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 to3 more program educational objectives of their own may be added by affiliated Institutes.

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

Dr. S. M. Khot
Chairman, Board of Studies in Mechanical Engineering, University of Mumbai

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**

T. E. Automobile-(Semester VI)

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
AEC601	Automotive System	3	2	3	1	4
AEC602	Machine Design I[&]	4	2	4	1	5
AEC603	Mechanical Vibrations[&]	4	2	4	1	5
AEC604	Thermal and Fluid Power Engineering[&]	4	2	4	1	5
AEC605	Operations Research	3	2	3	1	4
AEC606	Finite Element Analysis[&]	3	2	3	1	4
	Total	**21**	**12**	**21**	**6**	**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.					
AEC601	Automotive System	20	20	20	80	03	25	25	150
AEC602	Machine Design I[&]	20	20	20	80	03	25	--	125
AEC603	Mechanical Vibrations[&]	20	20	20	80	03	25	25*	150
AEC604	Thermal and Fluid Power Engineering[&]	20	20	20	80	03	25	--	125
AEC605	Operations Research	20	20	20	80	03	25	--	125
AEC606	Finite Element Analysis[&]	20	20	20	80	03	25	25	150
	Total	**--**	**--**	**120**	**480**	**--**	**150**	**75**	**825**

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

University of Mumbai, Automobile Engineering (Third and Final Year) Revised Course (Rev-2012)

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

		Radiation	
05		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**	10
		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	

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	Credits
AEC601	**Automotive Systems**	**3+1**

Objectives
1. To study basic and advance automotive systems.
2. To study working of different automotive systems and subsystems.
3. To study different vehicle layouts.
4. To have basic idea about how automotive systems are developed.

Outcomes: Learner will be able to……
1. Practically identify different automotive systems and subsystems.
2. Practically identify different automotive components.
3. Illustrate working and functions of various automotive components

Module	Details	Hrs.
1	**1. CLUTCHES** 1.1 Function requirements 1.2 Types of single plate clutch 1.3 Clutch control systems 1.4 Clutch center plate construction 1.5 Direct release clutch 1.6 Centrifugally operated clutches 1.7 Multiplate clutches 1.8 Angle spring clutch 1.9 Wet clutch	05

2	**2. TRANSMISSION**
	2.1 Purpose and element of gear box
	2.2 Constant mesh gear box
	2.3 Sliding mesh gear box
	2.4 Synchromesh gear box
	2.5 Gear selector mechanism
	2.6 Heavy vehicle gear boxes
	2.7 Fluid coupling and torque convertors
	    2.7.1 Fluid coupling
	    2.7.2 Torque converters
	2.8 Epicyclic gear box operation
	2.9 Semi – Automatic and Automatic transmission
	    2.9.1 Hydraulic control systems
	    2.9.2 Electro hydraulic control systems
	    2.9.3 Automatic layshaft gear boxes
	    2.9.4 Dual mode transmission with sequential gear change
	    2.9.5 Direct shift gear boxes
	    2.9.6 Over drive gears
	    2.9.7 Continuously variable transmissions
	2.10 Electric drives
	    2.10.1 General arrangement and description of electric transmissions
	    2.10.2 Working principle and control
	    2.10.3 Advantages and limitations of electric drives
		08

3	**3. DRIVE LINES**
	3.1 Drive Lines
	    3.1.1 Universal joints
	    3.1.2 Constant velocity joints
	    3.1.3 Propeller shaft construction
	    3.1.4 Drive line arrangement
	    3.1.5 Rear-wheel drive and front-wheel drive layouts
	    3.1.6 Front-wheel drive shafts
	    3.1.7 Tandem axle drive for heavy vehicles
	    3.1.8 Drive lines for public service vehicles
		05

4	**4. FINAL DRIVE AND REAR AXLES**
	4.1 Final drive gears and bearings
	4.2 Differential gears
	4.3 Differential- All types
	4.4 Rear axle construction
	4.5 Heavy vehicle rear axle
	4.6 Four wheel drive systems
	    4.6.1 Basic consideration of four wheel drive
	    4.6.2 Part time four wheel drive
	    4.6.3 Full time four wheel drive
		05

