkinson's Tester. 3.3 Special measuring Equipments: Principles of measurement using Tool Maker's microscope, profile projector & 3D coordinate measuring machine.	**12**
04	**Quality Control:** Introduction, definition and concept of quality & quality control, set up policy and objectives of quality control, quality of design and quality of conformance, compromise between quality & cost, quality cost and planning for quality.	**07**
05	**SQC and SQC tools:** Importance statistical methods in QC, measurement of statistical control variables and attributes, pie charts, bar charts/ histograms, scatter diagrams, pareto chart, GANT charts, control charts, X chart, X bar charts, R charts, P charts, np charts their preparation, analysis and applications. Elementary treatment on modern SQC tools.	**08**
06	**Sampling Techniques:** Sampling inspection and basic concepts, OC curves, consumer & producer risk, single & double sampling plans and use of sampling tables.	**04**

List of Experiments

1. Use of comparators.
2. Thread measurement.
3. Gear measurement.
4. Use of Profile projectors.
5. Use of linear and angular measuring instruments.
6. Measurement of surface roughness.
7. Measurement of flatness.

Term Work

Term work shall consist of minimum 5 experiments from the list and presented with inferences and one assignment 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. Experiment for the examination shall be based on the list of experiments mentioned in the term work.
2. The distribution of marks for practical/oral examination shall be as follows:
    i. Practical performance: 15 marks
    ii. Oral: 10 marks
3. Evaluation of practical examination to be done based on the experiment performed and the output of the experiments during practical examination.
4. Students work along with evaluation report to be preserved till the next examination

Theory Examination

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

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

References

1. Practical Engineering Metrology, K.W.B.Sharp, Pitman Publication
2. Engineering Metrology, K.J.Hume, Kalyani publication
3. Engineering. Metrology, I.C. GUPTA, DhanpatRai Publications.
4. Statistical quality control, A.L. Grant, McGraw Hill International, New York.
5. Engineering. Metrology, R.K.Jain, Khanna Publisher.
6. Metrology,Taher.
7. Statistical Quality control, R.C. Gupta
8. I.S. 919/1963.
9. I.S. 2709/1964.
10. Engineering. Metrology, Hume K.G., M C Donald, Technical &Scientific ,London.
11. Quality Control and Industrial Statistics, – Duncon A.J., D.B. Taraporevela& Co. Bombay.
12. Statistical quality Control, Mahajan M., DhanpatRai& Sons, Delhi.
13. Engineering Metrlogy-2nd Ed., P. Narayana, Scitech Publication.
14. Metal working & Metrology, P. Narayana et.al ,Scitech Publication.
15. Quality control 7 ed.,D.H. Besterfield Pearson education.
16. Juran's Quality Control Handbook.

Course Code	Course/Subject Name	Credits
AEC503	**Production Process - III[&]**	**4+1**

[&] Common with Mechanical Engineering

Objectives:

1. To study sheet metal forming as well as mechanical behavior of stress system in metal forming processes.
2. To develop capability to design jigs and fixtures.
3. To give exposure to Non-traditional machining operations.
4. To study concepts regarding modern manufacturing techniques like rapid prototyping, rapid tooling, agile manufacturing technologies etc.

Outcome: Learner will be able to…..

1. Understand sheet metal forming and various stress systems involved in metal forming operations.
2. Understand the intricacies involved in designing jigs and fixtures.
3. Get knowledge about non-conventional machining operations and its application areas.
4. Understand advanced concepts such as rapid prototyping and Agile manufacturing techniques.

