UNIVERSITY OF MUMBAI

Bachelor of Engineering

Mechanical Engineering

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

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

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

Deans Preamble

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

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

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

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

Chairman Preamble

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

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

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

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

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

Dr. S. M. Khot

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

Program Structure for B E Mechanical Engineering

T. E. Mechanical -(Semester V)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
MEC501	I C Engines [&]	4	2	4	1	5
MEC502	Mechanical Measurements and Control	4	2	4	1	5
MEC503	Production Process-III [&]	4	2	4	1	5
MEC504	Theory of Machines- II[&]	4	2	4	1	5
MEC505	Heat Transfer [&]	4	2	4	1	5
MEL5O1	Business Communication and Ethics [#]	-	2[$]+2	-	2	2
Total		**20**	**14**	**20**	**7**	**27**

Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
MEC501	I C Engines [&]	20	20	20	80	03	25	25	150
MEC502	Mechanical Measurements and Control	20	20	20	80	03	25	25	150
MEC503	Production Process-III [&]	20	20	20	80	03	25	--	125
MEC504	Theory of Machines- II[&]	20	20	20	80	03	25	--	125
MEC505	Heat Transfer [&]	20	20	20	80	03	25	25*	150
MEL5O1	Business Communication and Ethics [#]	--	--	--	--	--	50	--	50
Total		**--**	**--**	**100**	**400**	**--**	**175**	**75**	**750**

[$] Theory for entire class to be conducted **[#] common for all engineering programs**
[&] Common with Automobile Engineering *** Only ORAL examination based on term work and syllabus**

T. E. Mechanical -(Semester VI)

Subject Code	Subject Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
MEC601	Metrology and Quality Engineering	3	2	3	1	4
MEC602	Machine Design I [&]	4	2	4	1	5
MEC603	Mechanical Vibrations [&]	4	2	4	1	5
MEC604	Thermal and Fluid Power Engineering [&]	4	2	4	1	5
MEC605	Mechatronics	4	2	4	1	5
MEC606	Finite Element Analysis [&]	3	2	3	1	4
Total		**22**	**12**	**22**	**6**	**28**

Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
MEC601	Metrology and Quality Engineering	20	20	20	80	03	25	25	150
MEC602	Machine Design I [&]	20	20	20	80	03	25	--	125
MEC603	Mechanical Vibrations [&]	20	20	20	80	03	25	25*`	150
MEC604	Thermal and Fluid Power Engineering [&]	20	20	20	80	03	25	--	125
MEC605	Mechatronics	20	20	20	80	03	25	--	125
MEC606	Finite Element Analysis [&]	20	20	20	80	03	25	25	150
Total		**--**	**--**	**120**	**480**	**--**	**150**	**75**	**825**

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

Course Code	Course/Subject Name	Credits
MEC501	**Internal Combustion Engines[&]**	**4+1**

[&]Common with Automobile 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. Carburetors and fuel injection system in S I Engines :**Theory of carburetion, Simple carburetor, Essential parts of modern carburetor, Types of carburetors, 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 Break Horse Power, Indicated Power, 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 and volumetric efficiency of the engine
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
MEC502	**Mechanical Measurement and Control**	**4+1**

Objectives

1. To impart knowledge of architecture of the measurement system
2. To deliver working principle of mechanical measurement system
3. To study concept of mathematical modelling of the control system
4. To Analyse control system under different time domain

Outcomes: Learner should be able to…

1. Identify and select proper measuring instrument for specific application
2. Illustrate working principle of measuring instruments
3. Explain calibration methodology and error analysis related to measuring instruments
4. Mathematically model and analyze system/process for standard input responses

Modules.	Details	Hrs.
01	1.1 Significance of Mechanical Measurements, Classification of measuring instruments, generalized measurement system, types of inputs: Desired, interfering and modifying inputs. 1.2 Static characteristics: Static calibration, Linearity, Static Sensitivity, Accuracy, Static error, Precision, Reproducibility, Threshold, Resolution, Hysteresis, Drift, Span & Range etc. 1.3 Errors in measurement: Types of errors, Effect of component errors, Probable errors.	08
02	**2.1 Displacement Measurement** : Transducers for displacement, displacement measurement, potentiometer, LVDT, Capacitance Types, Digital Transducers (optical encoder) , Nozzle Flapper Transducer **2.2 Strain Measurement** : Theory of Strain Gauges, gauge factor, temperature Compensation, Bridge circuit, orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors **2.3 Measurement of Angular Velocity**: Tachometers, Tachogenerators, Digital tachometers and Stroboscopic Methods. **2.4 Acceleration Measurement**, theory of accelerometer and vibrometers, practical accelerometers, strain gauge based and piezoelectric accelerometers.	08
03	**3.1 Pressure Measurement:** Elastic pressure transducers viz. Bourdon tubes, diaphragm, bellows and piezoelectric pressure sensors, High Pressure Measurements, Bridge man gauge. Vacuum measurement: Vacuum gauges viz. McLeod gauge, Ionization and Thermal Conductivity gauges. **3.2 Flow Measurement**: Bernoullis flowmeters, Ultrasonic Flowmeter, Magnetic flow meter, rotameter. **3.3 Temperature Measurement**: Electrical methods of temperature measurement Resistance thermometers, Thermistors and thermocouples, Pyrometers. **3.3 Sensitivity analysis of sensor**-influence of component variation, **Signal conditioning**: Amplifier, Conversion, Filtering, Impedance Buffering, Modulation / Demodulation, Linearization, Grounding and Isolation.	08