5	**5. BRAKING AND SUSPENSION SYSTEMS**
	5.1 Braking System
	    5.1.1 Hydraulic brake systems
	    5.1.2 Air brake systems
	    5.1.3 Endurance brake systems
	5.2 Suspension System
	    5.2.1 Basic ride considerations
	    5.2.2 Types of suspension systems
	    5.2.3 Types of suspension spring
	    5.2.4 Tandem axle suspension
	    5.2.5 Shock dampers
	    5.2.6 Adaptive suspension systems
	    5.2.7 Active roll control systems
		07

6	**6. STEERING , TYRES, ROAD WHEELS AND HUBS**
	6.1 Steering systems
	    6.1.1 Steering principles and layout
	    6.1.2 Front end geometry and wheel alignment
	    6.1.3 Steering and suspension ball joints
	    6.1.4 Manual steering gears
	    6.1.5 Steering axles for heavy vehicles
	    6.1.6 Hydraulic power-assisted steering
	    6.1.7 Speed-sensitive hydraulic power-assisted steering
	    6.1.8 Electro-hydraulic power-assisted steering
	    6.1.9 Electrical power-assisted steering
	    6.1.10 Types of four-wheel steering
	6.2 Tyres, Road wheels and Hubs
	    6.2.1 Introduction to Tyre characteristics
	    6.2.2 Tyre construction
	    6.2.3 Road wheels and hubs
		06

List of Assignments/Practical's

Study of cut section models covering all the modules is desirable.

1. Dismantling and reassembling of Clutch.
2. Dismantling and reassembling of Gear box.
3. Dismantling and reassembling of Propeller Shaft.
4. Dismantling and reassembling of Differential.
5. Dismantling and reassembling of Steering gear linkages and steering gear box.
6. Dismantling and reassembling of all types of braking systems.

Case Studies

Assign case studies for each student on any one of the following topics:

1. **Four wheelers**: Light and Heavy vehicles (Passenger and Commercial)
2. **Three wheelers**: Case study of Indian models. Front mounted engine and rear mounted engine types. Auto rickshaws, Pick up van, Delivery van and Trailer, Bijili electric vehicle.
3. **Two wheelers**: Case study of major Indian models of major motor cycles, scooters and mopeds.
4. **Off Road Vehicles:** Case study regarding working principle and construction of each- Earth Moving Machines, Scrappers, Graders, Shovels and Ditchers, Farm Equipment's, Military and Combat Vehicles.

Term Work

Term work shall consist of

A. Assignments/ Practical's as per list
B. Case Studies as above

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

- Part A **:** **10 marks**
- Part B : **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 shall be conducted in a group of not more than 4 students. Examination shall be based on dismantling and reassembling performed during the semester.
2. Examiners are expected to evaluate each group and conduct oral based on the same
3. The distribution of marks for practical/oral examination shall be as follows:
    iii. Practical performance …… 15 marks
    iv. Oral …… ………………. .10 marks
4. Students work along with dismantling and reassembling 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. Light and Heavy Vehicle Technology, M.J. Nunney, Elsevier, Fourth Edition.
2. Automotive Technology, Jack Erjavec, Cengage Learning, Fifth Edition.
3. Automotive Braking, Thomas W. Birch, Cengage Learning, Third Edition.
4. Motor Automotive technology, Anthony E. Schwaller, Delmar, Third Edition.
5. Automotive suspension and steering systems, Thomas W. Birch, Delmar Cengage Learning, Third Edition.

Course Code	Course/Subject Name	Credits
AEC602	**Machine Design-I$^{&}$**	**4+1**

$^{&}$ **Common with Mechanical Engineering**

Objectives
1. To study basic principles of machine design
2. To acquaint with the concepts of strength design related to various components.

