University of Mumbai

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विद्याविषयक प्राधिकरणे
सभा आणि सेवा विभाग(ए.ए.एम.एस)
रूम नं. १२८ एम.जी.रोड, फोर्ट,
मुंबई – ४०० ०३२
टेलिफोन नं. – ०२२ – ६८३२००३३

(नॅक पुनर्मूल्यांकनाद्वारे ३.६५ (सी.जी.पी.ए.) सह अ++ श्रेणी
विद्यापीठ अनुदान आयोगाद्वारे श्रेणी १ विद्यापीठ दर्जा)

क्र.वि.प्रा.स.से./आयसीडी/२०२५-२६/३७ दिनांक : २७ मे, २०२५

परिपत्रक:-

सर्व प्राचार्य/संचालक, संलग्नित महाविद्यालये/संस्था, विद्यापीठ शैक्षणिक विभागांचे संचालक/ विभाग प्रमुख यांना कळविण्यात येते की, राष्ट्रीय शैक्षणिक धोरण २०२० च्या अमंलबजावणीच्या अनुषंगाने **शैक्षणिक वर्ष २०२५-२६** पासून **पदवी व पदव्युत्तर अभ्यासक्रम** विद्यापरिषदेच्या दिनांक २८ मार्च २०२५ व २० मे, २०२५ च्या बैठकीमध्ये मंजूर झालेले सर्व अभ्यासक्रम मुंबई विद्यापीठाच्या www.mu.ac.in या संकेत स्थळावर NEP २०२० या टॅब वर उपलब्ध करण्यात आलेले आहेत.

मुंबई – ४०० ०३२
२७ मे, २०२५

(डॉ. प्रसाद कारंडे)
कुलसचिव

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8	The Deputy Registrar, Executive Authorities Section (EA) eau120@fort.mu.ac.in He is requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to the above circular.
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AC – 20/5/2025
Item No. – 6.35 (N)

As Per NEP 2020

University of Mumbai

Syllabus for Major Vertical – 1, 4, 5 & 6		
Name of the Programme – B.E. (Mechanical Engineering)		
Faculty of Engineering		
Board of Studies in Mechanical Engineering		
U.G. Second Year Programme	**Exit Degree**	**U.G. Diploma in Mechanical Engineering.**
Semester		**III**
From the Academic Year		**2025-26**

University of Mumbai

(As per NEP 2020)

Sr. No.	Heading	Particulars
1	**Title of program** **O:_____**	**B.E. (Mechanical Engineering)**
2	**Exit Degree**	**U.G. Diploma in Mechanical Engineering.**
3	**Scheme of Examination** **R: _____**	NEP 40% Internal 60% External, Semester End Examination Individual Passing in Internal and External Examination
4	**Standards of Passing** **R: _____**	**40%**
5	**Credit Structure** **R. TEU-580C** **R. TEU-580D**	**Attached herewith**
6	**Semesters**	**Sem. III**
7	**Program Academic Level**	**5.00**
8	**Pattern**	**Semester**
9	**Status**	**New**
10	**To be implemented from Academic Year**	**2025-26**

Sd/-	**Sd/-**	**Sd/-**
Dr. S. M. Khot	**Dr. Deven Shah**	**Prof. Shivram S. Garje**
BoS-Chairman-Mechanical Engineering	**Associate Dean**	**Dean**
Faculty of Technology	**Faculty of Science & Technology**	**Faculty of Science & Technology**

Preamble

To meet the challenge of ensuring excellence and NEP 2020 policy in engineering education, the issue of quality needs to be addressed, debated, and taken forward systematically. Accreditation is the principal means of quality assurance in higher education. The major emphasis of the 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 the University of Mumbai has taken the lead in incorporating the philosophy of NEP 2020 education in the process of curriculum development.

The second-year engineering course is a core training program to impart scientific and logical thinking training to learners in general, with a choice of course selection from the program core course, multidisciplinary minor, and vocational skill-enhanced course. Simultaneously, the objectives of NEP 2020 demand nurturing the core program and skills required for the Information Technology Branch of engineering in the learner. Keeping this in view, a pool of courses is offered in Core Courses covering fundamentals required to understand core and modern engineering practices and emerging trends in technology. Considering the shift in pedagogy and the convenience of a stress-free learning process, a choice-based subject pool is offered in the coursework under the heads of Information Technology in Engineering for open electives and multidisciplinary minor courses in the third and fourth semesters. Essentially, to give a glimpse of trends in the industry under vocational and enhanced skill practices, the pool is offered to nurture and develop creative skills in contemporary industrial practices. Criteria met in the structure is the opportunity for learners to choose the course of their interest in all disciplines.

Program Core Course Cover Information Technology core courses. Also, OE and MDM where a pool of subjects are given for selection. Considering the present scenario, diverse choices need to be made available to fulfill the expectation of a learner to aspire for a career in the field of current trends of Technology and interdisciplinary research. Ability enhancement can be achieved in Undergraduate training by giving an objective viewpoint to the learning process and transitioning a learner from a rote learner to a creative professional. for the purpose Design Thinking is introduced in the First Semester to orient a journey learner to become a skilled professional. Considering the NEP-2020 structure of award of Certificate & Diploma at multiple exit-point pools of Vocational skills is arranged for giving exposure to the current Industry practices.

The faculty resolved that course objectives and course outcomes are to be clearly defined for every course so that all faculty members in affiliated higher education institutes understand the depth and approach of the course to be taught, which will enhance the learner's learning process. NEP 2020 grading system enables a much-required shift in focus from teacher-centric to continuous-based 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 a 15-week teaching-learning process for NEP 2020, however, the content of courses is to be taught in 12-13 weeks, and the remaining 2-3 weeks are to be utilized for revision, tutorial, guest lectures, coverage of content beyond the syllabus, etc.

There was a concern that in the present system, the second-year syllabus must not be heavily loaded to the learner and it is of utmost importance that the learner entering into the second year of an engineering course should feel at ease by lowering the burden of syllabus and credits. This is necessary for a learner to get accustomed to the new environment of a college and to create a bond between the teacher and the learner. The present curriculum will be implemented for the Second Year of Engineering from the academic year 2054-26. Subsequently, this system will be carried forward for Third Year and Final Year Engineering in the academic years 2026-27, and 2027-28, respectively.

Sd/-	**Sd/-**	**Sd/-**
Dr. S. M. Khot **BoS-Chairman-Mechanical Engineering** **Faculty of Technology**	**Dr. Deven Shah** **Associate Dean** **Faculty of Science & Technology**	**Prof. Shivram S. Garje** **Dean** **Faculty of Science & Technology**

Under Graduate Diploma in Engineering- Mechanical Engineering.

Credit Structure (Sem. III)

	R. TEU-580C								
Level	**Semester**	**Major**		**Minor**	**OE**	**VSC, SEC (VSEC)**	**AEC, VEC, IKS**	**OJT, FP, CEP, CC, RP**	**Cum. Cr. / Sem.**	**Degree/ Cum. Cr.**
		Mandatory	**Electives**							
5.0	III	2403111 2403112 2403113 2403114 2403115 2403116	--	--	OE:2	--	VEC: 2 HSL: 2	CEP: 2	22	**UG Diploma 45**
	R. TEU-580D									
	IV	2404111 2404112 2404113 2404114 2404115	--	MDM: 4	OE:2	VSEC:2	VEC: 2 EEM:2	--	23	
	Cum Cr.	25	--	4	4	2	*2+2+2+2*	2	45	

Exit option: Award of UG Diploma in Major and MDM with 90 credits and additional 4 credits core **one** theory subject with 3 credits and **one** lab with 1 credit from one third year from where they want to take Exit degree. Along with theory and practical course student must compulsory do internship for **one month or 160 hours** which internship is equal to 4 credits.