Module	Details	Hrs.
01	Introduction to High speed machines, special purpose machines, transfer line and other mass production machines. Types of automats and its tooling.	**04**
02	**Sheet Metal Forming** Elementary treatment of press working, Operation on presses, Press devices Classification of presses, Constructional features of blanking, piercing, compound, combination, progressive, bending, forming and drawing dies, Load calculations, development of blanks, scrap strip layout, punches, selection of die sets, stock guides, strippers, pilots, stops etc. selection of presses, capacities and other details.	**10**
03	**Design of Jigs and Fixtures** Need for jigs and fixtures, elements of Jigs and fixtures, principles of location, design of locating elements, locating pins support pins spring back, vee blocks, etc. principles of clamping simple hand operated clamps, like screw clamp, lever clamps and other types of clamps. Drill bushes-their types and applications indexing devices, auxiliary elements. Design of drill jigs like plate, leaf solid and box types for drilling combined with reaming, spot facing etc. design of milling fixtures such as plain, string, gang and indexing types. Design of turning fixtures.	**12**
04	**Non-traditional Machining** Ultrasonic Machining (USM), Abrasive Jet Machining (AJM),Water Jet Machining, Electrochemical Machining (ECM),Chemical Machining (CHM)Electrical Discharge Machining (EDM),Plasma Arc Machining (PAM),Laser Beam Machining (LBM),Electron Beam Machining (EBM), Arc cutting processes and Oxy fuel cutting process.	**08**
05	**Plastics Injection Mold Design** General arrangement of an injection mold, Basic systems of the mold – Feeding system, cooling system and ejection systems, Concepts of three plate molds and tooling for moulding articles with undercuts, Concepts of split molds, hot runner systems – Their advantages and limitation over conventional systems. Basic concepts of mold standardization and innovative mold components.	**08**

06	**Agile Manufacturing Technologies** Introduction, Developing agile manufacturing, Integration of Product/Process Development, Application of IT/IS concepts, Agile supply chain management, Design of skill and knowledge and Computer control of Agile manufacturing. Flexible manufacturing systems.	**06**

Term Work

1. At least six assignments on concepts, Case studies and analysis based on the topics mentioned above.
2. Term work shall consist of minimum 6 assignments. The distribution of marks for term work shall be as follows

- Lab work (Case Studies): **10 marks**
- Assignments: **10 marks**
- Attendance: **05marks**

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. Mechanical Metallurgy, G E Dieter ,McGraw Hill.
2. Jigs and Fixtures, P H Joshi, Mc Graw Hill.
3. Production Technology, R C Patel & C G Gupte.
4. Production Technology, HMT, Tata Mc Graw Hill.
5. Introduction to Jigs and Tool design, HA Kempster, Butterworth Heinemann Ltd.
6. Manufacturing Process, R A Lindberg, PHI India.
7. Agile Manufacturing- Forging Mew Frontiers, Poul T Kidd,Amagow Co. UK.
8. Agile Manufacturing, AGunasekharan, the 21st Century Competitive strategy, Elsevier Press,India.
9. Stereo Lithography and other RP & M Technologies, Paul F.Jacobs: SME, NY 1996.
10. Rapid Manufacturing, Flham D.T &Dinjoy S.S Verlog London2001.
11. Fundamentals of modern Manufacturing, Fourth Edition, Mikell P Groover, John Wiley & Sons.
12. Metals handbook ,Forming and Forging, Vol. 14, ASM.

Course Code	Course/Subject Name	Credits
AEC504	**Theory of Machines-II[&]**	**4+1**

[&] Common with Mechanical Engineering

Objectives

1. To acquaint with working principles of clutches and its constructional details.
2. To study working and types of brakes and dynamometers.
3. To acquaint with working principles and applications of gyroscope and governors.
4. To demonstrate different types of gear trains and its applications.

