UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Mechanical Engineering

Second Year with effect from AY 2020-21

Third Year with effect from AY 2021-22

Final Year with effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC 23/07/2020

Item No. 119

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Second Year B.E. in Mechanical Engineering**
2	Eligibility for Admission	**After Passing First Year Engineering as per the Ordinance 0.6242**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6242**
5	No. of Years / Semesters	**8 semesters**
6	Level	~~P.G.~~ **/ U.G./** ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ **/ Semester** (Strike out which is not applicable)
8	Status	**New /** ~~Revised~~ (Strike out which is not applicable)
9	To be implemented from Academic Year	**From Academic Year: 2020-2021**

Date

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

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 Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are 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. Choice 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. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 171, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

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Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C ' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

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Preface

When the entire world is discussing about 'Industry 4.0', we are at the crossroads. There are so many expectations from the graduating engineers, who shall be the major contributors to ecosystem for development of the Nation. Engineering education in India, in general, is being revamped so as to impart the theoretical knowledge along with industrial exposure. It is our attempt, when we are introducing a new curriculum; to bridge the industry-academia gap. To enable this, we have introduced components such as skill-based laboratories and project-based learning. We trust that this will allow the learner to apply knowledge gained in previous and current semesters to solve problems for gaining better understanding. What once were pure mechanical systems have now been transformed into multidisciplinary systems of mechatronics, electronics and computer science. Interdisciplinary knowledge is gaining importance as we are moving towards automated world as technology advances. Keeping this in mind the curriculum has been designed in a way so that learner shall be acquainted with many Interdisciplinary subjects.

Engineers develop new technological solutions. During the engineering design process, the responsibilities of the engineer may include defining problems, conducting and narrowing research, analyzing criteria, finding and analyzing solutions, and making decisions. The Program Educational Objectives for Undergraduate Program were finalized in a brain storming session, which was attended by several faculty members and Industry experts. The Program Educational Objectives proposed for the undergraduate program in Mechanical Engineering are listed below:

1. To prepare the stake holder to exhibit leadership qualities with demonstrable attributes in lifelong learning to contribute to the societal needs.
2. To make ready the stake holder to pursue higher education for professional development
3. To help the stake holder to acquire the analytical and technical skills, knowledge, analytical ability attitude and behavior through the program
4. To prepare the stakeholders with a sound foundation in the mathematical, scientific and engineering fundamentals
5. To motivate the learner in the art of self-learning and to use modern tools for solving real life problems and also inculcate a professional and ethical attitude and good leadership qualities
6. To prepare the stake holder to able to Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

We trust this revised version of syllabus come up to the expectations of all stakeholders. We trust this revised version of syllabus come up to the expectations of all stakeholders. We wish to place on record our sincere thanks and appreciations to the various contributors from the academia and industry for their most learned inputs in framing this syllabus.

Board of Studies in Mechanical Engineering

Dr. Vivek K. Sunnapwar : Chairman
Dr. S. M. Khot : Member
Dr. V. M. Phalle : Member
Dr. Siddappa Bhusnoor : Member
Dr. S.S. Pawar : Member
Dr. Sanjay U. Bokade : Member
Dr. Dhanraj Tambuskar : Member

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
MEC401	Engineering Mathematics-IV	3	--	1	3	--	1	4
MEC402	Fluid Mechanics	3	--	--	3	--	--	3
MEC403	Kinematics of Machinery	3	--	--	3	--	--	3
MEC404	CAD/CAM	3	--	--	3	--	--	3
MEC405	Industrial Electronics	3	--	--	3	--	--	3
MEL401	Industrial Electronics	--	2	--	--	1	--	1
MEL402	Kinematics of Machinery	--	2	--	--	1	--	1
MEL403	Python Programming	--	2	--	--	1	--	1
MESBL401	CNC and 3-D Printing	--	4	--	--	2	--	2
MEPBL401	Mini Project – 1B	--	4$	--	--	2	--	2
Total		**15**	**14**	**1**	**15**	**7**	**1**	**23**

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.					
MEC401	Engineering Mathematics-IV	20	20	20	80	3	25	--	125
MEC402	Fluid Mechanics	20	20	20	80	3	--	--	100
MEC403	Kinematics of Machinery	20	20	20	80	3	--	--	100
MEC404	CAD/CAM	20	20	20	80	3	--	--	100
MEC405	Industrial Electronics	20	20	20	80	3	--	--	100
MEL401	Industrial Electronics	--	--	--	--	--	25	25	50
MEL402	Kinematics of Machinery	--	--	--	--	--	25	--	25
MEL403	Python Programming	--	--	--	--	--	25	25	50
MESBL401	CNC and 3-D Printing	--	--	--	--	--	25	25	50
MEPBL401	Mini Project – 1B	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	--	**150**	**100**	**750**

$ indicates work load of Learner (Not Faculty), for Mini Project
SBL – Skill Based Laboratory
PBL – Project Based Learning

Students group and load of faculty per week.