[Abbreviation - OE – Open Electives, VSC – Vocation Skill Course, SEC – Skill Enhancement Course, (VSEC), AEC – Ability Enhancement Course, VEC – Value Education Course, IKS – Indian Knowledge System, OJT – on Job Training, FP – Field Project, CEP – Continuing Education Program, CC – Co-Curricular, RP – Research Project]

Sem. - III

S.E. Mech. Scheme

Program Structure for Second Year of Mechanical Engineering

UNIVERSITY OF MUMBAI (With Effect from 2025-2026)

SEMESTER III

Course Code	Course Description	Teaching Scheme (Contact Hours)			Credit Assigned			
		Theory	Practical	Tutorial	Theory	Tutorial	Practical	Total Credits
2403111	**Engineering Mathematics III**	2	--	1	2	1	–	3
2403112	**Strength of Materials**	3	–	--	3	–	–	3
2403113	**Thermodynamics**	3	--	--	3	–	–	3
2403114	**Material Science**	3	--	--	3	–	–	3
2403311	To be taken from the bucket provided by the University from other Faculty	2	--	--	2	–	–	2
2403115	**Material Testing Lab**	--	2	–	–	–	1	1
2403116	**Working drawing-GD&T****	--	2	–	–	–	1	1
2403611	Mini Project (group project)	--	4	–	–	–	2	2
2403511	**Entrepreneurship Development** (Syllabus common to all Branches).	--	2*+2	---	–	–	2	2
2403512	**Environmental Science for Engineers** (Syllabus common to all Branches).	--	2*+2	--	–	–	2	2
	Total	**13**	**16**	**01**	**13**	**01**	**08**	**22**

* Two hours of practical class to be conducted for full class as demo/discussion. Theory / Tutorial 1 credit for 1 hour and Practical 1 credit for 2 hours

Institute shall offer a course for Open Elective from Science/Commerce/Management stream bucket provided by the University of Mumbai.

#Institute shall offer a course for MDM from other Engineering Boards.

Course Code	Course Description	Examination Scheme							
		Internal Assessment Test (IAT)			End Sem. Exam Marks	End Sem. Exam Duration (Hrs)	Term Work (Tw)	Oral & Pract.	Total
		IAT-I	IAT-II	Total (IAT-I) + IAT-II)					
2403111	**Engineering Mathematics III**	20	20	40	60	2	25	--	125
2403112	**Strength of Materials**	20	20	40	60	2	--	--	100
2403113	**Thermodynamics**	20	20	40	60	2	--	--	100
2403114	**Material Science**	20	20	40	60	2	--	--	100
2403311	To be taken from the bucket provided by the University from other Faculty	20	20	40	60	2	--	--	100
2403115	**Material Testing Lab**	--	--	--	--	--	25	25	50
2403116	**Working drawing-GD&T****	--	--	--	--	--	25	25	50
2403611	Mini Project (group project)	--	--	--	--	--	50	25	75
2403511	**Entrepreneurship Development** (Syllabus common to all Branches).	--	--	--	--	--	50	--	50
2403512	**Environmental Science for Engineers** (Syllabus common to all Branches).	--	--	--	--	--	50	--	50
Total		**100**	**100**	**200**	**300**	**10**	**225**	**125**	**800**

Vertical – 1
Major

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2403111	Engineering Mathematics-III	02	-	01	02	-	01	03

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2403111	Engineering Mathematics-III	20	20	40	60	02 hrs	25	-	125

Pre-requisite: Applied Mathematics-I, Applied Mathematics-II

Rationale: Engineering has always been the backbone of modern industries and civilization Now, new technologies like Artificial Intelligence (AI) in engineering are entirely changing existing engineeringfields and creating new ones. Mechanical engineering concern with the responsible development of products, processes, and power, at scales ranging from molecules to large and complex systems. Mechanical engineering principles and skills are involved at some stage during the conception, design, development, and manufacture of every human-made object with moving parts.

Course Objectives:

1. To familiarize with the Laplace transform, Inverse of various functions, its applications.
2. To familiarize with the Inverse Laplace transform of various functions, its applications.
3. To acquaint with the concept of Fourier series of periodic functions with various period.
4. To familiarize with the concept of complex variables, C-R equations with applications.
5. To introduce concepts and fundamentals Matrix algebra for engineering problems.
6. To study the application of the knowledge of matrices and numerical methods in complex engineering problems.

Course Outcomes: Learner will be able to….

1. Apply the concept of Laplace transform to solve the real integrals in engineering problems.
2. Apply the concept of inverse Laplace transform of various functions in engineering problems.
3. Expand the periodic function by using Fourier series for real life problems and omplex engineering problems.
4. Find analytic function by using basic concepts of complex variable theory.
5. Apply Matrix algebra to solve the engineering problems.

   Solve Partial differential equations by applying numerical solution and analytical methods for one dimensional heat and wave equations.

Module	Detailed Contents	Hrs.	CO Mapping
01	**Module: Laplace Transform** 1.1 Definition of Laplace transform, Condition of Existence of Laplace transform, Laplace Transform (L) of Standard Functions like e^{at}, $sin(at)$, $cos(at)$, $sinh(at)$, $cosh(at)$ and t^n , $where\ n \geq 0$. 1.2 Properties of Laplace Transform: Linearity, First Shifting theorem, change of scale Property, multiplication by *t*, Division by *t*, Laplace Transform of integrals (Properties without proof). 1.3 Evaluation of integrals by using Laplace Transformation. **Self-learning topics:** Laplace Transform of derivatives ,Heaviside's Unit Step function, Laplace Transform of Periodic functions, Dirac Delta Function, Second Shifting Theorem.	05	CO1
02	**Module: Inverse Laplace Transform** 2.1 Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivative 2.2 Partial fractions method & first shift property to find inverse Laplace transform. 2.3 Inverse Laplace transform using Convolution theorem (without proof) **Self-learning Topics:** Applications to solve initial and boundary value problems involving ordinary differential equations.	04	CO2
03	**Module: Fourier Series:** 3.1 Dirichlet's conditions, Definition of Fourier series. Fourier series of periodic function with period 2π and $2l$ (No questions should be ask on split function) 3.2 Fourier series of even and odd functions. (No question should be ask on split function) 3.3 Half range Sine and Cosine Series. **Self-learning Topics:** Complex form of Fourier Series, orthogonal and orthonormal set of functions, Parseval's Identity.	05	CO3
04	**Module: Complex Variables:** 4.1 Function *f*(z) of complex variable, limit, continuity and differentiability of *f*(z), Analytic function, necessary and sufficient conditions for *f*(z) to be analytic (without proof), Cauchy-Riemann equations in cartesian coordinates (without proof) 4.2 Milne-Thomson method to determine analytic function *f*(z) when real part (u) or Imaginary part (v) is given. 4.3 Harmonic function, Harmonic conjugate. **Self-learning Topics:** Milne-Thomson method to determine analytic function *f*(z) when (u+v or u-v) is given, Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations, orthogonal trajectories.	04	CO4

05	**Module: Matrices:** 5.1 Characteristic equation, Eigen values and Eigen vectors, Properties of Eigen values and Eigen vectors. (**No theorems/ proof**) 5.2 Cayley-Hamilton theorem (without proof): Application to find the inverse of the given square matrix and to determine the given higher degree polynomial matrix. 5.3 Similarity of matrices, Diagonalization of matrices **Self-learning Topics:** Verification of Cayley Hamilton theorem, Minimal polynomial and Derogatory matrix & Quadratic Forms (Congruent transformation & Orthogonal Reduction), Functions of square matrix.	04	CO5
06	**Module: Numerical methods for PDE** 6.1 Introduction of Partial Differential equations, method of separation of variables, Vibrations of string, Analytical method for one dimensional heat equations. (only problems) 6.2 Crank Nicholson method 6.3 Bender Schmidt method **Self-learning Topics:** Analytical method for one dimensional wave equations, Analytical methods of solving two and three dimensional problems.	04.	CO6
	Total Hours	26	

References:

1 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 Advanced Engineering Mathematics, H.K. Das, S. Chand Publication
5 Higher Engineering Mathematics B.V. Ramana, McGraw Hill Education
6 Complex Variables and Applications, Brown and Churchill, McGraw-Hill Education,
7 Text book of Matrices, Shanti Narayan and P K Mittal, S. Chand Publication
8 Laplace transforms, Murray R. Spiegel, Schaum's Outline Series

Term Work:

General Instructions:

1 Batch wise tutorials are to be conducted. The number of student's per batch should be as per University pattern for practicals.
2 Students must be encouraged to write at least 6 class tutorials on entire syllabus.
3 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 (IA) for 20 marks:

IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test Duration of each test shall be one hour.

End Semester Examination:

- Question Paper will comprise of a total of Six **questions each carrying 15 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **Four questions** need to be answered.

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2403112	Strength of Materials	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2403112	Strength of Materials	20	20	40	60	2	--	--	100

Course Objectives:

1. To introduce students to the fundamental concepts of stress, strain, and mechanical properties of materials, including the analysis of principal stresses and strains under different loading conditions.
2. To equip students with the ability to analyze structural members subjected to axial, torsional, and bending loads, using theoretical formulations such as torsion equations, bending theory, and stress-strain relationships.
3. To develop the skills in students to construct shear force and bending moment diagrams and evaluate beam deflections using methods such as double integration and Maxwell's reciprocal theorem.
4. To explain failure theories related to columns, and to enable students to compute critical buckling loads and stress distributions in thin shells.