04	4.1 Introduction to control systems. Classification of control system. Open loop and closed loop systems. 4.2 Mathematical modelling of control systems, concept of transfer function, Block diagram algebra.	06
05	**5.1 Transient and steady state analysis of first and second order system.** Time Domain specifications. Step response of second order system. Steady-state error, error coefficients, steady state analysis of different type of systems using step, ramp and parabolic inputs.	06
06	**Stability analysis** 6.1 Introduction to concepts of stability. The Routh criteria for stability. 6.2 Experimental determination of frequency response, Stability analysis using Root locus, Bode plot and Nyquist Plots. 6.3 State space modeling. 6.4 Process control systems, ON-OFF control. P-I-D Control.	12

List of Experiments

1. Calibration of Displacement sensors like LVDT, Potentiometers etc.
2. Calibration of Pressure Gauges
3. Calibration of Vacuum Gauges
4. Torque measurement using strain gauges
5. Calibration of tachometers
6. Vibration Measurement & Calibration of Accelerometers.
7. Experiments on feedback control systems and servomechanisms
8. System Identification of any one of the sensor
9. Experiment on frequency response system identification
10. Experiment on transient state response of a control system.
11. Experiment on design of PID controller for a system.

(Design based experiments shall be encouraged using standard National Instrument/ texas instrument/ dSPACE Gmbh/ Arduino or any other platform)

Term Work

Term work shall consist of minimum **08** experiments (04 from the measurement group and 04 from the control group), assignments 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:
   iii. Practical performance …… 15 marks
   iv. 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. Measurement Systems (Applications and Design) 5th ed.- E.O. Doebelin - *McGraw Hill.*
2. Mechanical Engineering Measurement - Thomas Beckwith, N.Lewis Buck, Roy Marangoni - *Narosa Publishing House, Bombay.*
3. Mechanical Engineering Measurements - A. K. Sawhney - *DhanpatRai& Sons, New Delhi.*
4. Instrumentation Devices & Systems - C.S. Rangan&G.R.Sarrna - *Tata McGraw Hill.*
5. Instrumentation & Mechanical Measurements - A.K. Thayal.
6. Control System Engineering: by Nagrath IJ. and Gopal .M., *Wiley EasternLtd.*
7. Modem Control engineering: by K.Ogata, *Prentice Hall*
8. Control systems: Dhanesh Manik, Cengage Learning
9. Automatic Control System, Benjamin Kuo, Prentice Hall
10. Control system theory with engineering applications, Lysherski, Sergey E, Springer
11. Instrumentation and Control System, W. Bolton, Elsevier
12. Experimental Methods for Engineers - J. P. Holman. - McGraw Hills Int. Edition.
13. Engineering Experimentation - E.O. Doebelin - McGraw Hills Int. Edition
14. Mechanical Measurements- S.P.Venkateshan, Ane books, India
15. Theory and Design for Mechanical Measurements, 3rd ed., Wiley
16. Control System Engineering: Norman Nise, John Wiley and Sons
17. Feedback Control System, Charles Phillips, R. D. Harbor

Course Code	Course/Subject Name	Credits
MEC503	**Production Process - III[&]**	**4+1**

[&] Common with Automobile 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. Demonstrate understanding of sheet metal forming and various stress systems involved in metal forming operations.
2. Design jigs and fixtures for a given applications.
3. Get knowledge about non-conventional machining operations and its application areas.
4. Illustrate advanced concepts such as rapid prototyping and Agile manufacturing.

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
MEC504	**Theory of Machines-II[&]**	**4+1**

[&] Common with Automobile 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
MEC505	**Heat Transfer [&]**	**4+1**

[&] Common with Automobile 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 should 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, Drop wise 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
MEL501	**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**	**06**
	6.1	Cover letter	
	6.2	Resume	
	6.3	Group Discussion	
	6.4	Presentation Skills	
	6.5	Interview Skills	
		Total	**26**

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, "*Organizational 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.