Mini Project 1A / 1B: Students can form groups with minimum 2 (Two) members and not more than 4 (Four) members

Faculty Load: 1 hour per week per four groups

Course Code	Course Name	Credits
MEC401	**Engineering Mathematics-IV**	**04**

Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II, Engineering Mathematics-III, Binomial Distribution, Physical Interpretation of Vector differentiation, Vector differentiation operator, Gradient of scalar point function, Directional derivative, Divergence of vector point function, Curl of vector point function**.**

Objectives:

1. To study the concept of Vector calculus & its applications in engineering.
2. To study Line and Contour integrals and expansion of complex valued function in a power series.
3. To familiarize with the concepts of statistics for data analysis.
4. To acquaint with the concepts of probability, random variables with their distributions and expectations.
5. To familiarize with the concepts of probability distributions and sampling theory with its applications.

Outcomes: On successful completion of course learner/student will be able to:

1. Apply the concept of Vector calculus to evaluate line integrals, surface integrals using Green's theorem, Stoke's theorem & Gauss Divergence theorem.
2. Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.
3. Apply the concept of Correlation, Regression and curve fitting to the engineering problems in data science.
4. Illustrate understanding of the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.
5. Apply the concept of probability distribution to engineering problems & testing hypothesis of small samples using sampling theory.
6. Apply the concepts of parametric and nonparametric tests for analyzing practical problems.

Module	Detailed Contents	Hrs.
01	**Module : Vector Calculus** 1.1 Solenoidal and irrotational (conservative) vector fields. 1.2 Line integrals – definition and problems. 1.3 Green's theorem (without proof) in a plane, Stokes' theorem (without Proof), Gauss' Divergence theorem (without proof) and problems (only evaluation). **Self Learning Topics**: Identities connecting Gradient, Divergence and Curl, Angle between surfaces. Verifications of Green's theorem, Stoke's theorem & Gauss-Divergence theorem, related identities & deductions.	**07**
02	**Module: Complex Integration** 2.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof). 2.2 Taylor's and Laurent's series (without proof). 2.3 Definition of Singularity, Zeroes, poles of *f(z)*, Residues, Cauchy's Residue Theorem (without proof) **Self-learning Topics:** Application of Residue Theorem to evaluate real integrations.	**07**

03	**Module: Statistical Techniques** 3.1 Karl Pearson's Coefficient of correlation (r) and related concepts with problems 3.2 Spearman's Rank correlation coefficient (R) (Repeated & non repeated ranks problems) 3.3 Lines of regression 3.4 Fitting of first and second degree curves. **Self-learning Topics:** Covariance, fitting of exponential curve.	**06**
04	**Module: Probability Theory:** 4.1 Conditional probability, Total Probability and Baye's Theorem. 4.2 Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, 4.3 Expectation, Variance, Co-variance, moments, Moment generating functions, (Four moments about the origin &about the mean). **Self- learning Topics:** Properties variance and covariance,	**06**
05	**Module: Probability Distribution and Sampling Theory-I** 5.1 Probability Distribution: Poisson and Normal distribution 5.2 Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Degree of freedom. 5.3 Students' t-distribution (Small sample). Test the significance of single sample mean and two independent sample means and paired t- test) **Self -learning Topics:** Test of significance of large samples, Proportion test, Survey based project.	**07**
06	**Module: Sampling theory-II** 6.1 Chi-square test: Test of goodness of fit and independence of attributes (Contingency table) including Yate's Correction. 6.2 Analysis of variance: F-test (significant difference between variances of two samples) **Self- learning Topics:** ANOVA: One way classification, Two-way classification (short-cut method).	**06**

Term Work:

General Instructions:

1. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
2. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering Mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Assessment:

Internal Assessment Test:
Assessment consists of two class tests of 20 marks each. The first class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment II) when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:
1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

References:

1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited,
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication,
4. Vector Analysis, Murray R. Spiegel, Schaum Series
5. Complex Variables and Applications, Brown and Churchill, McGraw-Hill education
6. Probability, Statistics and Random Processes, T. Veerarajan, Mc. Graw Hill education.

Links for online NPTEL/SWAYAM courses:
1. https://www.youtube.com/watch?v=2CP3m3EgL1Q&list=PLbMVogVj5nJQrzbAweTVvnH6-vG5A4aN5&index=7
2. https://www.youtube.com/watch?v=Hw8KHNgRaOE&list=PLbMVogVj5nJQrzbAweTVvnH6-vG5A4aN5&index=8
3. https://nptel.ac.in/courses/111/105/111105041/

Course Code	Course Name	Credits
MEC402	**Fluid Mechanics**	**03**

Objectives:

1. To study Fluid Statics and Fluid Dynamics.
2. To acquaint with dimensional analysis of Thermal and Fluid systems.
3. To familiarize with application of mass, momentum and energy equations in fluid flow.
4. To study various flow measurement techniques.
5. To familiarize with the dynamics of fluid flows and the governing nondimensional parameters.