Course Outcomes: Learner will be able to…

1. Identify and compute different types of stresses and strains and determine principal stresses and planes using analytical and graphical methods.
2. Analyze torsional stresses in solid and hollow shafts and evaluate strain energy under various loading conditions.
3. Construct shear force and bending moment diagrams for statically determinate beams and apply area moment of inertia concepts.
4. Determine bending and shear stress distributions in beams and analyze stresses in thin cylindrical and spherical shells.
5. Calculate deflections and slopes of beams under various loading.
6. Evaluate buckling loads for columns with different end conditions.

Module	Detailed Contents	Hrs	CO Mapping
	Pre-requisites: Concepts of equilibrium in beams, support reactions; Centroid		
1.	**1.1 Introduction-Concept of Stress** Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses, Stress Strain Diagram, elastic constants and their relations- volumetric, linear and shear strains. Thermal stress and strain.	05	CO1
	1.2 Principal Stresses Principal stresses and Principal planes- Mohr's circle.	03	

2.	**2.1 Area Moment of Inertia** Area Moment of Inertia about centroidal axes, Parallel Axes theorem, Polar Moment of Inertia.	**02**	**CO2**
	2.2 Torsion: Torsion equation, Torsion of circular shafts-solid and hollow, stresses in shafts when transmitting power	**05**	
	2.3 Strain Energy: Strain energy stored in the member due to gradual, sudden and impact loads, Strain energy due to bending and torsion.	**03**	
3.	**Shear Force and Bending Moment Diagrams in Beams**	**05**	**CO3**
	Introduction to types of beams, supports and loadings. Definition of bending moment and shear force, relationship between load intensity, bending moment and shear force. Shear force and bending moment diagrams for statically determinate beams subjected to point load, uniformly distributed loads, couple and their combinations.		
4.	**Stresses in Beams and Thin Shells**		**CO4**
	4.1 Bending and Shear Stresses in Beams Theory of bending of beams, bending stress distribution, shear stress distribution for point and distributed loads in simply supported and cantilever beams.	**04**	
	4.2 Thin Shells Stresses and deformation in Thin Cylindrical and Spherical Shells subjected to internal pressure.	**02**	
5.	**Deflection of Beams** Deflection of a beam: Double integration method, Macauley's method for computation of slopes and deflection in beams for point and distributed loads.	**05**	**CO5**
6.	**Columns** Buckling load, Types of end conditions for column, Euler's column theory and its limitations and Rankine formula.	**05**	**CO6**
	Total Hours	**39**	

Textbooks

1. James M. Gere and Barry J. Goodno: Mechanics of Materials, 2nd Edition, Cengage Learning (2009)
2. S. Ramamrutham: Strength of Materials, 14th Edition, Dhanpat Rai Pvt. Ltd. (2014)
3. S. B. Junnarkar: Mechanics of Structures, 24th Edition, Charotar Publication. (2015)
4. S. S. Ratan: Mechanics of Materials, 2nd Edition, Tata McGraw Hill Pvt. Ltd. (2011)

Reference Books

1. W. Nash, Schaum's Outline Series: Strength of Materials, 5th Edition, McGraw Hill Publication, Special Indian Edition. (2015)
2. Beer, Johnston, DeWolf and Mazurek: Mechanics of Materials, 8th Edition, TMH Pvt Ltd, New Delhi. (2020)
3. Ryder: Strength of Materials, 3rd Edition, Macmillan (Publisher) (1969)
4. Irwin H. Shames: Introduction to Solid Mechanics, 3rd Edition, Pearson Publisher (2015)
5. R. Subramanian: Strength of Materials, 3rd Edition, Oxford University Press (2016)

Web Resources

1 https://swayam.gov.in/nd1_noc20_ce34 – Swayam Course Material.
2 https://nptel.ac.in/courses/112107146 – NPTEL Course Material.
3 https://archive.nptel.ac.in/courses/105/105/105105108 – NPTEL Course Material.

Assessment:

Internal Assessment for 40 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)

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**.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2403113	Thermodynamics	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2403113	Thermodynamics	20	20	40	60	2	--	--	100

Rationale :

Thermodynamics concepts are useful in understanding and designing systems involving energy transfer and energy transformation.

Course Objectives: Six Course Objectives

1. To familiarize the concepts of Energy in general and Heat and Work in particular
2. To study the fundamentals of quantification and grade of energy
3. To study the effect of energy transfer on properties of substances in the form of charts and diagrams
4. To familiarize with the application of the concepts of thermodynamics in vapour power and gas power cycles.
5. To study the concepts of compressible fluid flow
6. To study the concepts of reactive systems

Course Outcomes: Six Course outcomes (Based on Blooms Taxonomy)

1. Demonstrate application of the laws of thermodynamics to a wide range of systems.
2. Compute heat and work interactions in thermodynamic systems
3. Demonstrate the interrelations between thermodynamic functions to solve practical problems.
4. Compute thermodynamic interactions using the steam table and Mollier chart
5. Compute efficiencies of heat engines, power cycles.
6. Apply the fundamentals of compressible fluid flow to the relevant systems

Prerequisite:

DETAILED SYLLABUS: Total six module for each subject (13 Weeks)

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Thermodynamics system and types, Microscopic and Macroscopic approach, System, Boundary and Surrounding, Thermodynamic properties, Zeroth Law of Thermodynamics, First law of thermodynamics, Internal Energy, Concept of Enthalpy and Entropy		
I	**Basic Concepts :**	**Introduction and Basic Concepts of Thermodynamics :** Thermodynamic state, path, process and cycle, Point and Path functions, Quasi-static process & Equilibrium, Characteristic gas equation, Heat and Work. Concept of PdV work. **First Law of Thermodynamics:** Statement & Equation, First law for Cyclic process (Joule's experiment), Perpetual Motion Machine of the First Kind, Application of first law to non-flow systems (Ideal gas processes with numerical) First law applied to flow system: Concept of flow process and flow energy, Concept of the steady flow process, Energy balance in a steady flow, Application of steady flow energy equation to nozzle, turbine, compressor, pump, boiler, condenser, heat exchanger, throttling device. Steady flow work, Significance of – VdP work, Relation between flow and non-flow work	6	CO1
II	**Second Law of Thermodynamics:**	**Second Law of Thermodynamics:** Limitation of the first law of thermodynamics, Thermal reservoir, Concept of heat engine, Heat pump and Refrigerator, Statement of the second law of thermodynamics, Reversible and irreversible Process, Causes of irreversibility, Perpetual Motion Machine of the second kind,Carnot cycle, Carnot theorem. **Entropy:** Clausius theorem, Entropy is property of a system, Temperature-Entropy diagram, Clausius inequality, Increase of entropy principle, T ds relations, Entropy change During a process.	8	CO2
III	**Availability:**	**Availability:** Highgradeandlow-gradeenergy,AvailableandUnavailableenergy,DeadState, Useful work, Irreversibility, Availability of closed system& steady flow process, Helmholtz & Gibbs function **(Only Theory)** **Thermodynamic Relations:** Maxwell relations, Clausis-Clapeyron Equation, Mayer relation, Joule-Thomson coefficient **(Only Theory)**	4	CO3

IV	**Properties of Pure Substance:**	**Properties of Pure Substance:** Advantages and applications of steam, Phase change process of water, Saturation pressure and temperature, Terminology associated with steam, Different types of steam. Property diagram: T-v diagram, p-v diagram, p-T diagram, Critical and triple point, T-s and an h-s diagram for water, Calculation of various properties of wet, dry and superheated steam using the steam table and Mollier chart**.** **Vapour Power cycle:** Principal components of a simple steam power plant, Carnot cycle and its limitations as a vapour cycle, Rankine cycle with different turbine inlet conditions, Mean temperature of heat addition, Reheat Rankine Cycle.	7	CO4
V	**Gas Power cycles:**	**Gas Power cycles:** Nomenclature of a reciprocating engine, Mean effective pressure, Assumptions for Air Standard Cycle, Otto cycle, Diesel Cycle and Dual cycle, Comparison of Otto and Diesel cycle for same compression ratio, Brayton Cycle. Sterling Cycle, Ericsson Cycle, Lenoir cycle, and Atkinson cycle (Only theory).	6	CO5
VI	**Compressible Fluid flow:** **Reactive Systems**	**Compressible Fluid flow:** Propagation of sound waves through compressible fluids, Sonic velocity and Mach number; Stagnation properties, Application of continuity, momentum and energy equations for steady-state conditions; Steady flow through the nozzle, Isentropic flow through ducts of varying cross-sectional area, Effect of varying back pressure on nozzle performance, Critical pressure ratio **(Only Theory)** **Reactive Systems:** Combustion, theoretical and actual combustion processes, enthalpy of formation and enthalpy of combustion, Adiabatic flame temperature, first law analysis of reactive system **(Only Theory)**	8	CO6