Outcomes: Learner will be able to…

1. Apply the working principles of clutches and its constructional details.
2. Analyze working of brakes and dynamometers.
3. Demonstrate working mechanism of different types of governors.
4. Analyze and select gear trains.
5. Analyze gyroscopic effect on various applications

Module	Details	Hrs.
01	**1.1 Clutches:** Requirements of Clutches, Types of Clutches and Clutch materials, Positive clutches, friction clutches, Friction Clutches - Analysis of frictional torque, power transmission .Power loss in Friction in single plate, multiple plate clutch, and cone clutch, Centrifugal Clutches - construction, working	**08**
02	**2.1 Brakes:** Requirement of brake, Types of Brakes, Analysis of Block brakes - external and internal, Band brake-simple and differential, Band and block brake - simple and differential, Braking of vehicles - front wheels, rear wheels, all wheels on level and inclined roads, **2.2 Dynamometers** - Absorption and transmission dynamometers, Study and analysis of absorption type dynamometer - Proney brake, Rope brake, dynamometers, Study and analysis of transmission type dynamometers - Belt transmission, epicyclical, torsion dynamometers, Froude hydraulic dynamometer	**08**
03	**3.1 Governors:** Comparison between governors and flywheel, Types - centrifugal governors, inertia governors, **3.2 Force analysis of gravity loaded governors** - Watt, Porter, Proell, Force analysis of spring loaded governors - Hartnell, hartung, Wilson Hartnell, Force analysis of spring and gravity loaded governor, Performance characteristics of governors- stability, sensibility, isochronisms, Hunting, governor effort and governor power, coefficient of insensitiveness.	**08**
04	**4.1 Gyroscope:** Introduction - Gyroscopic couple and its effect on spinning bodies, Gyroscopic effect on naval ships during steering, pitching and rolling., Ship stabilization with gyroscopic effect **Two wheeler and four wheeler on curved path** - effect of gyroscopic and centrifugal couples, maximum permissible speeds on curve paths, Gyroscopic effect due to lateral misalignment of rigid disc mounted on shaft	**08**
05	**5.1 Gear Trains:** Kinematics and dynamic analysis of - simple gear trains, compound gear trains, reverted gear trains, epi-cyclic gear trains with spur or bevel gear combination. 5.2 **Transmissions:** Necessity of gear box, Sliding mesh, Constant mesh, Synchromesh and epicyclic gear box,	**08**

06	**6.1 Static and Dynamic force analysis** in slider crank mechanism (neglecting mass of connecting rod and crank), Engine force analysis, Turning moment on crank shaft. **6.2 Dynamically equivalent systems** to convert rigid body to two mass with and without correction couple. **6.3 Flywheel and its applications**, Fluctuation in energy, function of flywheel , estimating inertia of flywheel for reciprocating prime movers and machines.	**08**

List of Experiments

1. Study of Clutches
2. Study of Brakes
3. Experiments on Dynamometers - Rope Brake Dynamometer, Torsion Dynamometer
4. Experiments on Governors - Proell Governor, Hartnell Governor,
5. Experiments on Gyroscope
6. Study of power transmission system in automobile
7. Study of Cams & Followers.
8. Plotting of displacement-time, velocity-time, acceleration-time & jerk-time for uniform velocity, UARM, SHM &Cycloidal motion.
9. At least two numerical simulations using C++/MATLAB based on systems discussed in syllabus

Term Work

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

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

- Laboratory work (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. Theory of Machines - Thomas Bevan - C. B. S. Publishers
2. Theory of Machines - S. S. Ratan - Tata McGraw Hill
3. Theory of Machines - P. L. Ballaney, Khanna Publishers, Delhi
4. Dynamics of Machines – Norton, *McGraw Hill Publication*
5. Theory of Mechanisms and Machines - A. Ghosh and A. Malik - *Affiliated East – West Press Pvt. Ltd., New Delhi*
6. Theory of Machines - W. G. Green – *Bluckie & Sons Ltd.*
7. Mechanics & Dynamics of Machinery - J. Srinivas, *Scitech*
8. Kinematics, Dynamics and Design of Machinery, 2nd ed., Kenneth Waldron, Gary Kinzel, *Wiley India Edition*
9. Essential MATLAB for Engineers and Scientist - Brian D. Hanhn, Daniel Valentine,