Outcomes: Learner will be able to…

1. **Define** properties of fluids**, classify** fluids and **evaluate** hydrostatic forces on various surfaces.
2. **Illustrate** understanding ofdimensional analysis of Thermal and Fluid systems.
3. **Differentiate** velocity potential function and stream function and solve for velocity and acceleration of a fluid at a given location in a fluid flow.
4. **Formulate** and **solve** equations of the control volume for fluid flow systems and Apply Bernoulli's equation to various flow measuring devices.
5. **Calculate** pressure drop in laminar and turbulent flow, evaluate major and minor losses in pipes.
6. **Calculate** resistance to flow of incompressible fluids through closed conduits and over surfaces.

Module	Detailed Contents	Hrs.
1.	**1.1 Basic Concepts:** Significance of fluid mechanics, physical properties of fluid, Newton's law of viscosity, Newtonian and non-Newtonian Fluid. **1.2 Fluid Statics:** Pascal's law, hydrostatic law, hydrostatic force on submerged surfaces (vertical, inclined & curved). Archimedes principle, buoyancy.	**06**
2.	**2.1 Fluid Kinematics:** Classification of fluid flow, streamline, path line, streak line, acceleration of fluid particle, differential equation of continuity, rotational flow and vortices, stream function, potential function, concept of circulation. **2.2 Dimensional Analysis:** Introduction to dimensional analysis of thermal and fluid systems, Methods of dimensional analysis - Buckingham π Theorem and Rayleigh's Method (Only derivations, no numerical)	**07**
3.	**3.1 Fluid Dynamics:** Concept of control volume and control surface, Importance of Reynolds Transport theorem (RTT) and its derivation (No numerical). Forces acting on fluid in motion, Euler's equation in Cartesian coordinates, Expression of Bernoulli's equation from principle of energy conservation and by integration of Euler's equation. Application of Bernoulli's equation in Orifice meter, Venturi meter, Rotameter and Pitot tube. Momentum of fluid in motion: impulse momentum relationship and its applications for determination of thrust for pipe bend.	**09**

4.	**4.1 Laminar Viscous flow:** Introduction to Reynolds number, critical Reynolds number, Navier-Stokes equation of motion, Relationship between shear stress and pressure gradient in laminar flow, Laminar flow between parallel plates (Plane Poiseuille&Couette flow), Laminar flow in circular pipe (Hagen-Poiseuille flow).	**06**
5.	**5.1 Flow through pipes** : Reynolds experiment, Head loss in pipes due to friction (Darcy-Weisbach equation), Loss of energy in pipe (major and minor), Hydraulic gradient and Energy gradient line, Pipes in series and parallel, concept of equivalent pipe.	**06**
6.	**6.1 Hydrodynamic Boundary Layer Theory:** Concept of formation of boundary layer, boundary layer parameters, boundary layer along a long thin plate and in pipe, Prandtl boundary layer equation, Separation of boundary layer and its methods of control. **6.2 Flow around submerged objects:** Concept of drag and lift, Types of drag, Streamlined and bluff bodies, Drag and lift on an aerofoil.	**05**

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
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 any module other than module 3)
4. Only Four questions need to be solved

References:

1. Fluid Mechanics by Yunus A Cengel and John M Cimbala, Tata McGraw Hill Education, 3rd Edition, 2014.
2. Fluid Mechanics and Machinery by C S P Ojha, Chandramouli and R Berndtsson, Oxford University Press, 1st Edition, 2010.
3. Fox and McDonald's Introduction to Fluid Mechanics by Philip J. Pritchard and John W. Mitchell, Wiley Publishers, 9th Edition,2016.
4. A textbook of Fluid Mechanics by R K Bansal, Laxmi Publication, 1st Edition, 2015.
5. Fluid Mechanics by Frank M. White, McGraw Hill Education, 7th Edition, 2011.
6. Fluid Mechanics by Victor Streeter, Benjamin Wylie and K W Bedford, McGraw Hill Education, 9thEdition, 2010.
7. Engineering Fluid Mechanics by K. L. Kumar, Eurasia Publishing House (P) Ltd, 1st Edition and Reprint 2016.
8. Introduction to Fluid Mechanics by James A. Fay, MIT Press, Campbridge, 1st Edition, 1996.
9. Fluid Mechanics and Hydraulics by Suresh Ukarande, Ane Books Pvt.Ltd, Revised & Updated 1st Edition, 2016.