Text Books:

1. Thermodynamics by P K Nag, 6thEdition,TMH

2. Thermodynamics by Onkar Singh, 4th Edition New Age International

3. Thermodynamics by C P Arora,1stEditionTMH

References:

1. Thermodynamics: An Engineering Approach by Yunus A. Cengel and Michael A. Boles, 9thedition, TMH
2. Basic Engineering Thermodynamics by Rayner Joel, 5thedition, Longman Publishers
3. Engineering Thermodynamics by P Chattopadhyay, 2ndedition, Oxford University Press India
4. Engineering Thermodynamics Through Examples by Y V C Rao, Universities Press (India) Pvt Ltd
5. Fundamentals of Thermodynamics by Moran &Shapiro, Eighth Edition, Wiley
6. Fundamentals of Classical Thermodynamics by Van Wylen G.H. & Sonntag R.E., 9th Edition John Wiley& Sons
7. Thermodynamics by W.C. Reynolds, McGraw-Hill &Co
8. Thermodynamics by J P Holman, 4th Edition McGraw-Hill & Co

Online References:

Sr. No.	Website Name
1.	https://nptel.ac.in/courses/112/105/112105266
2.	https://nptel.ac.in/courses/112/103/112103275
3.	https://nptel.ac.in/courses/112/105/112105220
4	https://nptel.ac.in/courses/101/104/101104063

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

 Question paper format

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

- A total of **Three questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2403114	Material Science	3	-	-	3	-	-	3

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2403114	Material Science	20	20	40	60	2	--	--	100

Rationale:
Materials are the basis for all technologies and hence is relevant to engineering.

Course Objectives: Six Course Objectives

1. To familiarize with the concept of crystal formation and imperfections
2. To understand the concept of effect of temperature on deformability of metals.
3. To acquaint with the mechanism of crystallization and phase transformations
4. To make understand the phase transformations of Iron-Iron carbide system
5. To familiarize with the heat treatment processes
6. To Understand mechanism of failure in materials.

Course Outcomes: Six Course outcomes (Based on Blooms Taxonomy)

1) Identify the various classes of materials and comprehend their properties
2) Differentiate between concepts of hot and cold working.
3) Able to interpret solidification behavior and phase transformation.
4) Apply phase diagram concepts to engineering applications
5) Apply particular heat treatment for required property development
6) Identify the probable mode of failure in materials and suggest measures to prevent them

Prerequisite:
DETAILED SYLLABUS: total six module for each subject (13 Weeks)

Sr. No.	Name of Module	Detailed Content	Hours	CO Mapping
0	Prerequisite			
I	Introduction to Crystals and Imperfections	Classification of materials: Introduction to engineering materials, significance of structure property correlations in all classes of engineering materials. Concepts of crystals- Crystalline and Non-crystalline Materials Unit cell, Crystal structures of metals, Crystal systems, Crystallographic planes and directions, Crystal Defects: Crystal Imperfections- definition, classification and significance of imperfections ,point defects, line defects, Surface defects and volume defects. Importance of dislocations in deformation and its mechanisms. Critical resolved shear stress, Slip systems and deformability of FCC, BCC and HCP lattice systems.	08	1
II	Hot -Cold Working mechanisms	Concept of Recrystallization, effects and mechanism of cold work and hot work, Need for Recrystallization Annealing, the stages of recrystallization annealing and factors affecting.	05	2
III	Crystallization & Phase Transformations	Nucleation-Homogeneous and Heterogeneous Nucleation and Growth. Solidification of metals and alloys, Cooling curves. Classification of Alloys based on phases and phase -diagrams Binary alloy phase diagrams – ,Isomorphous, Eutectics type I and II, Peritectic.	07	3
IV	Iron-Iron carbide phase diagram	Invariant reactions, microstructural changes of hypo and hyper-eutectoid steel, Solidification of different alloys from the Iron-Iron carbide diagram, TTT and CCT diagram-Hardenability and its tests, Graphitization in cast irons.	08	4
V	Heat treatment & Alloy Steel	Objectives, Thorough treatments: Annealing and types, normalizing, hardening and tempering. Isothermal treatments austempering and martempering. Surface hardening processes: Carburizing , Nitriding ,Cyaniding and Carbonitriding, induction and flame hardening. Alloy steels-Stainless steels, Tool steels, Maraging steels and Ausformed steels	06	5
VI	Fracture & Failure Mechanism	Fracture of metals, Ductile Fracture, Brittle Fracture, Ductile to Brittle Transition Temperature (DBTT), Griffith's criteria and Orowan's modification. Fatigue/Endurance limit of ferrous and non-ferrous metals, Fatigue test, S-N curves, factors affecting fatigue, structural changes accompanying fatigue. Creep, mechanism of creep, stages of creep and creep test, creep resistant materials.	05	6

Text Books:

1. Callister's Materials Science and Engineering, 2nd edition by R.Balasubramanium Wiley India Pvt. Ltd
2. Introduction to Engineering Materials, B K Agrawal, Tata Mcgraw Hill
3. Materials Science and Engineering : A First Course, RaghavanV , Prentice Hall India
4. MATERIAL SCIENCE AND METALLURGY FOR ENGINEERS by Dr. V.D Kodgire and S.V Kodgire.Everest Publishing House

References:

1. . Introduction to Physical Metallurgy, SidneyH. Avner, Tata McgrawHill
2. Introduction to Materials Science for Engineers; 8th Edition by James F. Shackelford Pearson
3. Fundamentals of Materials Science and Engineering: An Integrated Approach, 5th Edition by William D. Callister, Jr., David G. Rethwisch , Wiley & Sons.
4. Materials Science and Engineering, 5th edition by V.Raghavan, Prentice Hall India
5. R. A. Higgins ENGINEERING METALLURGY Part I R.A.Higgins (Higgins, Raymond A.)

Links:

1 https://archive.nptel.ac.in/courses/113/102/113102080/
2 https://www.youtube.com/watch?v=JOQpbJIakRM
3. https://www.youtube.com/watch?v=2F9NEoXvkQE
4. https://www.youtube.com/watch?v=XUB1wiKfbUk
5 https://www.youtube.com/watch?v=MoiJSjwjbxs
6. https://www.youtube.com/watch?v=Yx-bIKo-_wg

Online References:

Sr. No.	Website Name
1.	https://iisc.ac.in/outreach/publications/iisc-lecture-notes-series/
2.	https://ocw.mit.edu/courses/3-012-fundamentals-of-materials-science-fall-2005/pages/lecture-notes/
3.	https://www.usna.edu/NAOE/_files/documents/Courses/EN380/Course_Notes/Ch11_Fracture.pdf

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

Question paper format

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **Three questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2403115	Materials Testing		2	-		1	-	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. of 2 Tests				
2403115	Materials Testing	--	--	--	--	25	25	50

Lab Objectives: Six Lab Objectives

1. To familiarize students with examination techniques of microstructure in ferrous and or non-ferrous metals to make them understand a correlation between microstructure and mechanical properties.
2. To introduce students to fundamentals of testing methods used to evaluate the mechanical properties of engineering materials.
3. To familiarize the students about fatigue test and S-N curve.
4. To introduce to the students simple tension test to analyze the stress - strain behaviour of materials
5. To develop hands-on skills in students in conducting standard material tests such as impact, hardness, torsion, and compression.
6. To cultivate the ability in students to interpret and analyze test results in relation to properties and behavior of materials under different loading conditions.

Lab Outcomes: Six Lab outcomes (Based on Blooms Taxonomy)

1. Prepare metallic samples for studying its microstructure following the appropriate procedure.
2. Identify effects of heat treatment on microstructure of medium carbon steel and hardenability of steel using Jominy end quench test.
3. Perform fatigue test and draw S-N curve.
4. Perform simple tension test to analyze the stress - strain behaviour of materials.
5. Measure torsional strength, hardness and impact resistance of the material.
6. Perform flexural test with central and three-point loading conditions.