Course Code	Course/Subject Name	Credits
AEC505	**Heat Transfer [&]**	**4+1**

[&] Common with Mechanical Engineering

Objectives

1. Study and analysis of basic heat transfer concepts applicable for steady state and transient conditions
2. Study mathematical modeling and designing concepts of heat exchangers

Outcomes: Learner will be able to…

1. Identify & explain the three modes of heat transfer (conduction, convection and radiation).
2. Develop mathematical model for each mode of heat transfer
3. Demonstrate and explain mechanism of boiling and condensation
4. Design and analyze different heat exchangers

Module	Detailed Contents	Hrs.
01	**Introduction** Typical heat transfer situations, Modes of heat transfer, heat transfer parameters, various thermo physical properties	02
02	**Conduction** Fourier's law of heat conduction, thermal conductivity, differential equation of heat conduction with heat generation in unsteady state in the Cartesian coordinate system, Boundary and initial conditions, Solution to three dimensional steady heat conduction problems, Steady heat conduction in plane walls, composite walls, Concept of thermal resistance and thermal resistance network, Heat conduction in cylinders and spheres, Differential equation of heat conduction in cylindrical co-ordinates, Conduction through Cylindrical and Spherical composite walls (Derivation NOT INCLUDED for Spherical walls), Critical thickness/radius of insulation and its importance.	10
03	**Extended Surfaces** Heat transfer from finned surfaces, Types of fins, Fin equation for rectangular fin and its solution, Fin efficiency, Fin effectiveness **Transient Heat Conduction** Lumped system analysis, One dimensional transient problems analytical solutions, One dimensional Heisler charts **Numerical Methods in Conduction** Importance of numerical methods, Finite difference formulation of one dimensional steady heat conduction equations	08
04	**Convection** Physical mechanism of convection, Natural and Forced convection, Velocity/hydrodynamic and Thermal boundary layer, Velocity and temperature profile, Differential equation of heat convection, Laminar flow heat transfer in circular pipe, constant heat flux and constant wall temperature, thermal entrance region, Turbulent flow heat transfer in circular pipes, Pipes of other cross sections, Heat transfer in laminar and turbulent flow over a flat plate, Heat pipe introduction and applications, Principles of dimensional analysis and its application in convective heat transfer, Empirical correlations for convection, Physical significance of various dimensionless numbers useful in natural and forced convection	10

05	**Radiation** Thermal radiation, Blackbody radiation, Radiation intensity, Radiative properties, Basic laws of radiation (Plank's law, Kirchoff's law, Stefan-Boltzman law, Wien's displacement law, Lambert's cosine law, Radiation exchange between black surfaces, Shape factor, Radiation exchange between gray surfaces, Radiosity- Irradiation method, Radiation shield and the radiation effect	08
06	**Boiling and Condensation** Boiling heat transfer, Pool boiling, Flow boiling, Condensation heat transfer, Film condensation, Dropwise condensation **Heat Exchangers** Types of heat exchangers, Overall heat transfer coefficient, Analysis of heat exchangers, LMTD method, Effectiveness-NTU method, Correction factor and effectiveness of heat exchangers	10

List of Experiments

1. Thermal conductivity of metal bar /composite wall / liquid /Insulating Material
2. Determination of contact resistance
3. Effect of area on Heat transfer
4. Radial heat conduction
5. Determination of fin efficiency and fin effectiveness
6. Unsteady state heat transfer
7. Heat pipe
8. Natural and Forced convection for flow over flat plate /through a circular pipe
9. Comparison of Overall heat transfer coefficient and effectiveness for double pipe/plate type /shell & tube heat exchanger
10. Determination of emissivity of a grey surface

Term Work

Term work shall consist of minimum 7 experiments from the list, 3 assignments containing numerical based on modes of heat transfer and One Assignment based on live problem relevant to heat exchanger analysis

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

- Laboratory work (Experiments) **:** **10 marks**
- Numerical Assignments : **05 marks**
- Live problem assignment**:** **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.