Links for online NPTEL/SWAYAM courses:

1. https://nptel.ac.in/courses/112/105/112105269
2. https://swayam.gov.in/nd1_noc20_ce59/preview

Course Code	Course Name	Credits
MEC403	**Kinematics of Machinery**	**03**

Objectives:

1. To acquaint with basic concept of kinematics and kinetics of machine elements
2. To familiarize with basic and special mechanisms
3. To study functioning of motion and power transmission machine elements

Outcomes: Learner will be able to…

1. Identify various components of mechanisms
2. Develop mechanisms to provide specific motion
3. Draw velocity and acceleration diagrams of various mechanisms
4. Choose a cam profile for the specific follower motion
5. Predict condition for maximum power transmission in the case of a belt drive
6. Illustrate requirements for an interference-free gear pair

Module	Content	Hrs.
1	**1.1 Kinetics of Rigid Bodies** Concept of mass moment of inertia and its application to standard objects. Kinetics of rigid bodies: Work and energy Kinetic energy in translating motion, Rotation about fixed axis and in general plane motion, Work energy principle and Conservation of energy **1.2 Basic Kinematics** Structure, Machine, Mechanism, Kinematic link & its types, Kinematic pairs, Types of constrained motions, Types of Kinematic pairs, Kinematic chains, Types of joints, Degree of freedom (mobility), Kutzbach mobility criterion, Grűbler's criterion & its limitations Four bar chain and its inversions, Grashoff's law, Slider crank chain and its inversions, Double slider crank chain and its inversions	**07**
2	**Special Mechanisms** (No problems on this module) **2.1 Straight line generating mechanisms:** Introduction to Exact straight line generating mechanisms - Peaucillier's and Hart's Mechanisms, Introduction to Approximate Straight line generating mechanisms- Watt's, Grasshopper mechanism, Tchebicheff's mechanisms **2.2 Offset slider crank mechanisms** - Pantograph, Hook-joint (single and double). **2.3 Steering Gear Mechanism** - Ackerman, Davis steering gears	**04**
3	**3.1 Velocity Analysis of Mechanisms (mechanisms up to 6 links)** Velocity analysis by instantaneous centre of rotation method (Graphical approach), Velocity analysis by relative velocity method (Graphical approach) **3.2 Acceleration Analysis of Mechanisms (mechanisms up to 6 links)** Acceleration analysis by relative method including pairs involving Coriolis acceleration (Graphical approach)	**10**
4	**Cam and Follower Mechanism** 4.1 Cam and its Classification based on shape, follower movement, and manner of constraint of follower; Followers and its Classification based on shape, movement, and location of line of movement; Cam and follower terminology; 4.2 Motions of the follower: SHM, Constant acceleration and deceleration (parabolic), Constant velocity, Cycloidal; Introduction to cam profiles (No problems on this point)	**04**

5	**Belts, Chains and Brakes:** **5.1 Belts**: Introduction, Types and all other fundamentals of belting, Dynamic analysis –belt tensions, condition of maximum power transmission **5.2 Chains** (No problems)**:** types of chains, chordal action, variation in velocity ratio, length of chain (No problems) **5.3 Brakes** (No problems)**:** Introduction, types and working principles, Introduction to braking of vehicles	**04**
6	**Gears and Gear Trains:** **6.1 Gears**- Introduction, Types, Law of gearing, Forms of teeth, Details of gear terminology, Path of contact, Arc of contact, Contact ratio, Interference in involutes gears, Minimum number of teeth for interference free motion, Methods to control interference in involutes gears, Static force analysis in gears - spur, helical, bevel, worm & worm wheel (No problems on this point) **6.2 Gear Trains:** Kinematics and dynamic analysis of simple and compound gear trains, reverted gear trains, epi-cycle gear trains with spur or bevel gear combination	**10**

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
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 any module other than module 3)
4. Only Four questions need to be solved.

Text Books:

1. S.S. Ratan, “Theory of Machines”, Tata McGraw Hill
2. Ghosh and A.K. Mallik, “Theory of Mechanisms and Machines”, East-West Press

References:

1. J.J. Uicker, G.R. Pennock, and J.E. Shigley, “Theory of Machines and Mechanism”, Oxford Higher Education
2. P.L. Ballaney, “Theory of Machines”, Khanna Publishers
3. M.A. Mostafa, “Mechanics of Machinery”, CRC Press
4. R.L. Norton, “Kinematics and Dynamics of Machinery”, McGraw Hill
5. A.G. Erdman, G.N. Sander, and S. Kota, “Mechanism Design: Analysis and Synthesis Vol I”, Pearson

Links for online NPTEL/SWAYAM courses:

1. https://nptel.ac.in/courses/112/105/112105268/
2. https://www.youtube.com/playlist?list=PLYRGB44zNZWVibVLmWANp-7obQzOhJLRt
3. http://www.nptelvideos.in/2012/12/kinematics-of-machines.html

Course Code	Course Name	Credits
MEC404	**CAD/CAM**	**03**

Objectives:

1. To familiarize with basic concepts of computer graphics.
2. To acquaint with the process of using biomedical data for 3D modeling.
3. To study programming aspects of subtractive manufacturing process.
4. To familiarize with basic process of additive manufacturing in particularly 3D printing.

Outcomes: Learner will be able to…

1. Identify suitable computer graphics techniques for 3D modeling.
2. Transform, manipulate objects & store and manage data.
3. Develop 3D model using various types of available biomedical data.
4. Create the CAM Toolpath for specific given operations.
5. Build and create data for 3D printing of any given object using rapid prototyping and tooling processes.
6. Illustrate understanding of various cost effective alternatives for manufacturing products.