Prerequisite: Material Science & Strength of Materials Course

DETAILED SYLLABUS: Syllabus related Lab experiment must be considered and mapped with Blooms Taxonomy.
Total six module for each subject lab (13 weeks) to be distributed among six modules.

A. List of Experiments: Minimum ***eight*** experiments to be performed (***Four*** Experiments each from both the groups):.

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	**Comment** (Prerequisite syllabus should not be considered for paper setting)		
1.		Metallographic characterization involves preparing and analyzing metal samples to reveal their microstructure. This process includes sample preparation steps like cutting, mounting, grinding, and polishing, followed by etching to enhance structural details.	**02**	**LO1**
2.		This experiment investigates the changes in microstructure and hardness of medium carbon steel after annealing, normalizing, and hardening heat treatments. The study focuses on how these treatments affect the steel's mechanical properties, particularly hardness and ductility	**02**	**LO2**
3.		Experimental studies on tempering hardened steel demonstrate that increasing the tempering temperature leads to a decrease in hardness and an increase in toughness. Tempering also reduces brittleness and improves ductility.	**02**	**LO2**
4.		The Jominy end quench test is a standard method for determining the hardenability of steel, which is the ability of steel to transform from austenite to martensite upon cooling from a high temperature. The test involves heating a cylindrical steel sample, then quenching one end with water to create a cooling gradient. Hardness measurements are then taken along the sample's length to determine the depth of hardening.	**02**	**LO2**
5.		Rotating beam fatigue testing involves applying a bending stress to a cylindrical specimen while it rotates, inducing alternating tensile and compressive stresses on its surface. This method simulates the fatigue conditions experienced by components like axles or shafts under cyclic loading. The test is run until the specimen fails or a predetermined number of cycles is reached, allowing for the determination of fatigue endurance limits and life cycles.	**02**	**LO3**
		Group B		

6.		A tension test on a mild steel bar is a destructive test used to determine its mechanical properties like stress-strain behavior, yield strength, and modulus of elasticity. The test involves applying a tensile force to the specimen, measuring the resulting elongation, and analyzing the load-elongation data to create a stress-strain curve. This curve reveals the material's elastic and plastic behavior, including the yield point where permanent deformation begins, and the ultimate tensile strength.	**02**	**LO4**
7.		A torsion test on mild steel or cast iron bars involves twisting a bar to induce shear stress, measuring the resulting angle of twist, and recording the torque applied. This test is used to determine material properties like modulus of rigidity (G) and shear strength.	**02**	**LO5**
8.		Impact tests, like Izod and Charpy, evaluate a material's resistance to sudden impact loads by measuring the energy absorbed during fracture. These tests, often using a notched specimen and a swinging pendulum, provide insights into a material's toughness and ductility. The Charpy test, for example, is typically performed with the specimen supported horizontally, while the Izod test uses a vertical specimen.	**02**	**LO5**
9.		The Brinell and Rockwell hardness tests are two methods used to determine the hardness of metals by measuring the resistance to indentation. The Brinell test uses a steel or carbide ball pressed into the metal surface, and the hardness is determined by measuring the diameter of the indentation. The Rockwell test measures the depth of indentation produced by a diamond cone or hardened steel ball under a specific load.	**02**	**LO5**
10		A flexural test on a beam with central loading, also known as a three-point bending test, is a method to determine the material's resistance to bending stresses. In this test, a beam is placed on supports, and a load is applied at the center (mid-span). The test measures the load required to cause a specific deflection or fracture, allowing the calculation of flexural strength and modulus.	**02**	**LO6**

Text Books:

1. Callister's Materials Science and Engineering, 2nd edition by R.Balasubramanium Wiley India Pvt. Ltd

References:

1. Introduction to Materials Science for Engineers; 8th Edition by James F. Shackelford Pearson
2. Introduction to Physical Metallurgy,2nd edition by Sidney Avner, TataMcGrawHill
3. Mechanical Metallurgy, 3rd edition by GH Dieter,TataMcGraw Hill
4. Fundamentals of Materials Science and Engineering: An Integrated Approach, 5th Edition by William D. Callister, Jr., David G. Rethwisch, Wiley & Sons.
5. Materials Science and Engineering,5th edition by V.Raghavan, Prentice Hall India

Online Resources:

Sr. No.	Website Name
1	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-mm09
2	https://nptel.ac.in/courses/113/102/113102080/
3	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-mm09/
4	https://nptel.ac.in/content/storage2/courses/112108150/pdf/PPTs/MTS_09_m.pdf
5	https://nptel.ac.in/content/storage2/courses/112108150/pdf/PPTs/MTS_08_m.pdf
67	https://nptel.ac.in/courses/112/104/112104229/
8	https://nptel.ac.in/courses/118/104/118104008/
9	https://nptel.ac.in/content/storage2/courses/112104173/Mod_1_smart_mat_lec_6.pdfhttps://nptel.ac.in/courses/112/104/112104229/
10	https://nptel.ac.in/courses/118/104/118104008/
11	https://nptel.ac.in/content/storage2/courses/112104173/Mod_1_smart_mat_lec_6.pdf

List of Experiments.

Sr No	List of Experiments	Hrs
01	Study of Characterization techniques and Metallographic sample preparation and etching.	02
02	Comparison of Microstructures and hardness before and after Annealing, Normalizing and Hardening in medium carbon steel.	02
03	Study of tempering characteristics of hardened steel.	02
04	Determination of hardenability of steel using Jominy end Quench Test (Using different hardness testers to measure the Hardness)	02
05	Fatigue test using Rotating Beam Specimen.	02
	Group B	
06	Tension test on mild steel bar (stress-strain behaviour, determination of yield strength and modulus of elasticity)	02
07	Torsion test on mild steel bar / cast iron bar	02
08	Impact test on metal specimen (Izod/Charpy Impact test)	02
09	Hardness test on metals — (Brinell/ Rockwell Hardness Number	02
10.	Flexural test on beam (central loading)	02

Sr No	**Group C. List of Assignments / Tutorials** (At least ***two*** problems on each of the following topics☺	**Hrs**
01	Simple Stress and Strain	2
02	Torsion and Strain Energy	2
03	SFD and BMD	2
04	Stresses in Beams and Thin Shells	2
05	Deflection of Beams	2
06	Buckling of Columns	2

Project Based Learning may be incorporated by judiciously reducing number of assignments. For example, project on topics like, Preparation and Testing of parts made of composite material/s, testing of components made using 3D Printing, etc. ***may be*** considered.

Assessment :
Term Work: Term Work shall consist of at least 8 to 9 practical based on the above list. Also, Term work Journal must include at least 2 assignments.
Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)
Practical& Oral Exam: An Oral & Practical exam will

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2403116	Working Drawing-GD & T	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg. of 2 Tests				
2403116	Working Drawing-GD & T	--	--	--	--	25	25	50

Lab Objectives: Six Lab Objectives

1. To familiarize with different types of drawings and symbols used in working drawings
2. To impart fundamentals of - limits, tolerances and fits used in working drawings
3. To impart fundamentals of- surface roughness, machining symbols and working drawing reading
4. To impart fundamentals of GD & T
5. To familiarize with symbols, rules and datums used in GD & T
6. To familiarize with form, orientation and position used in GD & T

Lab Outcomes: Six Lab outcomes (Based on Blooms Taxonomy)
After completion of this laboratory course, the students will be able to

Interpret appropriate symbols used in working drawings
Interpret tolerances used in working drawings
Show the surface roughness components on the working drawing and read the working drawings
Show geometric characteristic symbols on a working drawing
Apply GD & T symbols in a working drawing
Show form and orientation on a part drawing

Prerequisite:
ESC201: Engineering Graphics
ESL201: Engineering Graphics Lab

DETAILED SYLLABUS: Syllabus related Lab experiment must be considered and mapped with Blooms Taxonomy.
total six module for each subject lab (13 weeks) to be distributed among six modules.