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. Introduction to Thermodynamics and Heat Transfer, 2nd ed., Yunus A Cengel, McGraw Hill International.
2. Fundamentals of Heat and Mass Transfer, F. P. Incropera and D. P.DeWitt, Wiley India
3. Heat and Mass Transfer, 2nd ed., R Rudramoorthy and L Mayilsamy, PEARSON
4. Fundamentals of Engineering Heat and Mass Transfer, 4th ed., R C Sachdeva, New Age International
5. Heat Transfer, 2nd ed., A F Mills and V Ganesan, PEARSON
6. Heat Transfer, 9th ed., J P Holman, McGraw Hill
7. Engineering Heat and Mass Transfer, Mahesh M Rathore, Laxmi Publication
8. Principles of Heat Transfer, 6th ed., Frank Kreith, CENGAGE Learning
9. Heat and Mass transfer, 6th ed.,D S Kumar, S K Kataria and Sons
10. Heat Transfer, S P Sukhatme, University Press
11. Heat and Mass Transfer, 2nd ed., P K Nag, Tata McGraw Hill
12. Fundamentals of Heat and Mass Transfer, Thirumaleshwar, Pearson Education
13. Engineering Heat Transfer, N V Suryanarayana, Penram Publication
14. Heat and Mass transfer, C P Arora, Dhanpatrai and Co.
15. Heat Transfer, Y V C Rao, University Press
16. Heat and Mass Transfer, R K Rajput, S.Chand and Company
17. Elements of Heat Transfer, Jakole and Hawkins
18. Heat Transfer, James Sueee, JAICO Publishing House
19. Heat Transfer, Donald Pitts & L E Sisson, Schaums Series, Mc Graw Hill International
20. Engineering Heat Transfer, Shao Ti Hsu
21. Heat Transfer, M Necati Ozisik, McGraw Hill International edition
22. Heat Transfer, Ghosdastidar, Oxford University Press

Course Code	Course/Subject Name	Credits
AEL501	**Business Communication & Ethics[&]**	**2**

[#] **Common with all Engineering Programs**

Pre-requisite

- FEC206 Communication Skills

Objectives

1. To inculcate in students professional and ethical attitude, effective communication skills, teamwork, skills, multidisciplinary approach and an ability to understand engineer's social responsibilities.
2. To provide students with an academic environment where they will be aware of the excellence, leadership and lifelong learning needed for a successful professional career.
3. To inculcate professional ethics and codes of professional practice
4. To prepare students for successful careers that meets the global Industrial and Corporate requirement' provide an environment for students to work on Multidisciplinary projects as part of different teams to enhance their team building capabilities like leadership, motivation, teamwork etc.

Outcomes: A learner will be able to …..

1. communicate effectively in both verbal and written form and demonstrate knowledge of professional and ethical responsibilities
2. Participate and succeed in Campus placements and competitive examinations like GATE, CET.
3. Possess entrepreneurial approach and ability for life-long learning.
4. Have education necessary for understanding the impact of engineering solutions on Society and demonstrate awareness of contemporary issues.

Module	Unit No.	Topics	Hrs
1.0	**1.0**	**Report Writing**	**07**
	1.1	Objectives of report writing	
	1.2	Language and Style in a report	
	1.3	Types of reports	
	1.4	Formats of reports: Memo, letter, project and survey based	
2.0	**2.0**	**Technical Proposals**	**02**
	2.1	Objective of technical proposals	
	2.2	Parts of proposal	
3.0	**3.0**	**Introduction to Interpersonal Skills**	**07**
	3.1	Emotional Intelligence	
	3.2	Leadership	
	3.3	Team Buliding	
	3.4	Assertiveness	
	3.5	Conflict Resolution	
	3.6	Negotiation Skills	
	3.7	Motivation	
	3.8	Time Management	
4.0	**4.0**	**Meetings and Documentation**	**02**
	4.1	Strategies for conducting effective meetings	
	4.2	Notice	
	4.3	Agenda	
	4.4	Minutes of the meeting	