Module	Details	Hrs.
1.	**Computer Graphics** 1.1 Introduction: Scope of CAD/CAM in product life cycle, CAD/CAM hardware and software, 2D and 3D computer graphics representation, Mapping of Geometric Models. 1.2 Parametric representation of curves and surfaces: Synthetic Curves - Bezier curves, Hermite Curves, B-spline curves. Surface representation. 1.3 Solid Modeling: Constructive solid geometry (CSG), Boundary Representation (B-Rep), Wire Frame Modeling, Solid Modeling, Surface Modeling, Parametric Modeling, Feature based modeling, Constraint Based Modeling.	**07**
2.	**Geometric Transformation** 2.1 Homogeneous Coordinate system, Matrix representation, Concatenations, 2D and 3D geometric transformation (Translation, Reflection, Scaling, Rotation)	**07**
3.	**Modeling based on Biomedical data** 3.1 Introduction to medical imaging: Computed tomography (CT), Cone beam CT (CBCT), Magnetic resonance (MR), Noncontact surface scanning, Medical scan data , Point cloud data 3.2 Working with medical scan data: Pixel data operations, Using CT data: a worked example, Point cloud data operations, Two-dimensional formats, Pseudo 3D formats, True 3D formats, File management and exchange	**06**
4.	**Subtractive Manufacturing** 4.1 Introduction: NC/CNC/DNC machines, Machining Centers, Coordinate system 4.2 CNC machining practices and programming: setup, and operation of two- and three-axis CNC machines programming using manual part programming method, Canned Cycles.	**07**

5.	**Additive Manufacturing** 5.1 Rapid Prototyping: Introduction, Classification of RP Processes, Advantages & disadvantages. RP Applications; in Design, Concept Models, Form & fit checking, Functional testing, CAD data verification, Rapid Tooling, and bio fabrication. 5.2 Working Principle, Application, Advantages & disadvantages: of Stereolithography Apparatus (SLA) Selective Laser Sintering (SLS), 3D Printing, Fused Deposition Modeling (FDM), and Laminated Object Manufacturing (LOM)	**07**
6.	**Virtual Manufacturing** 6.1 Virtual Manufacturing: Introduction, Scope, Socio-economic Aspects and Future Trends	**05**

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
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 any module other than module 3)
4. Only Four questions need to be solved.

References:

1. CAD/ CAM, Theory & Practice, Ibrahim Zeid, R. Sivasubramanian, Tata McGraw Hill Publications
2. CAD/CAM Principles and Applications, P. N. Rao, Tata McGraw Hill Publications
3. CAD/CAM Computer Aided and Manufacturing, Mikell P. Groover and Emory W. Zimmers, Jr., Eastern Economy Edition
4. CNC Technology and Programming, Krar, S., and Gill, A., McGraw Hill Publishers.
5. Medical Modelling The Application of Advanced Design and Rapid Prototyping Techniques in Medicine, Richard Bibb, Dominic Eggbeer and Abby Paterson, Woodhead Publishing Series in Biomaterials: Number 91, Elsevier Ltd.
6. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, I. Gibson l D. W. Rosen l B. Stucker, Springer Publication.
7. Rapid Prototyping and Manufacturing, P. F. Jacobs, Society of Manufacturing Engineers
8. Advanced Machining and Manufacturing Processes, Kaushik Kumar DivyaZindani, J. Paulo Davim, Springer International Publishing

Links for online NPTEL/SWAYAM courses:

1. https://nptel.ac.in/courses/112/102/112102101/
2. https://nptel.ac.in/courses/106/102/106102065/
3. https://nptel.ac.in/courses/106/102/106102065/
4. https://nptel.ac.in/courses/112/102/112102103/
5. https://nptel.ac.in/courses/112/105/112105211/
6. https://nptel.ac.in/courses/112/104/112104265/
7. https://www.youtube.com/watch?v=2cCMty9v3Tg
8. https://www.youtube.com/watch?v=2zPh26Q1BT8

Course Code	Course Name	Credits
MEC404	**Industrial Electronics**	**03**

Objectives:

1. To study power electronic switches and circuits and their applications.
2. To acquaint with basics of analog and digital circuits for the design of mechanical processes control.
3. To study structure, working and characteristics of different types of industrial electric motors and their selection for a particular application.

Outcomes: Learner will be able to…

1. Illustrate construction, working principles and applications of power electronic switches.
2. Identify rectifiers and inverters for dc and ac motor speed control.
3. Develop circuits using OPAMP and Timer IC 555.
4. Identify digital circuits for industrial applications.
5. Demonstrate the knowledge of basic functioning of microcontrollers.
6. Analyze speed-torque characteristics of electrical machines for speed control.