Sr. No.	Module	Detailed Content	Hours	LO (Lab Outcome) Mapping
0	Prerequisite	**Comment** (Prerequisite syllabus should not be considered for paper setting)		
I	**Introduction**	Classification of drawings- machine drawing, production drawing, part drawing, assembly drawing and its types, patent drawing, Need of working drawing, difference between machine drawing and working drawing. Conventional representation (symbols) of materials, conventional representation of machine components – screw threads, welded joints, springs, gears, shafts bearings, knurling, Standard drafting and material abbreviations	**04**	**LO1**
II	**Limits, tolerances and fits**	Limit systems and terms used – tolerance, limits, deviation, actual deviation, upper deviation, lower deviation, allowance, basic size, design size, actual size. Tolerances- graphical illustration of tolerance zones, fundamental tolerances, fundamental deviation, calculation of fundamental shaft deviation, calculation of fundamental hole deviation Fits- types of fits with symbols and applications, hole basis and shaft basis systems	**04**	**LO2**
III	**Surface roughness, Machining symbols, working drawing**	Surface roughness representation, indication of surface roughness, symbols specifying direction of lay, indication of machining allowance and surface roughness allowance on drawings, Reading a working drawing	**06**	**LO3**
IV	**Introduction to GD & T**	What is GD & T, when to use GD & T, advantages of GD & T over Coordinate Dimensioning and Tolerancing. Geometric characteristic symbols like- Form, Profile, Orientation, Runout, Location, etc.	**04**	**LO4**
V	**Symbols, Rules and Datums**	Geometric characteristic Symbols The feature control frame Rules Material conditions - Regardless of feature size (RFS), Maximum material condition (MMC), Least material condition (LMC), Material condition symbols and abbreviations Degrees of freedom and immobilization of a part, application of Datums, datum feature selection, datum feature (inclined, cylindrical, etc.) identification, establishing datums, datum targets	**04**	**LO5**
VI	**Form, orientation and position**	Form- flatness, straightness, circularity, cylindricity Orientation- Parallelism, Perpendicularity, Angularity Position (general) - Specifying the Position Tolerance, Regardless of Feature Size, MMC, Shift Tolerance, LMC	**04**	**LO6**

Text Books:

1. Narayana KL, Kannaiah P, Reddy VK, Machine Drawing, by New Age International Publishers

2. Bhatt ND, Machine Drawing, Charotar Publishing House Pvt. Ltd., 50th Edition, ISBN-13: 978-9385039232, 2014

References:

1. Cogorno GR, Geometric Dimensioning and Tolerancing for Mechanical Design: A Self-Teaching Guide to ANSI Y 14.5M1982 and ASME Y 14.5M1994 Standards / Edition 1 by The McGraw-Hill Companies, Inc.

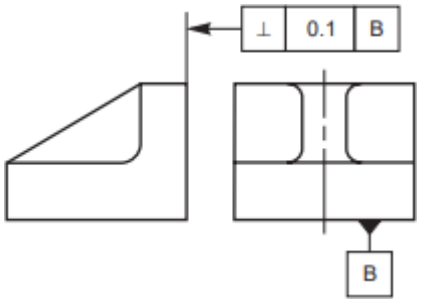
2. Kampbell RG, Roth ES, Integrated Product Design and Manufacturing Using Geometric Dimensioning and Tolerancing, by Marcel Dekker, Inc.

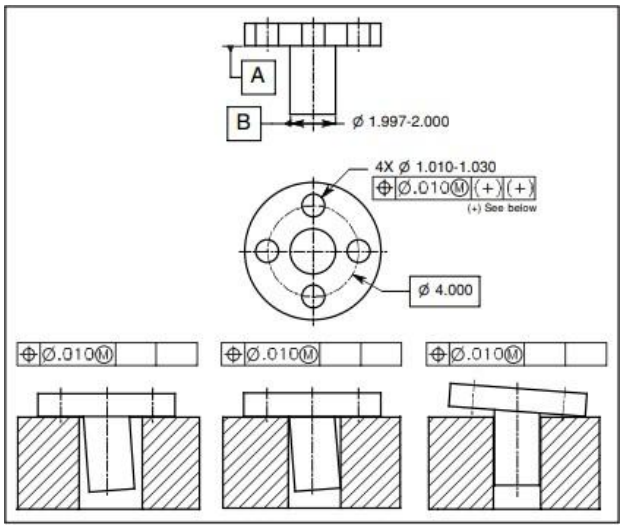
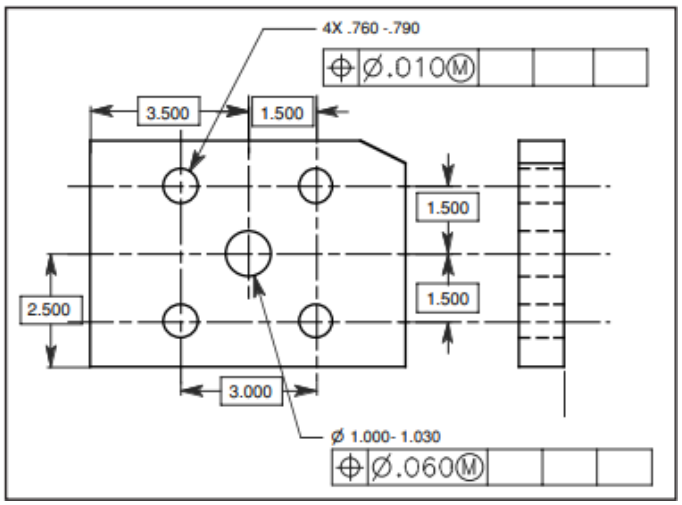
3. Meadows JD, Geometric dimensioning and tolerancing, by B.S Publications.

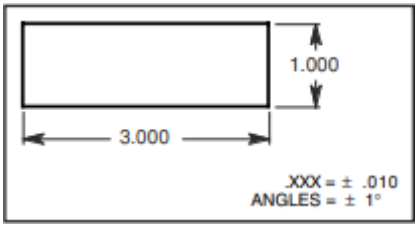
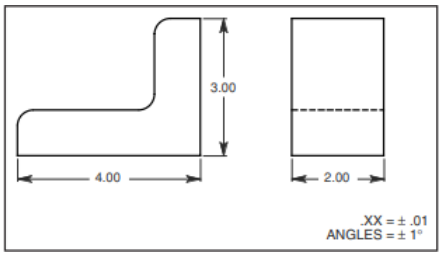
Online Resources:

Sr. No.	Website Name
	https://www.gdandtbasics.com/
	https://www.asme.org/codes-standards/y14-standards
	http://www.ttc-cogorno.com/Courses/BluePrint.pdf

List of Experiments.

Sr No	List of Exercises (Using AutoCAD)	Hrs
01 **(Module 2)**	Draw a simple mechanical part (sample part is shown in figure below) and write an interpretation of the meaning of the geometrical tolerances for it by means of neat sketches and explanatory notes.  **Figure for sample exercise:** Sample mechanical part	
02 **(Module 3)**	Students shall draw a simple mechanical part and indicate the following surface roughness components on it: Symmetrical surfaces requiring the same quality Cylindrical part Same surface quality all over	
03 **(Module 4)**	Students shall draw a working drawing of any mechanical component and show following geometric characteristic symbol on it - Form (straightness/flatness/circularity/cylindricity) Profile (line/surface) Orientation (angularity/perpendicularity/parallelism) Runout (circular/total) Location (position/concentricity/symmetry)	

04 **(Module 5)**	Students shall draw the given mechanical part and complete the feature control frames with datums and material condition symbols (few sample exercises are shown here) **Sample exercise 1:** Students shall draw the mechanical part and complete the feature control frames with datums and material condition symbols to reflect the drawing shown in figure below-  **Figure for sample exercise 1:** Datums at MMC and RFS **Sample exercise 2:** Students shall draw the mechanical part and provide the appropriate datum feature symbols on the drawing and datums in the feature control frames in the datum exercise shown in the figure below-  **Figure for sample exercise 2:** Specifying datums and datum feature symbols	
5 **(Module 6)**	Draw a simple mechanical part and specify following on it – Form- flatness, straightness, circularity, cylindricity Orientation- Parallelism, Perpendicularity, Angularity Position (General) - Specifying the Position Tolerance, Regardless of Feature Size, MMC, Shift Tolerance, LMC **Sample exercise (form):** Students shall draw the mechanical part shown in figure below and specify a flatness control of .005 for the top surface of the part-	

	 **Sample exercise (orientation):** Specify the 3cm surface of the part perpendicular to the bottom and back surfaces within a tolerance of 0.010 shown in figure below: 	

01 **(Module 1)**	To write an assignment showing – Conventional representation (symbols) of materials conventional representation of machine components – screw threads, welded joints, springs, gears, shafts bearings, knurling, Standard drafting and material abbreviations	
02 **(Module 3)**	Copy of a working drawing of mechanical components (such as- rear tool post, pump housing, gear box cover, steam stop valve, milling fixture, etc.) to be provided to the students along with the questions based on the drawing reading and students shall write answers to the questions based on the drawing reading. Sample questions are provided here- What is the overall size? How many bolts are provided? How many screws are provided? What is the size of the tap? How is the cover fixed to the gear box? (**Note:** These are sample questions and to be customized based on the type of component)	
03 **(Module 5)**	To write an assignment covering - the feature control frame, Material conditions - Regardless of feature size (RFS), Maximum material condition (MMC), Least material condition (LMC), Material condition symbols and abbreviations	

Assessment:
Term Work: Term Work shall consist of at least 10 to 12 practicals' based on the above list. Also, Term work Journal must include all the 05 exercises (prints) and 03 assignments.
Term Work Marks: 25 Marks (Total marks) = 20 Marks (Experiment/assignments) + 5 Marks (Attendance)
Practical& Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Vertical – 5

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2993511	Entrepreneurship Development	--	2*+2	-	-	2*+2	-	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg. of 2 Tests				
2993511	Entrepreneurship Development	--	--	--	--	50	--	50

Note: * Two hours of practical class to be conducted for full class as demo/discussion/theory.

Lab Objectives:

1. To introduce students to entrepreneurship concepts and startup development.
2. To develop business idea generation, validation, and business model preparation.
3. To provide hands-on experience in market research, financial planning, and business pitching.
4. To enhance problem-solving and decision-making skills in entrepreneurial ventures.
5. To familiarize students with government schemes and support systems for entrepreneurs.
6. To develop communication and presentation skills required for business pitching.

Lab Outcomes:

Upon successful completion of this course, students will be able to:

1. Understand the fundamental concepts of entrepreneurship and business models.
2. Conduct market research and develop business plans.
3. Utilize financial planning and cost analysis for startups.
4. Apply entrepreneurial skills to identify and solve business challenges.
5. Develop prototypes using open-source software for business operations.
6. Pitch business ideas effectively with structured presentations.

DETAILED SYLLABUS

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	**Prerequisite**	Fundamentals of communication and leadership skills.	01	--
I	**Introduction to Entrepreneurship**	Definition, Characteristics, and Types of Entrepreneurs. Entrepreneurial Motivation and Traits. Start-up Ecosystem in India. Challenges in Entrepreneurship	**02**	**LO1**
II	**Business Idea Generation & Validation**	Ideation Techniques: Design Thinking, Brainstorming, Mind Mapping. Business Model Canvas (BMC). Market Research & Customer Validation. Minimum Viable Product (MVP) Concept.	**04**	**LO2**
III	**Business Planning & Strategy**	Writing a Business Plan. SWOT Analysis and Competitive Analysis. Financial Planning and Budgeting. Risk Assessment and Management	**04**	**LO3**
IV	**Funding and Legal Framework**	Sources of Funding: Bootstrapping, Angel Investors, Venture Capital Government Schemes & Start-up India Initiatives. Business Registration & Legal Formalities. Intellectual Property Rights (IPR) & Patents	**05**	**LO4**
V	**Marketing & Digital Presence**	Branding and Digital Marketing. Social Media Marketing & SEO. Customer Relationship Management (CRM). E-commerce & Online Business Models	**05**	**LO5**
VI	**Business Pitching & Prototype Development**	Pitch Deck Preparation & Presentation Techniques. Prototyping with Open-source Tools. Elevator Pitch & Investor Pitch. Case Studies of Successful Start-ups	**05**	**LO6**

Text Books:

1. "Entrepreneurship Development and Small Business Enterprises" – Poornima M. Charantimath, Pearson, 3rd Edition, 2021.
2. "Innovation and Entrepreneurship" – Peter F. Drucker, Harper Business, Reprint Edition, 2019.
3. "Startup and Entrepreneurship: A Practical Guide" – Rajeev Roy, Oxford University Press, 2022.
4. "Essentials of Entrepreneurship and Small Business Management" – Norman Scarborough, Pearson, 9th Edition, 2021.
5. "The Lean Startup" – Eric Ries, Crown Publishing, 2018.

References:

1. "Disciplined Entrepreneurship: 24 Steps to a Successful Startup" – Bill Aulet, MIT Press, 2017.
2. "Zero to One: Notes on Startups, or How to Build the Future" – Peter Thiel, 2014.
3. "The $100 Startup" – Chris Guillebeau, Crown Business, 2019.
4. "Business Model Generation" – Alexander Osterwalder & Yves Pigneur, Wiley, 2020.
5. "Blue Ocean Strategy" – W. Chan Kim & Renée Mauborgne, Harvard Business Review Press, 2019.

Online Resources:

Website Name
1. Startup India Portal – https://www.startupindia.gov.in 2. MIT OpenCourseWare – Entrepreneurship – https://ocw.mit.edu/courses/sloan-school-of-management/ 3. Coursera – Entrepreneurship Specialization – https://www.coursera.org/specializations/entrepreneurship 4. Harvard Business Review – Entrepreneurship Articles – https://hbr.org/topic/entrepreneurship 5. Udemy – Startup & Business Courses – https://www.udemy.com/courses/business/entrepreneurship/

List of Experiments.

Sr No	List of Experiments	Hrs
01	Business Idea Generation using Mind Mapping.	02
02	Conducting Market Research & Customer Validation.	02
03	Preparing a Business Model Canvas for a Startup Idea.	02
04	Developing a Financial Plan & Break-even Analysis.	02
05	Creating a Website using WordPress/Wix.	02
06	Social Media Marketing Campaign using Open-source Tools.	02
07	Digital Prototyping using Figma/Inkscape.	02
08	Business Pitch Deck Preparation & Presentation.	02
09	Exploring Government Schemes for Startups.	02
10	Legal Compliance & IPR Basics (Case Study).	02

Sr No	List of Assignments / Tutorials	Hrs
01	a. Write a report on any successful entrepreneur and their startup journey. b. Conduct SWOT analysis for a real-life startup.	02
02	Develop a business idea and create a one-page business plan.	02
03	Conduct market research using surveys & present findings.	02
04	Design a simple logo and branding strategy for a startup.	02
05	Create a financial model and cost estimation for a startup.	02
06	Make a case study report on startup failure analysis.	02

List of Open-Source Software
1. Canva – Designing pitch decks, social media posts, and branding materials. 2. Trello / Asana – Project management for startups. 3. GIMP / Inkscape – Graphic design and logo creation. 4. WordPress / Wix – Website development for startups. 5. OpenCart / PrestaShop – E-commerce website setup. 6. Figma – UI/UX design and prototyping. 7. LibreOffice Calc – Financial planning and budgeting. 8. Google Suite (Docs, Sheets, Slides) – Documentation and presentations. 9. Python (Pandas, Flask, Django) – Data analytics and web application development. 10. MailChimp – Email marketing and customer engagement.

Assessment :

Term Work: Term Work shall consist of at least 9 to 10 practical's based on the above list. Also, Term work Journal must include at least 5 to 6 assignments.

Term Work Marks: 50 Marks (Total marks) = 20 Marks (Experiment) + 15 Marks (Assignments) + 5 Marks (Attendance)+ 10 Marks (Report)

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2993512	Environmental Science	--	2*+2	-	--	2*+2	-	2

Course Code	Course Name	Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg. of 2 Tests					
2993512	Environmental Science	--	--	--	--	--	50	--	50

Note: * Two hours of practical class to be conducted for full class as demo/discussion/theory.

Rationale:

Most of the engineering branches are offspring of applied sciences, and their practices have a significant impact on the environment. Understanding environmental studies is essential for engineers to develop sustainable solutions, minimize ecological footprints, and promote responsible resource management. This course equips students with the knowledge of ecosystems, biodiversity, pollution control, and environmental laws, enabling them to integrate sustainability into engineering practices.

Lab Objectives:

1. To understand the scope, importance, and role of environmental studies in public awareness and health.
2. To study different natural resources, their issues, and sustainable conservation.
3. To understand ecosystem types, structures, and functions.
4. To explore biodiversity, its importance, threats, and conservation.
5. To learn about pollution types, causes, effects, and control measures.
6. To understand environmental challenges, sustainability, and ethics.

Lab Outcomes:

1. Explain the significance of environmental studies and the role of IT in environment and health.
2. Describe resource types, associated problems, and conservation methods.
3. Classify ecosystems and explain their role in ecological balance
4. Analyze biodiversity levels and conservation strategies, especially in India.
5. Explain pollution impacts and suggest preventive measures.
6. Discuss environmental issues and propose sustainable solutions.

DETAILED SYLLABUS:

Unit Name	Topic Name	Topic Description	Hours	LO Mapping
I	**The Multidisciplinary Nature of Environmental Studies**	Definition, scope and importance. Need for public awareness, Role of information technology in environment and human health. Human population and the environment: Population growth, variation among nations. Population Explosion- family welfare program. Environment and human health Women and child welfare	**03**	LO1
II	**Natural Resources**	Renewable and non-renewable resources. Natural resources & associated problems: a) Forest resources: b) Water resources: Natural resources & associated problems c) Mineral resources: d) Food resources: e) Energy resources: Role of an individual in conservation of natural resources: f) Equitable use of resources for sustainable lifestyles.	**04**	LO2
III	**Ecosystems**	Concepts of an ecosystem. Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries). Case study on various ecosystems in India.	**05**	LO3
IV	**Biodiversity and its Conservation**	Introduction-Definition: genetic species and ecosystem diversity. Bio-geographical classification of India Value of biodiversity : Consumptive use, productive use, social, ethical, aesthetic and option values, Bio-diversity at global, national, local levels India as a mega diversity nation Case study on Bio diversity in India.	**05**	LO4
V	**Environmental Pollution Definition**	Causes, effects and control measures of: a) Air pollution b) Water pollution c) Soil pollution. Solid waste management: Causes, effect and control measures of urban and industrial wastes. Role of an individual in prevention of pollution, Case study on Pollution Disaster management: floods, earthquake, cyclone and landslides. Carbon Credits for pollution prevention	**05**	LO5

VI	**Social Issues and Environment**	From unsustainable to sustainable development Urban problems related to energy, Water conservation, rain water harvesting, watershed management. Environmental ethics: issues and possible solution. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. Consumerism and waste products. Environment protection act. Public awareness Case study on Environmental Ethics	**04**	LO6

Textbooks

1. Environmental Science: Towards a Sustainable Future, G. Tyler Miller and Scott Spoolman, 13th Edition, Cengage Learning 2021
2. Environmental Management: Text and Cases, Bala Krishnamoorthy, 3rd Edition, PHI Learning, Publication Year: 2016
3. Green IT: Concepts, Technologies, and Best Practices, Markus Allemann, Springer 2008
4. Sustainable IT: Slimming Down and Greening Up Your IT Infrastructure, David F. Linthicum, IBM Press 2009
5. Environmental Modelling: Finding Solutions to Environmental Problems, David L. Murray, Cambridge University Press 2016
6. Remote Sensing and Image Interpretation, Thomas M. Lillesand, Ralph W. Kiefer, and Jonathan W. Chipman, 9th Edition, John Wiley & Sons 2020
7. Business Ethics: Concepts and Cases, Manuel Velasquez, Pearson 2012

Reference Books

1. Environmental Law and Policy in India, Shyam Divan and Armin Rosencranz, 2nd Edition, Oxford University Press 2018
2. The International Handbook of Environmental Laws, David Freestone and Jonathon L. Rubin, Edward Elgar Publishing 2000
3. E-Waste Management: Challenges and Opportunities in Developing Countries, Ruediger Kuehr and Ram K. Jain, Springer 2008
4. The E-Waste Handbook: Managing Electronic Waste, Klaus Hieronymi, Ruediger Kuehr, and Ram K. Jain, Earthscan 2009
5. Environmental Ethics: An Introduction, J. Baird Callicott, University of Georgia Press1999

Online References:

Sr. No.	Website Name
1.	Centre for Science and Environment (CSE), Website: cseindia.org
2.	Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India
3.	CSIR-National Environmental Engineering Research Institute (NEERI)

List of Experiments.

Sr No	List of Experiments	Hrs
01	Study of Environmental Components and Ecosystems.	2
02	Visit and Report on Solid Waste Management Plant.	2
03	Study of Renewable Energy Sources (Solar, Wind, Biogas).	2
04	Analysis of Air and Water Quality Parameters.	2
05	Study of Local Biodiversity and Conservation Methods.	2
06	Awareness Activity on Environmental Issues.	2
07	Rainwater Harvesting System Design	2
08	Case Study on Environmental Pollution & Control Measures.	2
09	Report on Climate Change Impact and Adaptation.	2
10	Study of Environmental Laws and Acts.	2
11	Study of Disaster Management Techniques.	2
12	Report on Role of IT in Environmental Protection.	2

Sr No	List of Assignments / Tutorials	Hrs
01	Prepare a report on Renewable and Non-Renewable Resources.	2
02	Write a case study on Ecosystem Types in India	2
03	Write a report on Biodiversity in India.	2
04	Prepare a report on Pollution Types and Control Measures.	2
05	Prepare a report on Environmental Ethics and Sustainability.	2
06	Prepare a case study report on Global Warming and Climate Change.	2
07	Report on Role of an Individual in Environmental Protection.	2
08	Write a report on Disaster Management Techniques.	2
09	Prepare a report on Environmental Laws and Acts in India.	2
10	Case Study on E-waste Management and Recycling Techniques.	2

Assessment :

Term Work: Term Work shall consist of at least 10 to 12 practical's based on the above list. Also, Term work Journal must include at least 8 to 10 assignments.

Term Work Marks: 50 Marks (Total marks) = 20 Marks (Experiment) + 15 Marks (Assignments) + 5 Marks (Attendance)+ 10 Marks (Report)

Vertical – 6

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
2403611	Mini Project (Group Project)	--	4	-	-	2	-	2

Course Code		Theory					Term work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test 1	Test 2	Total					
2403611	Mini Project (Group	--	--	--	--	50	25	75	--

Course Objectives:

1. To acquaint yourself 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 yourself with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcomes: Learner will be able to

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

Guidelines for Minor 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 surveys and identify needs, which shall be converted into a problem statement for minor-project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Student groups shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of the minor project.
- A log book has to be prepared by each group, wherein the group can record weekly work progress, and the guide/supervisor can verify and record notes/comments.
- Faculty supervisors may give inputs to students during minor project activity; however, focus shall be on self-learning.
- Students in a group shall understand the problem effectively, propose multiple solutions and select the best possible solution in consultation with the guide/supervisor.
- Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.
- The solution has to be validated with proper justification and the report has to be compiled in the standard format.
- With the focus on self-learning and innovation, addressing societal problems and entrepreneurship quality development within the students through the Minor Projects, it is preferable that a single project of appropriate level and quality be carried out by all the groups of the students.

Guidelines for Assessment of Minor Project –Continuous assessment and Term Work:

- The review/ progress monitoring committee shall be constituted by heads of departments of each institute. The progress of the minor project to be evaluated on a continuous basis, Minimum two reviews in each semester- 50 marks.
- 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 the semester shall be as below:
    - Quality of project report and presentation- **25 marks**
    - Development of prototype/scaled model for project- **25 marks**

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

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 finalization of problem and proposed solution
    - Second shall be for implementation and testing of solutions.

Assessment criteria of Minor Project:

1. Quality of survey/need identification
2. Clarity of problem definition based on need
3. Innovativeness/uniqueness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness/uniqueness
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 as member or leader
13. Clarity in written and oral communication

Sample Minor Projects: Tensegrity Structures for Mechanical applications, Computer Aided Beam Analysis, Catapult etc Minor Project topics should involve the core subjects of semester 3.

Guidelines for Assessment of Minor Project - Practical/Oral Examination: 25 marks

- Report should be prepared as per the guidelines issued by the Department.
- Minor project shall be assessed through a presentation and demonstration of working model or the execution of programme code 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 the Head of Institution.
- Students shall be motivated to publish a paper based on the work in conferences or student competitions.

Letter Grades and Grade Points:

Semester GPA/ Programme CGPA Semester/ Programme	% of Marks	Alpha-Sign/ Letter Grade Result	Grading Point
9.00 - 10.00	90.0 – 100	O (Outstanding)	10
8.00 - < 9.00	80.0 - < 90.0	A+ (Excellent)	9
7.00 - < 8.00	70.0 - < 80.0	A (Very Good)	8
6.00 - < 7.00	60.0 - < 70.0	B+ (Good)	7
5.50 - < 6.00	55.0 - < 60.0	B (Above Average)	6
5.00 - < 5.50	50.0 - < 55.0	C (Average)	5
4.00 - < 5.00	40.0 - < 50.0	P (Pass)	4
Below 4.00	Below 40.0	F (Fail)	0
Ab (Absent)	-	Ab (Absent)	0

Sd/-

Dr. Vaishali D. Khairnar
BoS-Chairman-Information Technology
Faculty of Technology

Sd/-

Dr. Deven Shah
Associate Dean
Faculty of Science & Technology

Sd/-

Prof. Shivram S. Garje
Dean
Faculty of Science & Technology