Outcomes: Learner will be able to…
1. Demonstrate understanding of various design considerations
2. Apply basic principles of machine design
3. Design machine elements on the basis of strength concept

Modules	Details	Hrs.
01	Mechanical Engineering Design, Design methods, Aesthetic and Ergonomics consideration in design Material properties and their uses in design Manufacturing consideration in design Design considerations of casting and forging Basic principles of Machine Design, Modes of failures, Factor of safety, Design stresses, Principal stresses and strains, Theories of failures Standards, I. S. codes, Preferred Series and Numbers.	06
02	Curved Beams: Assumptions made in the analysis of curved beams. Design of curved beams: Bending stresses in curved beams, such as crane hook, C-frame, etc. Thick cylinders: Design of thick cylinders subjected to an internal pressure using Lame's equation.	06
03	Design against static Loads: Cotter joint, knuckle joint, Turn Buckle Bolted and welded joints under eccentric loading. Power Screw - Screw Presses, C- Clamps along with the Frame, Screw Jack	12
04	Design against Fluctuating Loads Variables stresses, reversed, repeated, fluctuating stresses Fatigue Failure Static and fatigue stress concentration factors Endurance limit - estimation of endurance limit Design for finite and infinite life Soderberg and Goodman design criteria Fatigue design under combined stresses	06
05	Design of shaft - power transmitting, power distribution shafts Module (excluding crank shaft) under static and fatigue criteria. Keys - Types of Keys and their selection based on shafting condition. Couplings- Classification of coupling. Design of Split muff couplings, Flange couplings, Bush pin flexible couplings	11
06	Design of Springs: Helical compression, tension springs under static and variable loads, Leaf springs.	07

List of Assignments

Design exercises in the form of design calculations with sketches and or drawings on following machine system

1. Knuckle joint,
2. Turn Buckle
3. Screw Jack
4. Flexible flange couplings

Term Work

Term work shall consist of

A. Minimum 3 design exercises from the list which may include computer aided drawing on A3 size sheets
B. Stress analysis of any machine element mentioned in the syllabus using any application software and programming language

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

- Part A **:**   **15 marks**
- Part B :   **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.

NOTE:

Use of standard design data books like PSG Data Book, Design Data by Mahadevan is permitted at the examination and shall be supplied by the college.

References

1. Design of machine elements -- V. B. Bhandari. Tara Mc-Graw Hill Pub.
2. Design of machine elements -- Sharma,Purohit. Prentice Hall India Pub.
3. Machine Design - An Integrated Approach -- Robert L. Norton – Pearson Education.
4. Machine Design - Pandya & Shah- Charotar PI/blishing.
5. Mechanical Engineering Design - J. E. Shigley - McGraw Hill
6. Recommended Data Books - PSG, K. Mahadevan
7. Machine Design - Reshetov - Mir Publication
8. Machine Design - Black Adams-Mcgraw Hill
9. Fundamentals of Machine Elements - Hawrock, Jacobson Mcgraw Hill
10. Machine Design - Patel, Pandya, Sikh, Vol. - I & II, C. Jamnadas & Co. Educational & Law Publishers
11. Design of Machine Elements - V.M. Faires
12. Design of Machine Elements - Spotts.

Course Code	Course/Subject Name	Credits
AEC603	**Mechanical Vibration**[&]	**4+1**

[&] **Common with Mechanical Engineering**

Objectives
1. To study basic concepts of vibration analysis
2. To acquaint with the principles of vibration measuring instruments
3. To study balancing of mechanical systems

Outcomes: Learner will be able to…
1. Develop mathematical model to represent dynamic system
2. Estimate natural frequency of mechanical element/system
3. Analyze vibratory response of mechanical element/system
4. Estimate the parameters of vibration isolation system

Modules	Details	Hrs
01	**1.1 Basic Concepts of Vibration :** Vibration and oscillation, causes and effects of vibrations, Vibration parameters – spring, mass, damper, Damper models, Motion – periodic, non periodic, harmonic, non- harmonic, Degree of freedom, static equilibrium position, Vibration classification, Steps involved in vibration analysis. **1.2 Free Undamped Single Degree of Freedom Vibration System** Longitudinal, transverse, torsinal vibration system, Methods for formulation of differential equations by Newton, Energy, Lagrangian and Rayleigh's Method,.	08
02	**2.1 Free Damped Single Degree of Freedom Vibration System** : Viscous damped system – under damped, critically damped, over damped; Logarithmic decrement; Coulomb's damping; Combined viscous and coulomb's damping. **2.2 Equivalent Single Degree of Freedom Vibration System :** Conversion of multi-springs, multi masses, multi – dampers into a single spring and damper with linear or rotational co-ordinate system	08
03	**3.1 Free Undamped Multi Degree of Freedom Vibration System :** Eigen values and Eigen vectors for linear system and torsional two degree of freedom; Holzer method for linear and torsional unbranched system; Two rotors, Three rotors and geared system; Dunkerley's and Rayleigh's method for transverse vibratory system	09
04	**4.1 Forced Single Degree of Freedom Vibratory System :** Analysis of linear and torsional systems subjected to harmonic force excitation and harmonic motion excitation (excluding elastic damper) **4.2 Vibration Isolation and Transmissibility:** Force Transmissibility, Motion Transmissibility Typical isolators& Mounts **4.3 Rotor Dynamics:** Critical speed of single rotor, undamped and damped.	09
05	**5.1 Vibration Measuring Instruments:** Principle of seismic instruments, vibrometer, accelerometer - undamped, damped **5.2** Introduction to Conditioning Monitoring and Fault Diagnosis.: Atleast two case studies in detail based on Conditioning Monitoring and Fault Diagnosis.	06
06	**6.1 Balancing** Static and dynamic balancing of multi rotor system, Balancing of reciprocating masses In-line engines, V- engines (excluding radial Engines)	08

University of Mumbai, Automobile Engineering (Third and Final Year) Revised Course (Rev-2012)

List of Experiments
1. Experimental prediction of natural frequency of compound pendulum, prediction of equivalent simple pendulum system.
2. Experimental prediction of natural frequency for longitudinal vibrations of helical springs, and springs in series and parallel
3. Experimental prediction of natural frequencies, and nodal points for single rotor and two-rotor vibratory system, and comparison with theoretical results
4. Experimental and theoretical investigation of whirling of shaft (i.e. . comparison of experimental and theoretical natural frequency and justification of discrepancy between experiment and theory)
5. Experimental investigation of viscous and coulomb damping, prediction of system parameter (spring stiffness, damping coefficient) from damped oscillations
6. Experimental and theoretical investigation of frequency response of mechanical system, and comparing both and justification of discrepancy between theory and experiments
7. Experiments' on distributed parameter system: Transverse vibrations of beam (Dunkerley's Rule Expt.)
8. Experimental balancing of single and multi-rotor system.
9. Introduction to FFT analyzer, and prediction spectral response of vibrating machine from workshop.
10. Experiments on vibration isolation system and prediction of force transmissibility, motion transmissibility of system.
11. Vibration analysis of mechanical system using MATLAB

Term Work
Term work shall consist of minimum 8 experiments from the list and one assignment on each module containing at least 5 numerical.

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.

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. Mechanical Vibrations 4th ed- S. S. Rao - *Pearson Education*
2. Mechanical Vibrations - G. K. Grover
3. Fundamentals of Mechanical Vibration - S.Graham Kelly - *Tata McGraw Hill* 4.
4. Vibration Analysis - P. Srineevasan - Tata McGraw Hill
5. Mechanical Vibrations - Schaum's outline series - S.Graham Kelly- *McGraw Hill*
1. Mechanical Vibrations - Schaum's outline series - William W. Seto- *McGrmvHill* .
2. Theory and Practice of mechanical vibrations - J. S. Rao, K. Gupta - *New Age International Publications.*
3. Mechanical Vibrations - Den; Chambil, Hinckle
4. Mechanical Vibrations, J.P. Den Hartog, McGrawhill Book Company Inc.
5. Leonard Meirovitch, Introduction to Dynamics and Conti'oJ. *Wiley, New York,*
6. Leonard Meirovitch, Elements of Vibration Analysis. *McGrmv-Hill, New York,*
7. Leonard Meirovitch, Dynamics and Control of Structures. *Wiley, New York.* 4. Antony J. Pettofrezzo, Matrices and Transformations. Dover, New York.
8. Benson H. Tongue, Principles of Vibration. *Oxford University Press.*
9. W. Thomson, Theory of Vibrations with Applications, Second Edition, *Pearson Education*
10. Vibrations-BalakumarBalachandan, Edward Magrab, *CENGAGAE Learning.*

Course Code	Course/Subject Name	Credits
AEC604	**Thermal and Fluid Power Engineering$^&$**	**4+1**

$^&$ **Common with Mechanical Engineering**

Objectives

1. To study boilers, boiler mountings and accessories
2. To study utilization of thermal and hydraulic energy
3. To study gas turbine and its applications

Outcomes: Learner will be able to…

1. Identify utilities of thermal and hydraulic energy
2. Differentiate impulse and reaction turbines
3. Analyze performance of turbines

Module	Detailed Contents	Hrs.
01	**Steam Generators** Fire tube and Water tube boiler, Low pressure and high pressure boilers, once through boiler, examples, and important features of HP boilers, Mountings and accessories. Layout of a modern HP boiler. Equivalent evaporation of boilers. Boiler performance. Boiler efficiency	08
02	**Steam Nozzle and Turbines** Flow through steam nozzle-velocity at exit and condition for maximum discharge, nozzle efficiency **Steam Turbine-** Basic of steam turbine, Classification, compounding of turbine, Impulse turbine – velocity diagram. Condition for max efficiency. Reaction turbine - velocity diagram, degree of reaction, Parson's turbine. Condition for maximum efficiency	10
03	**Impact of Jets and Water Turbines** Impact of jet on flat and curved plates Types of hydro turbines - impulse and reaction, definition of various turbine parameters like gross head, discharge, work done, input power, output power, efficiencies etc., Eulers' equation applied to a turbine, turbine velocities and velocity triangles, expression for work done. **Pelton Turbine:** Components of Pelton turbine, definition of design parameters like speed ratio, jet ratio, and estimation of various parameters like head, discharge, and efficiency etc., determination of number of buckets. **Reaction Turbines:** Types of reaction turbines - inward and outward flow, radial mixed and axial; elements of the turbine, estimation of various parameters.	10
04	Similarity relations in turbines, definition of unit quantities and specific quantities, selection of turbines. Prediction of results of prototypes from the model test. Cavitations in turbines - causes, effects and remedies, Thoma's cavitations parameter G. Use of G v/s specific speed graphs. Determination of safe height of installation for the turbine. Characteristics of turbines, governing of turbines.	06

05	**Gas Turbines** Applications of gas turbine, Actual Brayton cycle, open and closed cycle gas turbine, methods to improve efficiency and specific output, open cycle with intercooling, reheat, and regeneration. Effect of operating variable on thermal efficiency and work ratio,	08
06	**Jet Propulsion Engines** Classification of jet propulsion engines, Thrust, Thrust power, Propulsive efficiency and thermal efficiency, Afterburner, Introduction to Turbojet, Turbofan, Ram jet, Turboprop and Rocket engine	06

List of Experiments
1. Study/Demonstration of Boilers
2. Study/Demonstration of Boiler mountings and accessories
3. Study of Steam Turbine
4. Trial on Impulse turbine
5. Trial on reaction turbine
6. Study of gas turbines
7. Study of Jet propulsion engines
8. Visit to Thermal Power Plant/Hydroelectric Power Plant/Gas Turbine Power Plant

Term Work
Term work shall consist of minimum 6 experiments from the list, 3 assignments containing numerical based on maximum contents of the syllabus and a visit report

The distribution of marks for term work shall be as follows:
- Laboratory work (Experiments) **:   10 marks**
- Assignments :   **05 marks**
- Visit report**:   05 Marks**
- Attendance (Theory and Practical) **: 05 marks**

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

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

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

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

References

1. Practical Boiler Operation Engineering and Power Plant, A R Mallick, 3rd ed, PHI Learning
2. Thermal Engineering, Ballaney, Khanna Publishers, Reprint 1994
3. Thermal Engineering, Kothandraman, Domkundwar, Khajuria, Arora, Dhanpatrai& Sons.
4. Turbines, Compressors & Fans, S M Yahya, TMH
5. Thermal Engineering, R K. Rajput, Laxmi Publication
6. Steam and gas turbine, R Yadav
7. Fluid Mechanics and Hydraulic Machinery, Modi and Seth, Standard Book House
8. Hydraulic Machinery, JagdishLal
9. Hydraulic Machines, Vasandani
10. Fluid Mechanics and Machinery-B C S Rao, McGraw Hill
11. Fluid Mechanics and hydraulic Machines,Gupta, Pearson Education
12. Principles of Thermodynamics, H.A. Sorensen, Amerimal Publications, 1972.
13. Applied Thermodynamics for Engineers and Technologists, Eastop and Mcconky Longman,1978
14. Hydraulic Turbines - Nechleba

Course Code	Course/Subject	Credits
AEC605	**Operations Research**	**3+1**

Objectives

1. To understand, different resources used in industries and optimize them.
2. To understand different quantitative methods of optimization.
3. To understand fundamentals of optimization technique that will help in higher study.
4. To have basic idea about quantitative techniques to be used in automobile industries.

Outcomes: Learner will be able to…..

1. Develop fundamental knowledge of optimization technique.
2. Formulate the industrial problem for optimization of resources.
3. Minimize idle time, manufacturing cost and maximize profit, sales etc.

Modules	Details	Hrs.
01	**Linear Programming** Problem Formulation, Graphical Method, Simplex Method – Artificial Variable Techniques - Big M- Method, Two Phase Method – Duality – Dual Simplex Method.	06
02	**Transportation Problem** Formulation – Solution by North West corner rule, Row Minima Method, Matrix Minima Method, Vogel's Approximation Method – Optimality by MODI Method – Unbalanced Transportation Method – Degeneracy. **Assignment** Formulation – Optimality by Hungarian Method, Travelling Salesman Problem.	06
03	**Queuing Models** Introduction, Poisson Arrivals – Exponential Service – Single Channel with Finite and Infinite Population. **Game Theory** Introduction, Maximin & Minimax Principle, Graphical Method (2 x m & n x 2) matrix – Method of Dominance – Method of Marices.	06
04	**Project Management** Phases of Project Management, Network construction, Critical Path Method, Project Evaluation & Review Technique – Resource Analysis-Resource Leveling.	06
05	**Inventory Control** Introduction – Deterministic Model – Instantaneous demand with & without shortage- Models with one and Multiple price break. **Simulation** Definition, Types of Simulation Models – Monte Carlo Technique – Practical Problems – Applications in Inventory & Queuing problems.	06
06	**Decision Theory** Introduction – Decision Making Environment – Decision Under Uncertainty, Criterion of Pessimism, Criterion of Optimism, Laplace Criterion, Hurwitz Criterion, Criterion of Regret – Decision Making Under Risk, Expected Monetary Value (EMV) Criterion, Expected Opportunity Loss (EOL) Criterion – Decision Tree.	06

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Term Work

Term work shall consist of minimum 06 assignments, at least one from each module. Introduction of software is desirable.

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. R. Pannerselvam, Operations Research: PHI Publications.
2. N.D. Vohra, Quantitative Technique in Management: Tata McGraw Hill Education Pvt. Ltd.
3. S.S. Rao, Optimization: Theory and Applications, New Age International Pvt. Ltd.
4. Introduction to Operations Research, Taha, Pearson Education

Course Code	Course/Subject Name	Credits
AEC606	**Finite Element Analysis**[&]	**3+1**

[&] Common with Mechanical Engineering

Objectives

1. To introduce the concepts of Mathematical Modeling of Engineering Problems.
2. To study the applicability of FEM to a range of Engineering Problems.
3. To acquaint with applications of numerical techniques for solving problems.

Outcomes: Learner will be able to…

1. Solve ordinary and partial differential equations using the Galerkin method.
2. Develop the finite element equations to model engineering problems governed by 2nd order partial differential equations.
3. Apply the basic finite element formulation techniques to solve engineering problems.
4. Use commercial FEA software, to solve problems related to mechanical engineering.

Module	Detailed Contents	Hrs.
01	**Introduction** 1.1 Introductory Concepts: Introduction to FEM, Historical Background, General FEM procedure. Applications of FEM in various fields. Advantages and disadvantages of FEM. 1.2 Mathematical Modeling of field problems in Engineering, Governing Equations, Differential Equations in different fields. 1.3 Approximate solution of differential equations-- Weighted residual techniques, Least squares, Galerkin methods, Boundary Value problems.	06
02	**FEA Procedure** 2.1 Discrete and continuous models, Weighted Residual Methods – Ritz Technique – Basic concepts of the Finite Element Method. 2.2 Definitions of various terms used in FEM like element, order of the element, internal and external node/s, degree of freedom, primary and secondary variables, boundary conditions. 2.3 Minimization of a functional. Principle of minimum total potential. Piecewise Rayleigh-Ritz method. Formulation of "stiffness matrix"; transformation and assembly concepts.	06
03	**One-Dimensional Problems** 3.1 One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors. 3.2 Assembly of Matrices - solution of problems in one dimensional structural analysis, heat transfer and fluid flow (Stepped and Taper Bars, Fluid Network, Spring-Cart systems) 3.3 Analysis of Plane Trusses, Analysis of Beams. 3.4 Solution of one Dimensional structural and thermal problems using FE Software, Selection of suitable Element Type, Modeling, Meshing, Boundary Condition, Convergence of solution, Result analysis, Case studies.	06
04	**Two Dimensional Finite Element Formulations** 4.1 Introduction, Three nodded triangular element, four nodded rectangular element, four nodded quadrilateral element, eight nodded quadrilateral element. 4.2 Natural coordinates and coordinates transformations: serendipity and Lagranges methods for deriving shape functions for triangular and quadrilateral element 4.3 Sub parametric, Isoperimetric, super parametric elements. Compatibility, Patch Test, Convergence criterion, Sources of errors.	06

05	**Two Dimensional Vector Variable Problems** 5.1 Equations of elasticity – Plane stress, plane strain and axisymmetric problems. 5.2 Jacobian matrix, stress analysis of CST and four node Quadratic element 5.3 Solution of 2-D Problems using FE Software (structural and Thermal), selection of element type, meshing and convergence of solution. (Can be covered during practical hours).	06
06	**Finite Element Formulation of Dynamics and Numerical Techniques** 6.1 Applications to free vibration problems of rod and beam. Lumped and consistent mass matrices. 6.2 Solutions Techniques to Dynamic problems, longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation, Transverse deflections and Natural frequencies of beams. 6.3 Finding frequencies of beam using FE Software (Can be covered during practical hours).	06

List of Assignment

Students should use the commercial software or programmes from the text-books or self-developed programs, to verify the results obtained by manual calculations. The input data and output results of the problem solved using the computer programs should be included in the Journal. The proposed list is as given below;

1. Any two problem using bar element
2. Any two problems using truss element
3. Any two problems using CST element
4. Any one problem using axisymmetric element
5. Any one problem of free vibration analysis using bar element
6. Any one problem on Steady State Heat conduction.

Course Project

A group of not more than four (04) students, shall do Finite Element Analysis of any mechanical engineering element/system, which involves element selection, assigning properties, meshing, assigning loads and boundary conditions, analysis and result interpretation.

Term Work

Term work shall consist of minimum **06** assignments and course project. The distribution of marks for term work shall be as follows:

- Laboratory work (experiments/assignments): **10** Marks.
- Course project: **10** Marks.
- Attendance: (Theory and Practicals): **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. Assignment for the examination shall be based on the list of assignment 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. Seshu. P. "Textbook of Finite Element Analysis" Prentice Hall of India, 2003.
2. J.N. Reddy, "Finite Element Method" Tata McGraw Hill, 2003.
3. Chandrupatla and Belegundu, "Introduction to Finite Elements in Engineering" 4th Ed Pearson Education, 2012.
4. Logan. D.L. "A first course in Finite Element Method", Thomson Asia Pvt. Ltd., 2002.
5. Cook R.D., Malkus. D.S. Plesha, ME., "Concepts and Applications of Finite Element Analysis", John – Wiley Sons 2003.
6. S.S. Rao, "The Finite Element Method in Engineering "Butter worth Heinemann, 2001.
7. M. Asghar Bhatti, "Fundamental Finite Element Analysis and Applications with Mathematica and MATLAB Computations", Wiley India Pvt. Ltd.