Module	Detailed Contents	Hrs.
1.	**Semiconductor Devices:** Review of diodes, V-I characteristics and Applications of: rectifier diode, zener diode, LED, photodiode; SCR V-I characteristics, UJT triggering circuit, turning-off of a SCR (preliminary discussion), basics of Gate Turn Off (GTO), Structure and V-I characteristics of Triac (modes of operation not needed) and Diac, Applications of Triac-Diac circuit; Characteristics of Power BJT, power MOSFET, IGBT; Comparison of SCR, Triac, Power BJT, power MOSFET, IGBT	**08**
2.	**Phase controlled rectifiers and Bridge inverters:** Full wave controlled rectifier using SCR's(semi controlled, fully controlled) with R load only, Block diagram of closed loop speed control of DC motors, Basic principle of single phase and three phase bridge inverters , block diagrams including rectifier and inverter for speed control of AC motors (frequency control only)	**07**
3.	**Operational amplifiers and 555 Timer:** Operational amplifier circuits, Ideal OPAMP behaviour, common OPAMP ICs; Basic OPAMP circuits- Inverting amplifier, Non-inverting amplifier, Voltage follower (Buffer), Comparator, Instrumentation Amplifier, Active first order filter: Low pass and high pass filter; Power Op Amps, IC-555 timer-Operating modes: monostable, astablemultivibrator	**05**
4.	**Digital logic and logic families:** Boolean algebra and logic gates. logic families: Logic Levels, Noise Immunity, Fan Out, Propagation Delay, TTL and CMOS logic families, Flip flops: Set Reset(SR), Trigger(T), clocked F/Fs; Registers, Multiplexer and Demultiplexer applications	**05**

5.	**Microprocessor and Microcontrollers:** Overview of generic microprocessor, architecture and functional block diagram, Comparison of microprocessor and microcontroller MSP430 architecture, assembly language programming, C compiler programming, basics of interfacing with external input / output devices (like reading external analog voltages, digital input output) Applications of microcontroller: Temperature measurement, Speed Measurement using Proximity Sensor, Piezoelectric Actuator Drive	**08**
6.	**Motors**: Review and comparison of DC motors and AC induction motors, Basic principles of speed control of AC induction motor, Basics of BLDC motor, Linear Actuator motor, Servo Motor; Motor Specifications, suitability of each motor for various industrial applications, Selection and sizing of motors for different applications. Applications for pumps, conveyors, machine tools, Microcontroller based speed control for Induction Motor.	**06**

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
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 any module other than module 3)
4. Only Four questions need to be solved.

References:

1. Power Electronics M.H. Rashid, Prentice-Hall of India
2. Power Electronics, P S Bhimbra
3. Power Electronics, VedamSubramanyam, New Age International
4. Power Electronics, Ned Mohan, Undeland, Robbins, John Wiley Publication
5. Electronic Devices and Circuits, Robert Boylestad and Louis Nashelsky, Prentice-Hall
6. Industrial Electronics and Control by S K Bhattacharya, S Chatterjee, TTTI Chandigarh
7. Modern Digitals Electronic, Jain R P, Tata McGraw Hill, 1984
8. Digital principal and Application, Malvino and Leach, Tata McGraw Hill, 1991
9. Fundamentals of Microcontrollers and Embedded System, Ramesh Gaonkar, PENRAM
10. MSP430 Microcontroller Basics, John H. Davies, Newnes; 1 edition 2008

Links for online NPTEL/SWAYAM courses:

1. https://nptel.ac.in/courses/108/108/108108122/
2. https://nptel.ac.in/courses/108/105/108105066/
3. https://nptel.ac.in/courses/108/101/108101091/
4. https://nptel.ac.in/courses/106/108/106108099/
5. https://nptel.ac.in/courses/108/105/108105102/
6. https://nptel.ac.in/courses/108/102/108102146/

Course Code	Course Name	Credits
MEL401	**Industrial Electronics**	**01**

Objectives:

1. To study operational characteristics of various analog and digital circuits.
2. To study microcontroller-based applications and its programming
3. To study operational characteristics of electrical motors.

Outcomes: Learner will be able to…

1. Demonstrate characteristics of various electrical and electronics components
2. Develop simple applications built around these components
3. Identify use of different logic gates and their industrial applications
4. Built and demonstrate parameter measurements using microcontroller
5. Test and Analyze speed-torque characteristics of electrical machines for speed control.

List of Experiments: Minimum ten experiments need to be performed, six from 1-9 and four from 10-15.

Sr.No.	**List of Experiments**
1.	MOSFET / IGBT as a switch
2.	V-I characteristics of SCR
3	Triggering circuit of SCR (UJT)
4.	Light dimmer circuit using Diac-Triac
5.	Full wave Rectifier using SCR with R /R-L load
6.	Single phase Bridge inverter with rectifier load
7.	OPAMP as Inverting and Non inverting amplifier.
8.	OPAMP as a Comparator
9.	555 timer as AstableMultivibrator
10.	Study of logic gates and Logic Operations like, NOT, AND, OR
11.	Realization of basic gates using universal gates
12.	Speed control of DC motor
13.	Speed control of induction motor
14.	Simple programs using microcontroller
15.	Simple microcontroller based application like Temp Measurement/ Speed Measurement using Proximity Sensor/ Piezoelectric Actuator Drive
16.	Microcontroller based speed control for Induction Motor

Assessment:

Distribution of marks for term work

Laboratory work	20 Marks
Attendance	05 Marks

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Distribution of marks for practical/viva examination shall be as follows:
    a. Practical performance 15 marks
    b. Viva 10 marks
3. Evaluation of practical examination to be done based on the experiment performed and the output of theexperiment during practical examination
4. Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
MEL402	**Kinematics of Machinery**	**01**

Objectives:

1. To familiarize with various mechanisms and inversions
2. To acquaint with basics of power transmission systems

Outcomes: Learner will be able to…

1. Draw velocity diagram usingInstantaneous Centre method
2. Find velocity and acceleration of a point on a four-bar mechanism by using Relative method.
3. Analyze velocity and acceleration of a specific link of a slider crank mechanism using graphical approach by Relative method.
4. Plot displacement-time, velocity-time, and acceleration-time diagrams of follower motion.
5. Draw cam profile for the specific follower motion.
6. Develop and build mechanisms to provide specific motion.

Term Work: Comprises of (a) and (b)

(a) Laboratory Work

Sr. No.	Details	Hrs.
1.	Analysis of velocity of mechanisms by Instantaneous Centre of Rotation method – 3 to 5 problems	**04**
2.	Analysis of velocity of mechanisms by Relative Velocity method – 3 to 5 problems	**04**
3.	Analysis of acceleration of mechanism by Relative method including pairs involving Coriolis acceleration – 3 to 5 problems	**04**
4.	Motion analysis and plotting of displacement–time, velocity-time and acceleration-time, jerk-time, and layout of cam profiles - 2 to 3 problems	**06**
5.	Mini project on design and fabrication of any one mechanism for a group of maximum 4 students	**08**

(b) Assignments: Minimum two problems on each of the following topics

Sr. No.	Topic
1.	Belts and Chains
2.	Brakes
3.	Gears and Gear trains

Assessment:

Distribution of marks for Term Work shall be as follows:

1. Laboratory Work : 15marks.
2. Assignments : 05 Marks
3. Attendance : 05 marks

Course Code	Course Name	Credits
MEL403	**Python Programming**	**01**

Objectives:

1. To introduce basic concepts of Python programming language as well as common packages and libraries.
2. To generate an ability to design, analyze and perform experiments on real life problems in mechanical engineering using python.

Outcomes: Learner will be able to….

1. Demonstrate understand of basic concepts of python programming.
2. Identify, install and utilize python packages
3. Develop and execute python programs for specific applications.
4. Develop and build python program to solve real-world engineering problems
5. Prepare a report on case studies selected.

Module	Details	Hrs.
1.	Introduction to python and its applications. Installation of Python and setting up a programming environment such as Anaconda and Spyder Python Basics: Variable and variable types, Booleans, Numbers (integers, floats, fractions, complex numbers), strings, lists, tuples, sets, dictionaries. bytes and byte arrays, Manipulating variables, indexing, slicing, basic operators (arithmetic, relational, logical, membership, identity). String methods, list methods, list slicing, set methods, in built python functions, input and output functions.	**04**
2.	Basic Coding in Python: If, else, elif statements, for loops, range function, while loops, List comprehensions, functions in python. Introduction to OOP, Classes, Objects, Reading and writing files.	**02**
3.	Python libraries: Installing of different libraries, packages or modules. Basic concepts of the following libraries: NumPy, Matplotlib, Pandas, SciPy Optional libraries based on case studies in Module 4: Pillow, Scikit, OpenCV, Python in Raspberry Pi	**04**
4.	Case Studies using Python (Select any 3): 1. Solving a linear differential equation using SciKit and plotting the result in matplotlib. Students can use differential equations from any previous topic studied in the programme such as mechanics, materials science, fluid mechanics, kinematics of machines, thermodynamics, production etc. 2. Image processing and manipulation and auto detection of any object. Applications in self-driving cars may be discussed. 3. Python programming of a Raspberry PI: Students can sense using a sensor, process the reading and then control some physical output (like motor or LED) 4. Project involving basic machine learning (Students should understand the basic concepts of machine learning and apply to specific situation) 5. Any other case study that uses Python to solve Mechanical Engineering problems. 6. Customizing applications by writing API programs using python like to create joints, get physical properties, get circle and arc data from edge.	**06**

Note: In module 4: Advanced learners may opt to do multiple case studies beyond minimum required. Student with laptops or personal computers should be encourages to install Python on it and independently work on these projects.
Students should prepare a short report for each case study and submit their findings. They should also give a presentation on their case study as well as a live demonstration of their projects.