5.0	**5.0**	**Introduction to Corporate Ethics and etiquettes**	**02**
	5.1	Business Meeting etiquettes, Interview etiquettes, Professional and work etiquettes, Social skills	
	5.2	Greetings and Art of Conversation	
	5.3	Dressing and Grooming	
	5.4	Dinning etiquette	
	5.5	Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response, the process of making ethical decisions)	
6.0	**6.0**	**Employment Skills**	**05**
	6.1	Cover letter	
	6.2	Resume	
	6.3	Group Discussion	
	6.4	Presentation Skills	
	6.5	Interview Skills	
		Total	**25**

List of Assignments

1. Report Writing (Synopsis or the first draft of the Report)
2. Technical Proposal (Group activity, document of the proposal)
3. Interpersonal Skills (Group activity and Role play)
4. Interpersonal Skills (Documentation in the form of soft copy or hard copy)
5. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
6. Corporate ethics and etiquettes (Case study, Role play)
7. Cover Letter and Resume
8. Printout of the PowerPoint presentation

Term Work

Term work shall consist of all assignments from the list.

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

- Assignments **:** **20 marks**
- Project Report Presentation**:** **15 marks**
- Group Discussion**:** **10 marks**
- Attendance **:** **05 marks**

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

References

1. Fred Luthans, "*Organisational Behavior"* , Mc Graw Hill, edition
2. Lesiker and Petit, "*Report Writing for Business"* , Mc Graw Hill, edition
3. Huckin and Olsen,"*Technical Writing and Professional Communication"*,McGraw Hill
4. Wallace and Masters, "*Personal Development for Life and Work"* , Thomson Learning, 12th edition
5. Heta Murphy, "*Effective Business Communication"* , Mc Graw Hill, edition
6. R.C Sharma and Krishna Mohan, "*Business Correspondence and Report Writing",*
7. B N Ghosh, "*Managing Soft Skills for Personality Development*", Tata McGraw Hill.Lehman,
8. Dufrene, Sinha, "*BCOM*", Cengage Learning, 2nd edition
9. Bell . Smith, "Management Communication" Wiley India Edition,3rd edition.
10. Dr. K. Alex ,"Soft Skills", S Chand and Company
11. Dr.KAlex,"SoftSkills",S Chand and Company
12. R.Subramaniam,"Professional Ethics" Oxford University Press 2013.

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	**AI and Internal Representation** Artificial Intelligence and the World, Representation in AI, Properties of Internal Representation, The Predicate Calculus **Intelligent Agents:** Concept of Rational Agent, Structure of Intelligent agents, Agent Environments**.** **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	**06**
02	**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	**06**
03	**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 **Multilayer Feed forward Networks :** Linearly Nonseparable Pattern Classification, Delta Learning Rule, Feed forward Recall and Error Back-Propagation Training, Learning Factor	**06**
04	**Fuzzy Systems** **Fuzzy Sets: Fuzzy** Relations, Fuzzy Function, Fuzzy Measures, probabilities possibilities. Fuzzy Modeling and applications of Fuzzy Control. Neural and fuzzy machine Intelligence	**06**
05	**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, 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	**06**

06	**Data Mining & Information Retrieval** Data warehousing & Data Mining. Online Analytic Processing [OLAP]: its architecture and its use. Java implementations, classification trees and exploratory data analysis [EDA]. 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. Case Studies	**06**

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	**Introduction:** A short history of early virtual reality, early commercial VR Technology, VR becomes an Industry, The five classical components of VR Systems. **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	06
02	**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.	06
03	**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.	06
04	**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.	06
05	**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	06

	Calibration. **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.	
06	**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. **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.	**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