Assessment:

Internal:
Distribution of term work marks as below;

1. Laboratory Work: 5 Marks
2. Case Study Reports and Presentation: 5 marks each: 15 marks
3. Attendance: 5 Marks

External Practical/Oral:

1. Practical examination of 2 hours duration followed by Oral to be conducted by Pair of Internal and External Examiner based on contents
2. Evaluation of practical examination to be done by examiner based on the printout of students work
3. Distribution of marks
    a. Practical examination: 20 marks
    b. Oral based on practical examination: 05 marks

Note: Students work along with evaluation report to be preserved till the next examination

References:

1. Core Python Programming, Dr. R. NageswaraRao, Dreamtech Press
2. Programming through Python, M.T.Savaliya and R.K.Maurya, StarEdu Solutions
3. Beginning Python: Using Python 2.6 and Python 3.1. James Payne, Wrox publication2.
4. Any digital resources and online guides for python or its packages. Such as "The Python Tutorial", http://docs.python.org/release/3.0.1/tutorial/

Course Code	Course Name	Credits
MESBL401	**Skill based Lab: CNC and 3-D Printing**	**02**

Objectives:

1. To familiarize with subtractive manufacturing process in particular CNC systems.
2. To acquaint with basic part programing process for specific operations.
3. To familiarize with additive manufacturing process in particularly 3D printing.
4. To acquaint with basic process of 3D modeling using biomedical data.

Outcomes: Learner will be able to….

1. Develop and execute part programing for any given specific operation.
2. Build any given object using various CNC operations.
3. Demonstrate CAM Tool path and prepare NC- G code.
4. Develop 3D model using available biomedical data
5. Build any given real life object using 3D printing process.
6. Convert 2D images into 3D model

Sr. No.	List of Exercises	Hrs.
1	Part programming and part fabrication on CNC Turning trainer (Involving processes like Step turning, facing, Taper turning, threading, etc.) (One job in a group of 4-5 students)	**24**
2	Part programming and part fabrication on CNC Milling trainer (Involving processes like contouring, drilling, facing, pocketing etc.) (One job in a group of 4-5 students)	
3	Part Programming Simulation for any Unconventional Machining Process (Electric Discharge Machining, laser cutting Machining, Plasma Cutting Machining etc.)	
4	Tool-path generation by translation of part geometry from computer aided design (CAD) to computer aided manufacturing (CAM) systems.	
5	Post processing of Code generated via CAM system	
6	Case Study: Report on a visit conducted to any Commercial CNC Machining Centre explaining the Design features, pre processing in CAM software and its capabilities.	
7	Development of physical 3D mechanical structure using any one of the rapid prototyping processes.	**24**
8	Check the constraints of any two RP systems for features like layer thickness, orientation of geometry, support generation, post processing etc.	

9	Design an object with free form surface & printing it using any RP process.	
10	Segmentation in Slicer's Segment Editor module for the purpose of 3D printing (3D Slicer open source) (Application: Any Bone part as per available Dicom files)	
11	Creation of 3D model from 2D images using any image processing software and printing it. (3D Slicer open source) (Application: Any body organ like Heart, Gallbladder etc. as per available Dicom files)	
12	Case Study: Usability of rapid tooling integrated investment casting process, with their advantages and limitations in any one of emerging areas of dentistry, jewelry, surgical implants, turbine blades, etc.	

Assessment:

Term work shall consist of

- Any **4 exercises from 1 to 6 and 3 exercises from 7 to 11 of the above list**
- Exercise 12 is mandatory.

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

1. Part A Exercises: 10 Marks
2. Part B Exercises: 10 Marks
3. Attendance: 05 Marks

Practical/Oral examination

1. Each student will be given a practical assignment on the basis of the above exerciseswhich will be completed within a given time and assessed by examiners during the oral examination.
2. The distribution of marks for oral-practical examination shall be as follows:
   a. Practical Assignment : 15 marks
   b. Oral : 10 marks
3. Evaluation of practical/oral examination to be done based on the performance of practical assignment.
4. Students work along with evaluation report to be preserved till the next examination

References:

1. CAD/CAM Principles and Applications, P. N. Rao, Tata McGraw Hill Publications
2. CNC Technology and Programming, Krar, S., and Gill, A., McGraw Hill Publishers.
3. CNC Programming for Machining, Kaushik Kumar, ChikeshRanjan, J. Paulo Davim, Springer Publication.
4. Medical Modelling The Application of Advanced Design and Rapid Prototyping Techniques in Medicine, Richard Bibb, Dominic Eggbeer and Abby Paterson, Woodhead Publishing Series in Biomaterials: Number 91, Elsevier Ltd.

5. Biomaterials, artificial organs and tissue engineering, Edited by Larry L. Hench and Julian R. Jones, Woodhead Publishing and Maney Publishing, CRC Press 2005
6. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, I. Gibson l D. W. Rosen l B. Stucker, Springer Publication.
7. Rapid Prototyping and Manufacturing, P. F. Jacobs, Society of Manufacturing Engineers

Course code	Course Name	Credits
MEPBL 401	**Mini Project - 1B**	**02**

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentalsto attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: Learner will be able to…

5. Identify problems based on societal /research needs.
6. Apply Knowledge and skill to solve societal problems in a group.
7. Develop interpersonal skills to work as member of a group or leader.
8. Draw the proper inferences from available results through theoretical/ experimental/simulations.
9. Analyse the impact of solutions in societal and environmental context for sustainable development.
10. Use standard norms of engineering practices
11. Excel in written and oral communication.
12. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
13. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.

- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of components/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication