MATHEMATICS – Third Semester B. Tech

(For all branches except Computer Science and Information Technology)

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MAT201	PARTIAL DIFFERENTIAL EQUATIONS AND COMPLEX ANALYSIS	BASIC SCIENCE COURSE	3	1	0	4

Preamble: This course introduces basic ideas of partial differential equations which are widely used in the modelling and analysis of a wide range of physical phenomena and has got application across all branches of engineering. To understand the basic theory of functions of a complex variable, residue integration and conformal transformation.

Prerequisite: A basic course in partial differentiation and complex numbers**.**

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the concept and the solution of partial differential equation.
CO 2	Analyse and solve one dimensional wave equation and heat equation.
CO 3	Understand complex functions, its continuity differentiability with the use of Cauchy-Riemann equations.
CO 4	Evaluate complex integrals using Cauchy's integral theorem and Cauchy's integral formula, understand the series expansion of analytic function
CO 5	Understand the series expansion of complex function about a singularity and Apply residue theorem to compute several kinds of real integrals.

Mapping of course outcomes with program outcomes

PO's	Broad area
PO 1	Engineering Knowledge
PO 2	Problem Analysis
PO 3	Design/Development of solutions
PO 4	Conduct investigations of complex problems
PO 5	Modern tool usage
PO 6	The Engineer and Society
PO 7	Environment and Sustainability
PO 8	Ethics
PO 9	Individual and team work

PO 10	Communication
PO 11	Project Management and Finance
PO 12	Life long learning

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	3	2	1				2		2
CO 2	3	3	3	3	2	1				2		2
CO 3	3	3	3	3	2	1				2		2
CO 4	3	3	3	3	2	1				2		2
CO 5	3	3	3	3	2	1				2		2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests(%)**		**End Semester Examination(%)**
	1	**2**	
Remember	10	10	10
Understand	30	30	30
Apply	30	30	30
Analyse	20	20	20
Evaluate	10	10	10
Create			

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions.

Course Outcome 1 (CO1):

1. Form the partial differential equation given $z = xf(x) + ye^2$
2. What is the difference between complete integral and singular integral of a partial differential equation
3. Solve $3z = xp + yq$
4. Solve $(p^2 + q^2)y = qz$
5. Solve $u_x - 2u_t = u$ by the method of separation of variables

Course Outcome 2 (CO2):

1. Write any three assumptions in deriving one dimensional wave equations
2. Derive one Dimensional heat equation
3. Obtain a general solution for the one dimensional heat equation $\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial t^2}$
4. A tightly stretched flexible string has it's ends fixed at $x = 0$and $x = l$. At $t = 0$, the string is given a shape defined by $f(x) = \mu x(l - x)$ where μ is a constant
5. Find the temperature $u(x, t)$ in a bar which is perfectly insulated laterally whose ends are kept at $0°C$ and whose initial temperature (in degree Celsius) is $f(x) = x(10 - x)$ given that it's length is 10 cm and specific heat is 0.056cal/gram deg

Course Outcome 3(CO3):

1. Separate the real and imaginary parts of $f(z) = \frac{1}{1+z}$
2. Check whether the function $f(z) = \frac{Re(z^2)}{|z|}$ is continuous at $z = 0$ given $f(0) = 0$
3. Determine a and b so that function $u = e^{-\pi x} cosay$ is harmonic. Find it's harmonic conjugate.
4. Find the fixed points of $w = \frac{i}{2z-1}$
5. Find the image of $|z| \leq \frac{1}{2}$, $-\frac{\pi}{8} < argz < \frac{\pi}{8}$under $w = z^2$

Course Outcome 4(CO4):

1. Find the value of $\int_C \ exp(z^2)dz$ where C is $|z| = 1$
2. Integrate the function $\int_C \frac{sinz}{z+4iz} dz$ where C is $|z - 4 - 2i| = 6.5$
3. Evaluate $\int_C \frac{e^z}{\left(z-\frac{\pi}{4}\right)^3} dz$ where C is $|z| = 1$
4. Find the Maclaurin series expansion of $f(z) = \frac{i}{1-z}$ and state the region of convergence.
5. Find the image of $|z| = 2$ under the mapping $w = z + \frac{1}{z}$

Course Outcome 5 (CO5):

1. Determine the singularity of $exp\left(\frac{1}{z}\right)$
2. Find the Laurent series of $\frac{1}{z^2(z-i)}$ about $z = i$
3. Find the residues of $f(z) = \frac{50z}{z^3 + 2z^2 - 7z + 4}$
4. Evaluate $\int_C \ tan2\pi z \, dz$ where C is $|z - 0.2| = 0.2$
5. Evaluate $\int_0^{2\pi} \frac{d\theta}{\sqrt{2} - cos\,\theta}$

Syllabus

Module 1 (Partial Differential Equations) (8 hours)

(Text 1-Relevant portions of sections 17.1, 17.2, 17.3, 17.4, 17.5, 17.7, 18.1, 18.2)

Partial differential equations, Formation of partial differential equations –elimination of arbitrary constants-elimination of arbitrary functions, Solutions of a partial differential equations, Equations solvable by direct integration, Linear equations of the first order-Lagrange's linear equation, Non-linear equations of the first order -Charpit's method, Solution of equation by method of separation of variables.

Module 2 (Applications of Partial Differential Equations) (10 hours)

(Text 1-Relevant portions of sections 18.3,18.4, 18.5)

One dimensional wave equation- vibrations of a stretched string, derivation, solution of the wave equation using method of separation of variables, D'Alembert's solution of the wave equation, One dimensional heat equation, derivation, solution of the heat equation

Module 3 (Complex Variable – Differentiation) (9 hours)

(Text 2: Relevant portions of sections13.3, 13.4, 17.1, 17.2 , 17.4)

Complex function, limit, continuity, derivative, analytic functions, Cauchy-Riemann equations, harmonic functions, finding harmonic conjugate, Conformal mappings- mappings $w = z^2$,, $w = e^z$,. Linear fractional transformation $w = \frac{1}{z}$, fixed points, Transformation $w = sinz$

(From sections 17.1, 17.2 and 17.4 only mappings $w = z^2$,, $w = e^z$, $w = \frac{1}{z}$, $w = sinz$ and problems based on these transformation need to be discussed)

Module 4 (Complex Variable – Integration) (9 hours)

(Text 2- Relevant topics from sections14.1, 14.2, 14.3, 14.4,15.4**)**

Complex integration, Line integrals in the complex plane, Basic properties, First evaluation method-indefinite integration and substitution of limit, second evaluation method-use of a representation of a path, Contour integrals, Cauchy integral theorem (without proof) on simply connected domain,Cauchy integral theorem (without proof) on multiply connected domain Cauchy Integral formula (without proof), Cauchy Integral formula for derivatives of an analytic function, Taylor's series and Maclaurin series.,

Module 5 (Complex Variable – Residue Integration) (**9 hours**)

(Text 2- Relevant topics from sections16.1, 16.2, 16.3, 16.4 **)**

Laurent's series(without proof), zeros of analytic functions, singularities, poles, removable singularities, essential singularities, Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral using residue theorem, Residue integration of real integrals – integrals of rational functions of $cos\theta$ and $sin\theta$, integrals of improper integrals of the form

$\int_{-\infty}^{\infty} f(x)\,dx$ with no poles on the real axis. ($\int_{A}^{B} f(x)\,dx$ whose integrand become infinite at a point in the interval of integration is excluded from the syllabus),

Textbooks:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2018.

2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2016.

References:

1. Peter V. O'Neil, Advanced Engineering Mathematics, Cengage, 7th Edition, 2012

Assignments

Assignment: Assignment must include applications of the above theory in the concerned engineering branches

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Partial Differential Equations**	
1.1	Partial differential equations, Formation of partial differential equations –elimination of arbitrary constants-elimination of arbitrary functions, Solutions of a partial differential equations, Equations solvable by direct integration,	3
1.2	Linear equations of the first order- Lagrange's linear equation, Non-linear equations of the first order - Charpit's method	3
1.3	Boundary value problems, Method of separation of variables.	2
2	**Applications of Partial Differential Equations**	
2.1	One dimensional wave equation- vibrations of a stretched string, derivation,	1
2.2	Solution of wave equation using method of separation of variables, Fourier series solution of boundary value problems involving wave equation, D'Alembert's solution of the wave equation	4
2.3	One dimensional heat equation, derivation,	1
2.4	Solution of the heat equation, using method of separation of variables, Fourier series solutions of boundary value problems involving heat equation	4

3	**Complex Variable – Differentiation**	
3.1	Complex function, limit, continuity, derivative, analytic functions, Cauchy-Riemann equations,	4
3.2	harmonic functions, finding harmonic conjugate,	2
3.3	Conformal mappings- mappingsof $w = z^2, , w = e^z, w = \frac{1}{z}, w = sinz$.	3
4	**Complex Variable – Integration**	
4.1	Complex integration, Line integrals in the complex plane, Basic properties, First evaluation method, second evaluation method, use of representation of a path	4
4.2	Contour integrals, Cauchy integral theorem (**without proof**) on simply connected domain, on multiply connected domain(**without proof**) .Cauchy Integral formula (**without proof**),	2
4.3	Cauchy Integral formula for derivatives of an analytic function,	2
4.3	Taylor's series and Maclaurin series.	1
5	**Complex Variable – Residue Integration**	
5.1	Laurent's series(**without proof**)	2
5.2	zeros of analytic functions, singularities, poles, removable singularities, essential singularities, Residues,	2
5.3	Cauchy Residue theorem (**without proof**), Evaluation of definite integral using residue theorem	2
5.4	Residue integration of real integrals – integrals of rational functions of $cos\theta$and $sin\theta$, integrals of improper integrals of the form $\int_{-\infty}^{\infty} f(x)dx$with no poles on the real axis. ($\int_A^B f(x)dx$**whose integrand become infinite at a point in the interval of integration is excluded from the syllabus**),	3

Model Question Paper

(For all branches except Computer Science and Information Technology)

(2019 Scheme)

Reg No: Name:

APJ ABDULKALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH. DEGREE EXAMINATION

(MONTH & YEAR)

Course Code:

Course Name: PARTIAL DIFFERENTIAL EQUATIONS AND COMPLEX ANALYSIS

MAX.MARKS: 100 DURATION: 3 Hours

PART A

Answer all questions, each carries 3 marks.

1. Derive a partial differential equation from the relation $z = f(x + at) + g(x - at)$
2. Solve $\frac{\partial^2 z}{\partial x \partial y} = x^2 y$
3. State any three assumptions in deriving the one dimensional wave equation
4. What are the possible solutions of one-dimensional heat equation?
5. If $f(z) = u + iv$ is analytic, then show that u *and* v are harmonic functions.
6. Check whether $f(z) = \bar{z}$ is analytic or not.
7. Evaluate $\int_c tan\, z\, dz$ where c is the unit circle.
8. Find the Taylor's series of $f(z) = \frac{1}{z}$ about $z = 2$.
9. What type of singularity have the function $f(z) = \frac{1}{\cos z - \sin z}$
10. Find the residue of $\frac{e^z}{z^3}$ at its pole.

PART B

Answer any one full question from each module, each question carries 14 marks.

Module-I

11. (a) Solve $x(y - z)p + y(z - x)q = z(x - y)$

    (b) Use Charpit's methods to solve $q + xp = p^2$
12. (a) Find the differential equation of all spheres of fixed radius having their centers in the xy-plane.

(b) Using the method of separation of variables, solve $\frac{\partial u}{\partial x} = 2\frac{\partial u}{\partial t} + u$, where $u(x,0) = 6e^{-3x}$.

Module – II

13. (a) Derive the solution of one dimensional wave equation $\frac{\partial^2 u}{\partial t^2} = c^2\frac{\partial^2 u}{\partial x^2}$ with zero boundary conditions and with initial conditions $u(x,0) = f(x)$ and $\left(\frac{\partial u}{\partial t}\right)_{t=0} = 0$.

(b) A homogeneous rod of conducting material of length 100 cm has its ends kept at zero temperature and the temperature initially is $u(x,0) = \begin{cases} x, 0 \le x \le 50 \\ 100 - x, 50 \le x \le 100 \end{cases}$. Find the temperature $u(x,t)$ at any time.

14. (a) A tightly stretched string of length l with fixed ends is initially in equilibrium position. It is set vibrating by giving each point a velocity $v_0\, sin^3\left({\pi x}/{l}\right)$. Find the displacement of the string at any time.

(b) An insulated rod of length l has its ends A and B are maintained at 0^0c and 100^0C respectively under steady state condition prevails. If the temperature at B is suddenly reduced to 0^0c and maintained at 0^0c, Find the temperature at a distance x from A at time t.

Module-III

15. (a) Show that $f(z) = e^z$ is analytic for all z. Find its derivative.

(b) Find the image of $|z - 2i| = 2$ under the transformation $w = \frac{1}{z}$

16. (a) Prove that the function $u(x,y) = x^3 - 3xy^2 - 5y$ is harmonic everywhere. Find its harmonic conjugate.

(b) Find the image of the infinite stripe $0 \le y \le \pi$ under the transformation $w = e^z$

Module-IV

17. (a) Evaluate $\int_0^{2+i} (\bar{z})^2\, dz$, along the real axis to 2 and then vertically to $2 + i$

(b) Using Cauchy's integral formula evaluate $\int_c \frac{5z+7}{z^2+2z-3} dz$, where c is $|z - 2| = 2$

18. (a) Evaluate $\int_c \frac{sin^2 z}{\left(z-\frac{\pi}{6}\right)^3} dz$, where C is $|z| = 1$.

(b) Expand $\frac{1}{(z-1)(z-2)}$ in the region $|z| < 1$

Module- V

19. (a) Expand $f(z) = \frac{z^2-1}{z^2-5z+6}$ in $2 < |z| < 3$ as a Laurent's series.

(b) Using contour integration evaluate $\int_0^{2\pi} \frac{d\theta}{2+cos\,\theta}$

20. (a) Use residue theorem to evaluate $\int_c \frac{cos\,h\,\pi z}{z^2+4} dz$ where are C is $|z| = 3$.

(b) Apply calculus of residues to evaluate $\int_{-\infty}^{\infty} \frac{1}{(x^2+1)^3} dx$.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MET201	MECHANICS OF SOLIDS	PCC	3	1	0	4

Preamble:

This course helps the students to understand the concept of stress and strain in different types of structure/machine under various loading conditions. The course also covers simple and compound stresses due to forces, stresses and deflection in beams due to bending, torsion in circular section, strain energy, different theories of failure, stress in thin cylinder thick cylinder and spheres due to external and internal pressure.

Prerequisite: EST100 ENGINEERING MECHANICS

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Determine the stresses, strains and displacements of structures by tensorial and graphical (Mohr's circle) approaches
CO 2	Analyse the strength of materials using stress-strain relationships for structural and thermal loading
CO 3	Perform basic design of shafts subjected to torsional loading and analyse beams subjected to bending moments
CO 4	Determine the deformation of structures subjected to various loading conditions using strain energy methods
CO 5	Analyse column buckling and appreciate the theories of failures and its relevance in engineering design

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	2									1
CO 2	3	3	2									1
CO 3	3	3	1									2
CO 4	3	3	1									1
CO 5	3	3	1									1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	20	20	30
Apply	20	20	50
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module and having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question carries 14 marks and can have a maximum of 2 subdivisions.

COURSE LEVEL ASSESSMENT QUESTIONS

Course Outcome 1 (CO1):

1. Determine the resultant traction at a point in a plane using the stress tensor.

2. Evaluate the principal stresses, principal strains and their directions from a given state of stress or strain.

3. Write the stress tensor and strain tensor.

Course Outcome 2 (CO2)

1. Write the generalized Hooke's law for stress-strain relations.

2. Estimate the state of strain from a given state of stress.

3. Analyse the strength of a structure subjected to thermal loading.

Course Outcome 3(CO3):

1. Design a shaft to transmit power and torque.

2. Draw the shear force and bending moment diagrams.

3. Determine the bending stress on a beam subjected to pure bending.

Course Outcome 4 (CO4):

1. Apply strain energy method to estimate the deformation of a structure.

2. Use strain energy method to calculate deformations for multiple loads.

3. Use strain energy method to estimate the loads acting on a structure for a maximum deflection.

Course Outcome 5 (CO5):

1. Analyse a column for buckling load.

2. Use Rankine formula to determine the crippling load of columns.

3. A bolt is subjected to a direct tensile load of 20 kN and a shear load of 15 kN. Suggest suitable size of this bolt according to various theories of elastic failure, if the yield stress in simple tension is 360 MPa. A factor of safety 2 should be used. Assume Poisson's ratio as 0.3.

SYLLABUS

Module 1

Deformation behaviour of elastic solids in equilibrium under the action of a system of forces, method of sections. Stress vectors on Cartesian coordinate planes passing through a point, stress at a point in the form of a matrix. Equality of cross shear, Cauchy's equation. Displacement, gradient of displacement, Cartesian strain matrix, strain- displacement relations (small-strain only), Simple problems to find strain matrix.Stress tensor and strain tensor for plane stress and plane strain conditions. Principal planes and principal stress,meaning of stress invariants, maximum shear stress. Mohr's circle for 2D case.

Module 2

Stress-strain diagram, Stress–Strain curves of Ductile and Brittle Materials, Poisson's ratio.
Constitutive equations-generalized Hooke's law, equations for linear elastic isotropic solids in terms of Young's Modulus and Poisson's ratio, Hooke's law for Plane stress and plane strain conditions
Relations between elastic constants E, G, ν and K(derivation not required).
Calculation of stress, strain and change in length in axially loaded members with single and composite materials, Effects of thermal loading – thermal stress and thermal strain. Thermal stress on a prismatic bar held between fixed supports.

Module 3

Torsional deformation of circular shafts, assumptions for shafts subjected to torsion within elastic deformation range, derivation of torsion formula Torsional rigidity, Polar moment of inertia, basic design of transmission shafts. Simple problems to estimate the stress in solid and hollow shafts.
Shear force and bending moment diagrams for cantilever and simply supported beams. Differential equations between load, shear force and bending moment.
Normal and shear stress in beams: Derivation of flexural formula, section modulus, flexural rigidity, numerical problems to evaluate bending stress, economic sections.
Shear stress formula for beams: (Derivation not required), shear stress distribution for a rectangular section.

Module 4

Deflection of beams using Macauley's method
Elastic strain energy and Complementary strain energy. Elastic strain energy for axial loading, transverse shear, bending and torsional loads. Expressions for strain energy in terms of load, geometry and material properties of the body for axial, shearing, bending and torsional loads. Castigliano's second theorem, reciprocal relation(Proof not required for Castigliano's second theorem, reciprocal relation).
Simple problems to find the deflections using Castigliano's theorem.

Module 5

Fundamentals of bucking and stability, critical load, equilibrium diagram for buckling of an idealized structure. Buckling of columns with pinned ends, Euler's buckling theory for long columns. Critical stress, slenderness ratio, Rankine's formula for short columns.
Introduction to Theories of Failure, Rankine's theory for maximum normal stress, Guest's theory for maximum shear stress, Saint-Venant's theory for maximum normal strain, Hencky-von Mises theory for maximum distortion energy, Haigh's theory for maximum strain energy

Text Books

1. Mechanics of materials in S.I. Units, R .C. Hibbeler, Pearson Higher Education 2018

2. Advanced Mechanics of Solids, L. S. Srinath, McGraw Hill Education

3. Design of Machine Elements, V. B Bhandari, McGraw Hill Education

Reference Books

1. Engineering Mechanics of Solids, Popov E., PHI 2002

2. Mechanics of Materials S. I. units, Beer, Johnston, Dewolf, McGraw Hills 2017

3. Mechanics of Materials, Pytel A. and Kiusalaas J. Cengage Learning India Private Limited, 2nd Edition, 2015

4. Strength of Materials, Rattan, McGraw Hills 2011

5. Strength of Materials, Surendra Singh, S. K. Kataria& Sons

COURSE PLAN

No	Topic	No of lectures
1	**Module 1: Stress and Strain Analysis**	**9 hours**
1.1	Describe the deformation behaviour of elastic solids in equilibrium under the action of a system of forces. Describe method of sections to illustrate stress as resisting force per unit area. Stress vectors on Cartesian coordinate planes passing through a point and writing stress at a point in the form of a matrix.	2 hr
1.2	Equality of cross shear (Derivation not required). Write Cauchy's equation (Derivation not required),Find resultant stress, Normal and shear stress on a plane given stress tensor and direction cosines (no questions for finding direction cosines).	2 hr
1.3	Displacement, gradient of displacement, Cartesian strain matrix, Write strain-displacement relations (small-strain only), Simple problems to find strain matrix given displacement field (2D and 3D), write stress tensor and strain tensor for Plane stress and plane strain conditions.	1 hr
1.4	Concepts of principal planes and principal stress, characteristic equation of stress matrix and evaluation of principal stresses and principal planes as an eigen value problem, meaning of stress invariants, maximum shear stress	2 hrs
1.5	Mohr's circle for 2D case: find principal stress, planes, stress on an arbitrary plane, maximum shear stress graphically using Mohr's circle	2 hrs
2	**Module 2: Stress - Strain Relationships**	**9 hours**
2.1	Stress-strain diagram, Stress–Strain curves of Ductile and Brittle Materials, Poisson's ratio	1 hr
2.2	Constitutive equations-generalized Hooke's law, equations for linear elastic isotropic solids in in terms of Young's Modulus and Poisson's ratio (3D). Hooke's law for Plane stress and plane strain conditions Relations between elastic constants E, G, ν and K(derivation not required), Numerical problems	2 hrs
2.3	Calculation of stress, strain and change in length in axially loaded members with single and composite materials, Effects of thermal loading – thermal stress and thermal strain. Thermal stress on a prismatic bar held between fixed supports.	2 hrs
2.4	Numerical problems for axially loaded members	4 hrs
3	**Module 3: Torsion of circular shafts, Shear Force-Bending Moment Diagrams and Pure bending**	**9 hours**
3.1	Torsional deformation of circular shafts, assumptions for shafts subjected to torsion within elastic deformation range, derivation of torsion formula	1 hr
3.2	Torsional rigidity, Polar moment of inertia, comparison of solid and hollow shaft. Simple problems to estimate the stress in solid and hollow shafts	1 hr
3.3	Numerical problems for basic design of circular shafts subjected to externally applied torques	1 hr
3.4	Shear force and bending moment diagrams for cantilever and simply	2 hrs

	supported beams subjected to point load, moment, UDL and linearly varying load	
3.5	Differential equations between load, shear force and bending moment.	1 hr
3.6	Normal and shear stress in beams: Derivation of flexural formula, section modulus, flexural rigidity, numerical problems to evaluate bending stress, economic sections Shear stress formula for beams: (Derivation not required),numerical problem to find shear stress distribution for rectangular section	3 hrs
4	**Module 4: Deflection of beams, Strain energy**	**8 hours**
4.1	Deflection of cantilever and simply supported beams subjected to point load, moment and UDL using Macauley's method (procedure and problems with multiple loads)	2 hrs
4.2	Linear elastic loading, elastic strain energy and Complementary strain energy. Elastic strain energy for axial loading, transverse shear, bending and torsional loads (short derivations in terms of loads and deflections).	2 hr
4.3	Expressions for strain energy in terms of load, geometry and material properties of the body for axial, shearing, bending and torsional loads. Simple problems to solve elastic deformations	2 hrs
4.4	Castigliano's second theorem to find displacements, reciprocal relation, (Proof not required for Castigliano's second theorem and reciprocal relation).	1 hr
4.5	Simple problems to find the deflections using Castigliano's theorem	1 hr
5	**Module 5: Buckling of Columns, Theories of Failure**	**8 hours**
5.1	Fundamentals of bucking and stability, critical load, Euler's formula for long columns, assumptions and limitations, effect of end conditions(derivation only for pinned ends), equivalent length	2 hr
5.2	Critical stress, slenderness ratio, Rankine's formula for short columns, Problems	3 hr
5.3	Introduction to Theories of Failure. Rankine's theory for maximum normal stress, Guest's theory for maximum shear stress, Saint-Venant's theory for maximum normal strain	2 hr
5.4	Hencky-von Mises theory for maximum distortion energy, Haigh's theory for maximum strain energy	1 hr

MODEL QUESTION PAPER

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION

Course Code : MET201

Course Name : MECHANICS OF SOLIDS

Max. Marks : 100 Duration : 3 Hours

PART – A

(*ANSWER ALL QUESTIONS, EACH QUESTION CARRIES 3 MARKS*)

1. Express the stress invariants in terms of Cartesian components of stress and principal stress.
2. Write down the Cauchy's strain displacement relationships.
3. Distinguish between the states of plane stress and plane strain.
4. Explain the generalized Hooke's law for a Linear elastic isotropic material.
5. List any three important assumptions in the theory of torsion.
6. Write the significance of flexural rigidity and section modulus in the analysis of beams.
7. Discuss reciprocal relation for multiple loads on a structure.
8. Express the strain energy for a cantilever beam subjected to a transverse point load at free end.
9. Discuss Saint-Venant's theory of failure.
10. Explain the term 'critical load' with reference to the buckling of slender columns.

PART – B

(*ANSWER ONE FULL QUESTION FROM EACH MODULE*)

MODULE – 1

11. a) The state of stress at a point is given by σ_{xx} = 12.31 MPa, σ_{yy} = 8.96 MPa, σ_{zz} = 4.34 MPa, τ_{xy} = 4.2 MPa, τ_{yz} = 5.27 MPa, τ_{xz} = 0.84 MPa. Determine the principal stresses. (7 marks)

    b) The displacement field for a body is given by **u**= $(x^2 + y)\boldsymbol{i}$+ $(3 + z)\ \boldsymbol{j}$ + $(x^2 + 2y)\boldsymbol{k}$. What is the deformed position of a point originally at (3,1,–2)? Write the strain tensor at the point (−3,−1,2).

    (7 marks)

OR

12. a) The state of plane stress at a point is given by σ_{xx} = 40 MPa, σ_{yy} = 20 MPa and τ_{xy} = 16 MPa. Using Mohr's circle determine the i) principal stresses and principal planes and ii) maximum shear stress. (7 marks)

b) The state of stress at a point is given below. Find the resultant stress vector acting on a plane with direction cosines n_x=0.47, n_y=0.82 and n_z=0.33. Find the normal and tangential stresses acting on this plane. (7 marks)

$$\sigma_{ij} = \begin{bmatrix} 10 & 5 & -10 \\ 5 & 20 & -15 \\ -10 & -15 & -10 \end{bmatrix} MPa$$

MODULE – 2

13. a) Calculate Modulus of Rigidity and Young's Modulus of a cylindrical bar of diameter 30 mm and of 1.5 m length if the longitudinal strain in a bar during a tensile stress is four times the lateral strain. Find the change in volume when the bar is subjected to a hydrostatic pressure of 100 N/mm^2. Take E = 10^5 N/mm (9 marks)

b) A straight bar 450 mm long is 40 mm in diameter for the first 250 mm length and 20 mm diameter for the remaining length. If the bar is subjected to an axial pull of 15 kNfind the maximum axial stress produced and the total extension of the bar. Take E = $2x10^5$ N/mm^2 (5 marks)

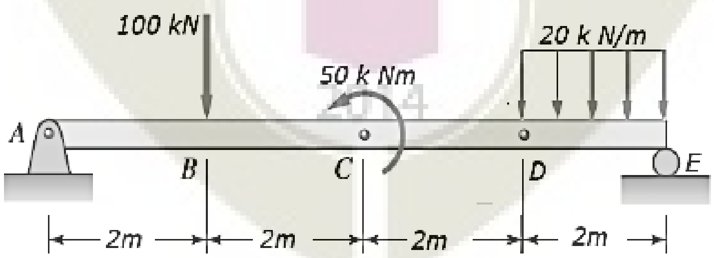
OR

14. a) A brass bar 20mm diameter is enclosed in a steel tube of 25mm internal diameter and 50mm external diameter. Both bar and tube is of same length and fastened rigidly at their ends. The composite bar is free of stress at 20°C. To what temperature the assembly must be heated to generate a compressive stress of 48MPa in brass bar? Also determine the stress in steel tube. E_{steel} = 200GPa and E_{brass} = 84GPa, α_{steel} = 12×10^{-6} / °C and α_{brass}= 18×10^{-6} / °C. (9 marks)

b) Draw the stress-strain diagram for a ductile material and explain the salient points. (5 marks)

MODULE – 3

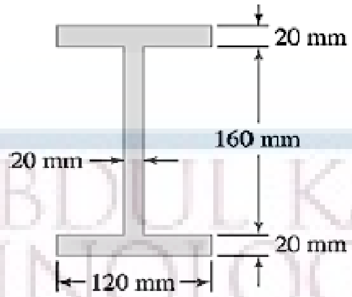
15. a) Draw shear force and bending moment diagram for the beam given in the figure. (9 marks)



b) Compare the strength of a hollow shaft of diameter ratio 0.75 to that of a solid shaft by considering the permissible shear stress. Both the shafts are of same material, of same length and weight. (5 marks)

OR

16. a) A simply supported beam of span of 10 m carries a UDL of 40 kN/m. The cross section is of I shape as given below. Calculatethe maximum stress produced due to bending and plot thebending stress distribution. (9 marks)



b) The shear stress of a solid shaft is not to exceed 40 N/mm^2 when the power transmitted is 20 kW at 200 rpm. Determine the minimum diameter of the shaft. (5 marks)

MODULE – 4

17. a) A horizontal girder of steel having uniform section is 14 m long and is simply supported at its ends. It carries concentrated loads of 120 kN and 80 kN at two points 3 m and 4.5 m from the two ends respectively. Moment of inertia for the section of the girder is 16×10^8 mm^4 and E_s = 210 kN/mm^2. Calculate the deflection of the girder at points under the two loads and maximum deflection using Macaulay's method. (8 marks)

b) Derive the expressions for elastic strain energy in terms of applied load/moment and material property for the cases of a) Axial force b) Bending moment. (6 marks)

OR

18. a) Calculate the displacement in the direction of load P applied at a distance of L/3 from the left end for a simply supported beam of span L as shown in the figure.

(10 marks)

b) State Castigliano's second theorem and explain its significance. (4 marks)

MODULE – 5

19. a) Find the crippling load for a hollow steel column 50mm internal diameter and 5mm thick. The column is 5m long with one end fixed and other end hinged. Use Rankine's formula and Rankine's constant as 1/7500 and σ_c = 335 N/mm^2. Compare this load by crippling load given by Euler's formula. Take E = 110 GPa. (8 marks)

b) Explain the maximum normal stress theory, maximum strain energy theory and maximum shear stress theory of failure. (6 marks)

OR

20. a) The principal stresses at a point in an elastic material are 22 N/mm^2(tensile), 110 N/mm^2 (tensile) and 55 N/mm^2 (compressive). If the elastic limit in simple tension is 210 N/mm^2, then determine whether the failure of material will occur or not according to Maximum principal stress theory, Maximum shear stress theory and maximum distortion energy theory. (9 marks)

b) Derive Euler's formula for a column with both ends hinged. (5 marks)

CODE MET203	COURSE NAME MECHANICS OF FLUIDS	CATEGORY	L	T	P	CREDIT
		PCC	3	1	-	4

Preamble :

This course provides an introduction to the properties and behaviour of fluids. It enables to apply the concepts in engineering, pipe networks. It introduces the concepts of boundary layers, dimensional analysis and model testing

Prerequisite : NIL

Course Outcomes :

After completion of the course the student will be able to

CO1	Define Properties of Fluids and Solve hydrostatic problems
CO2	Explain fluid kinematics and Classify fluid flows
CO3	Interpret Euler and Navier-Stokes equations and Solve problems using Bernoulli's equation
CO4	Evaluate energy loses in pipes and sketch energy gradient lines
CO5	Explain the concept of boundary layer and its applications
CO6	Use dimensional Analysis for model studies

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										
CO2	3	2	1									
CO3	3	2	1									
CO4	3	3	2									
CO5	3	2	1									
CO6	3	2	1									

Assessment Pattern

Blooms Category	CA			ESA
	Assignment	Test - 1	Test - 2	
Remember	25	20	20	10
Understand	25	40	40	20
Apply	25	40	40	70
Analyse	25			
Evaluate				
Create				

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

Mark distribution & Duration of Examination :

Total Marks	CA	ESE	ESE Duration
150	50	100	3 Hours

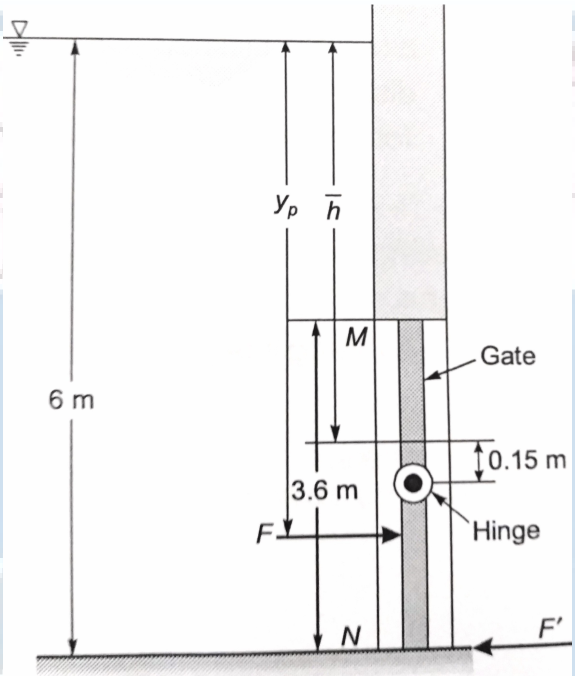
End semester pattern:

There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

COURSE LEVEL ASSESSMENT QUESTIONS

Course Outcome 1

1. A 3.6×1.5 m wide rectangular gate MN is vertical and is hinged at point 0.15 m below the center of gravity of the gate. The total depth of water is 6 m. What horizontal force must be applied at the bottom of the gate to keep the gate closed.



2. A stationary liquid is stratified so that its density is $\rho_0(1+h)$ at a depth h below the free surface. At a depth h in this liquid, what is the pressure in excess of $\rho_0 gh$?

3. If the velocity profile of a fluid is parabolic with free stream velocity 120 cm/s occurring at 20 cm from the plate, calculate the velocity gradients and shear stress at a distance of 0, 10, 20 cm from the plate. Take the viscosity of fluid as 8.5 poise.

Course Outcome 2

1. Differentiate between the Eulerian and Lagrangian method of representing fluid motion.

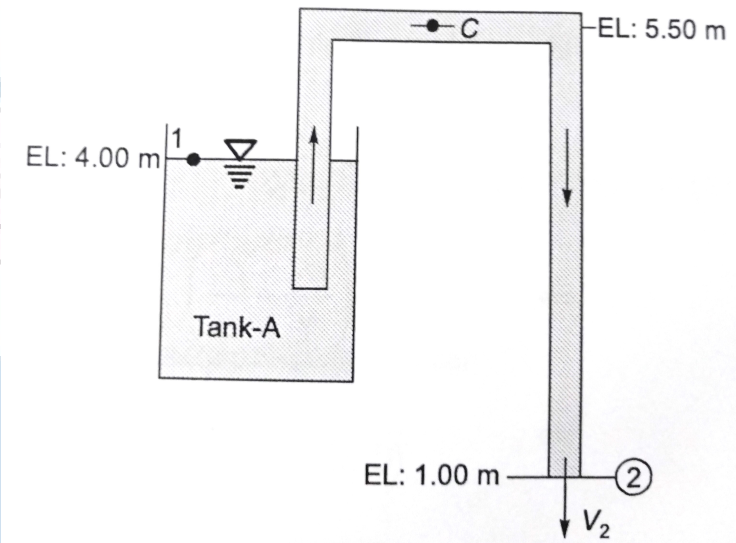
2. A velocity field is given by $u = 3y^2$, $v = 2x$ and $w = 0$ in arbitrary units. Is this flow steady or unsteady? Is it two or three dimensional? At (x,y,z)=(2,1,0), compute

   (a) velocity
   (b) local acceleration
   (c) convective acceleration

3. A stream function in two dimensional flow is $\psi = 2xy$. Show that the flow is irrotational and determine the corresponding velocity potential ϕ.

Course Outcome 3

1. A siphon consisting of a pipe of 15 cm diameter is used to empty kerosene oil (relative density=0.8) from tank A. The siphon discharges to the atmosphere at an elevation of 1.00 m. The oil surface in the tank is at an elevation of 4.00 m. The center line of the siphon pipe at its highest point C is at an elevation of 5.50 m. Estimate,



   (a) Discharge in the pipe
   (b) Pressure at point C.

   The losses in the pipe can be assumed to be 0.5 m up to the summit and 1.2 m from summit to the outlet.

2. Derive the Euler's equation of motion along a streamline and from that derive the Bernouli's equation.

3. What is water hammer? Explain different cases of water hammer. Derive the expression for pressure rise in any one of the case.

Course Outcome 4

1. Two reservoir with a difference in water surface elevation of 10 m are connected by a pipeline AB and BC joined in series. Pipe AB is 10 cm in diameter, 20 m long and has a value of friction factor $f = 0.02$. Pipe BC is 16 cm diameter, 25 m long and has a friction factor f=0.018. The junctions with reservoirs and between pipes are abrupt.

   (a) Sketch Total energy line and Hydraulic gradient line
   (b) Calculate the discharge.

2. Oil of viscosity 0.1 Pas and specific gravity 0.9 flows through a horizontal pipe of 25 mm diameter. If the pressure drop per meter length of the pipe is 12 KPa, determine

   (a) Discharge through the pipe
   (b) Shear stress at the pipe wall
   (c) Reynolds number of the flow

(d) Power required in Watts if the length of the pipe is 50m

3. In a hydraulic power plant, a reinforced concrete pipe of diameter D is used to transmit water from the reservoir to the turbine. If H is the total head supply at the entrance of the pipe and h_f is the loss of head in the pipe, then derive the condition for maximum power supply through the pipe.

Course Outcome 5

1. Write a short note on boundary layer separation and discuss any two methods to control the same.

2. Find the displacement thickness, momentum thickness and energy thickness for velocity distribution in boundary layer given by

$$\frac{u}{U_\infty} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2$$

3. A thin plate is moving in still atmospheric air at a velocity of 4m/s. The length of the plate is 0.5 m and width 0.4 m. Calculate the

   (a) thickness of the boundary layer at the end of the plate and

   (b) drag force on one side of the plate.

   Take density of air as 1.25 kg/m^3 and kinematic viscosity 0.15 stokes.

Course Outcome 6

1. State and explain Buckingham's pi theorem.

2. An underwater device is 1.5m long and is to move at 3.5 m/s speed. A geometrically similar model 30 cm long is tested in a variable pressure wind tunnel at a speed of 35 m/s. Calculate the pressure of air in the model if the model experience a drag force of 40 N, calculate the prototype drag force. [Assume density of water = 998 kg/m^3, density of air at standard atmospheric pressure = 1.17 kg/m^3, dynamic viscosity of air at local atmospheric pressure = $1.95 * 10^{-5}$ Pas and dynamic viscosity of water = $1 * 10^{-3}$ Pas]

3. Explain the importance of dimensionless numbers and discuss any two similarity laws. Where are these model laws used?

SYLLABUS

Module 1: Introduction: Fluids and continuum, Physical properties of fluids, density, specific weight, vapour pressure, Newton's law of viscosity. Ideal and real fluids, Newtonian and non-Newtonian fluids. Fluid Statics- Pressure-density-height relationship, manometers, pressure on plane and curved surfaces, center of pressure, buoyancy, stability of immersed and floating bodies, fluid masses subjected to uniform accelerations, measurement of pressure.

Module 2: Kinematics of fluid flow: Eulerian and Lagrangian approaches, classification of fluid flow, 1-D, 2-D and 3-D flow, steady, unsteady, uniform, non-uniform, laminar, turbulent, rotational, irrotational flows, stream lines, path lines, streak lines, stream tubes, velocity and acceleration in fluid, circulation and vorticity, stream function and potential function, Laplace equation, equipotential lines, flow nets, uses and limitations.

Module 3: Control volume analysis of mass, momentum and energy, Equations of fluid dynamics: Differential equations of mass, energy and momentum (Euler's equation), Navier-Stokes equations (without proof) in cartesian co-ordinates. Dynamics of Fluid flow: Bernoulli's equation, Energies in flowing fluid, head, pressure, dynamic, static and total head, Venturi and Orifice meters, Notches and Weirs (description only for notches and weirs). Hydraulic coefficients, Velocity measurements: Pitot tube and Pitot-static tube.

Module 4: Pipe Flow: Viscous flow: Reynolds experiment to classify laminar and turbulent flows, significance of Reynolds number, critical Reynolds number, shear stress and velocity distribution in a pipe, law of fluid friction, head loss due to friction, Hagen Poiseuille equation. Turbulent flow: Darcy-Weisbach equation, Chezy's equation Moody's chart, Major and minor energy losses, hydraulic gradient and total energy line, flow through long pipes, pipes in series, pipes in parallel, equivalent pipe, siphon, transmission of power through pipes, efficiency of transmission, Water hammer, Cavitation.

Module 5: Boundary Layer : Growth of boundary layer over a flat plate and definition of boundary layer thickness, displacement thickness, momentum thickness and energy thickness, laminar and turbulent boundary layers, laminar sub layer, velocity profile, Von- Karman momentum integral equations for the boundary layers, calculation of drag, separation of boundary and methods of control. Dimensional Analysis: Dimensional analysis, Buckingham's theorem, important non dimensional numbers and their significance, geometric, Kinematic and dynamic similarity, model studies. Froude, Reynolds, Weber, Cauchy and Mach laws- Applications and limitations of model testing, simple problems only

Text Books

John. M. Cimbala and Yunus A. Cengel, Fluid Mechanics: Fundamentals and Applications (4th edition, SIE), 2019

Robert W. Fox, Alan T. McDonald, Philip J. Pritchard and John W. Mitchell, Fluid Mechanics, Wiley India, 2018

Reference Books

White, F. M., Fluid Mechanics, McGraw Hill Education India Private Limited, 8th Edition, 2017

Rathakrishnan, E. Fluid Mechanics: An Introduction, Prentice Hall India, 3rd Edition 2012

COURSE PLAN

Module	Topics	Hours Allotted
I	Introduction: Fluids and continuum, Physical properties of fluids, density, specific weight, vapour pressure, Newton's law of viscosity. Ideal and real fluids, Newtonian and non-Newtonian fluids. Fluid Statics- Pressure-density-height relationship, manometers, pressure on plane and curved surfaces, center of pressure, buoyancy, stability of immersed and floating bodies, fluid masses subjected to uniform accelerations, measurement of pressure.	7-2-0
II	Kinematics of fluid flow: Eulerian and Lagrangian approaches, classification of fluid flow, 1-D, 2-D and 3-D flow, steady, unsteady, uniform, non-uniform, laminar, turbulent, rotational, irrotational flows, stream lines, path lines, streak lines, stream tubes, velocity and acceleration in fluid, circulation and vorticity, stream function and potential function, Laplace equation, equipotential lines, flow nets, uses and limitations.	6-2-0
III	Control volume analysis of mass, momentum and energy, Equations of fluid dynamics: Differential equations of mass, energy and momentum (Euler's equation), Navier-Stokes equations (without proof) in cartesian co-ordinates Dynamics of Fluid flow: Bernoulli's equation, Energies in flowing fluid, head, pressure, dynamic, static and total head, Venturi and Orifice meters, Notches and Weirs (description only for notches and weirs). Hydraulic coefficients, Velocity measurements: Pitot tube and Pitot-static tube.	6-2-0
IV	Pipe Flow: Viscous flow: Reynolds experiment to classify laminar and turbulent flows, significance of Reynolds number, critical Reynolds number, shear stress and velocity distribution in a pipe, law of fluid friction, head	9-3-0

	loss due to friction, Hagen Poiseuille equation. Turbulent flow: Darcy-Weisbach equation, Chezy's equation Moody's chart, Major and minor energy losses, hydraulic gradient and total energy line, flow through long pipes, pipes in series, pipes in parallel, equivalent pipe, siphon, transmission of power through pipes, efficiency of transmission, Water hammer, Cavitation.	
V	Boundary Layer : Growth of boundary layer over a flat plate and definition of boundary layer thickness, displacement thickness, momentum thickness and energy thickness, laminar and turbulent boundary layers, laminar sub layer, velocity profile, Von- Karman momentum integral equations for the boundary layers, calculation of drag, separation of boundary and methods of control. Dimensional Analysis: Dimensional analysis, Buckingham's theorem, important non dimensional numbers and their significance, geometric, Kinematic and dynamic similarity, model studies. Froude, Reynolds, Weber, Cauchy and Mach laws- Applications and limitations of model testing, simple problems only	8-2-0

MODEL QUESTION PAPER

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

IV SEMESTER B.TECH DEGREE EXAMINATION

MET203: MECHANICS OF FLUIDS

Mechanical Engineering

Maximum: 100 Marks Duration: 3 hours

PART A

Answer all questions, each question carries 3 marks

1. The specific gravity of a liquid is 3.0. What are its specific weight, specific mass and specific volume.
2. State Pascal's law and give some examples where this principle is used.
3. Explain Streamlines, Streaklines and Pathlines.
4. What do you understand by the terms: (i) Total acceleration, (ii) Convective acceleration, and (iii) Local acceleration.
5. Name the different forces present in a fluid flow. For the Euler's equation of motion, which forces are taken into consideration.
6. Differentiate between pitot tube and pitot static tube.
7. Define and explain the terms (i) Hydraulic gradiant line and (ii) Total energy line.
8. Show that the coefficient of friction for viscous flow through a circular pipe is given by

$$f = \frac{16}{Re}$$

   where Re is the Reynolds number.
9. What do you mean by repeating variables? How repeating variables are selected for dimensional analysis.
10. How will you determine whether a boundary layer flow is attached flow, detached flow or on the verge of separation.

(10×3=30 Marks)

PART B

Answer one full question from each module

MODULE-I

11. (a) Through a very narrow gap of height h, a thin plate of large extend is pulled at a velocity V. On one side of the plate is oil of viscosity μ_1 and on the other side oil of viscosity μ_2. Calculate the position of the plate so that

    i. the shear force on the two sides of the plate is equal.

    ii. the pull required to drag the plate is minimum.

    Assume linear velocity distribution in transverse direction. (7 Marks)

    (b) A metallic cube of 30 cm side and weight 500 N is lowered into a tank containing two fluid layers of water and mercury. Top edge of the cube is at water surface. Determine the position of the block at water mercury interface when it has reached equilibrium. (7 Marks)

12. (a) A rectangular tank 1.5 m wide, 3 m long and 1.8 m deep contains water to a depth of 1.2 m. Find the horizontal acceleration which may be imparted to the tank in the direction of length so that

    i. there is just no spilling from the tank

    ii. front bottom corner of the tank is just exposed.

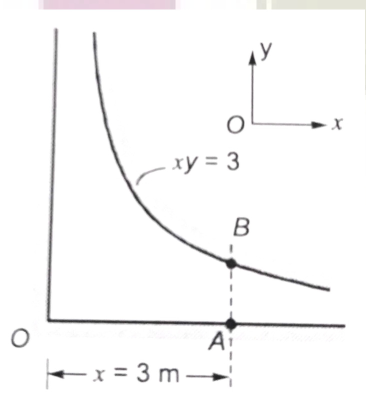
    (7 Marks)

    (b) A spherical water drop of 1 mm diameter splits up in air into 64 smaller drops of equal size. Find the work required in splitting up the drop. The surface tension coefficient of water in air = 0.073 N/m (7 Marks)

MODULE-II

13. (a) In a fluid flow field, velocity vector is given by $v = (0.5 + 8x)i + (0.5 - 0.8y)j$. Find the equation of streamline for the given velocity field. (7 Marks)

    (b) The stream function $\psi = 4xy$ in which ψ is in cm^2/s and x and y are in meters describe the incompressible flow between the boundary shown below:



    Calculate

    i. Velocity at B

    ii. Convective acceleration at B

iii. Flow per unit width across AB

(7 Marks)

14. (a) Consider the velocity field given by $u = x^2$ and $v = -2xy$. Find the circulation around the area bounded by $A(1,1), B(2,1), C(2,2), D(1,2)$. (7 Marks)

(b) Verify whether the following are valid potential functions.

i. $\phi = 2x + 5y$

ii. $\phi = 4x^2 - 5y^2$

(7 Marks)

MODULE-III

15. (a) A submarine moves horizontally in sea and has its axis 15 m below the surface of the water. A pitot tube properly placed just in front of the submarine and along its axis is connected to two limbs of a U tube containing mercury. The difference of level is found to be 170 mm. Find the speed of the submarine knowing that the specific gravity of mercury is 13.6 and that of sea water is 1.026 with respect to water. (7 Marks)

(b) A pitot tube is inserted in a pipe of 30 cm diameter. The static pressure of the tube is 10 cm of mercury vacuum. The stagnation pressure at the centre of the pipe recorded by the pitot tube is 1.0 N/cm^2. Calculate the rate of flow of water through the pipe, if the mean velocity of flow is 0.85 times central velocity. Assume coefficient of tube as 0.98. (7 Marks)

16. (a) A smooth pipe of uniform diameter 25 cm, a pressure of 50 KPa was observed at section 1 which has an elevation of 10 m. At another section 2, at an elevation of 12 m, the pressure was 20 KPa and the velocity was 1.25 m/s. Determine the direction of flow and the head loss between the two sections. The fluid in the pipe is water. (8 Marks)

(b) Petrol of specific gravity 0.8 is following through a pipe of 30 cm diameter. The pipe is inclined at 30° to horizontal. The venturi has a throat diameter of 10 cm. U tube manometer reads 6.25 cm Hg. Calculate the discharge through the pipe. Assume $C_d = 0.98$. (6 Marks)

MODULE-IV

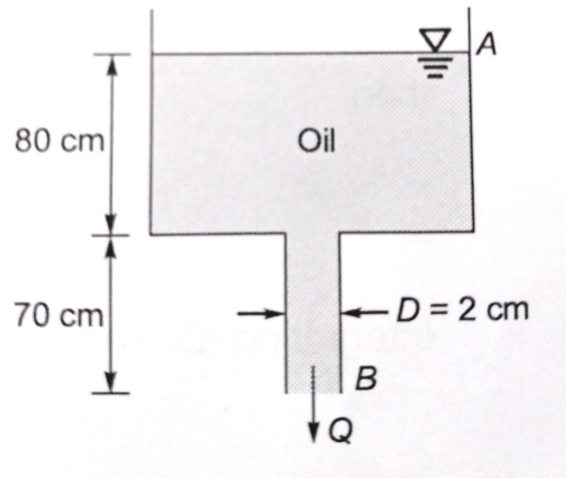
17. (a) Assuming viscous flow through a circular pipe derive the expression for,

i. Velocity distribution

ii. Shear stress distribution

Also plot the velocity and shear stress distribution. (7 Marks)

(b) A large tank shown in the figure has a vertical pipe 70 cm long and 2 cm in diameter. The tank contain oil of density 920 Kg/m^3 and viscosity 1.5 poise. Find the discharge through the tube when the height of oil level of the tank is 0.80 m above the pipe inlet.



(7 Marks)

18. (a) A compound piping system consist of 1800 m of 50 cm, 1200 m of 40 cm and 600 m of 30 com diameter pipes off same material connected in series.

    i. What is the equivalent length of a 40 cm pipe of same material?
    ii. What is the equivalent diameter of a pipe 3600 m long?
    iii. If three pipes are in parallel what is equivalent length of 50 cm pipe?

(10 Marks)

(b) A pipe line of 2100 m is used for transmitting 103 KW. The pressure at the inlet of the pipe is 392.4 N/cm^2. If the efficiency of transmission is 80%, find the diameter of the pipe. Take $f = 0.005$. (4 Marks)

MODULE-V

19. (a) The velocity profile u of a boundary layer flow over a flat plate is given by

$$\frac{u}{U_\infty} = \frac{3}{2}\left(\frac{y}{\delta}\right) - \frac{1}{2}\left(\frac{y}{\delta}\right)^3$$

If the boundary thickness is given as

$$\delta = \sqrt{\frac{280\nu x}{13U_\infty}}$$

develop the expression for local drag coefficient C_{fx} over the distance $x = L$ from the leading edge of the plate. (7 Marks)

(b) A model test is to be conducted in a water tunnel using a 1:20 model of a submarine which is used to travel at a speed of 12 km/h deep under the sea. The water temperature in the tunnel is so maintained that its kinematic viscosity is half as that of the sea water. At what speed the model test is to be conducted. (7 Marks)

20. (a) With a neat sketch explain the different regions of the boundary layer along a long thin flat plate. (7 Marks)

(b) Using Buckingham's pi theorem show that the velocity through a circular orifice is given by

$$\sqrt{2gH}\phi\left[\frac{D}{H}, \frac{\mu}{\rho VH}\right]$$

where H is the head causing flow, D is the diameter of the orifice, μ is the coefficient of viscosity, ρ is the mass density and g is the acceleration due to gravity. (7 Marks)

MET 205	METALLURGY & MATERIAL SCIENCE	CATEGORY	L	T	P	Credits	Year of Introduction
		PCC	3	1	0	4	2019

Preamble:

Understanding of the correlation between the chemical bonds and crystal structure of metallic materials to their mechanical properties.

Recognize the importance of crystal imperfections including dislocations in plastic deformation.

Learning about different phases and heat treatment methods to tailor the properties of Fe-C alloys.

Examine the mechanisms of materials failure through fatigue and creep.

To determine properties of unknown materials and develop an awareness to apply this knowledge in material design

Prerequisite: PHT 110 Engineering Physics and CYT 100 Engineering Chemistry

Course Outcomes - At the end of the course students will be able to

CO 1	Understand the basic chemical bonds, crystal structures (BCC, FCC, and HCP), and their relationship with the properties.
CO 2	Analyze the microstructure of metallic materials using phase diagrams and modify the microstructure and properties using different heat treatments.
CO 3	How to quantify mechanical integrity and failure in materials.
CO 4	Apply the basic principles of ferrous and non-ferrous metallurgy for selecting materials for specific applications.
CO 5	Define and differentiate engineering materials on the basis of structure and properties for engineering applications.

Mapping of course outcomes with program outcomes (Minimum requirements)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	-	-	-	-	-	-	-	-		-	-
CO 2	-	3		-	-	-	-	-	-	-	-	-
CO 3		-	-	2	-	-	-	-	-	-	-	-
CO 4		-	-	-	3	-	-	-	-	-	-	-
CO 5	-	-	-	-		-	-	-	-	-	-	2

ASSESSMENT PATTERN

Bloom's taxonomy	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 11 (Marks)	
Remember	25	25	25
Understand	15	15	15
Apply	30	25	30
Analyze	10	10	10
Evaluate	10	15	10
Create	10	10	10

Mark distribution

Total Marks	CIE marks	ESE marks	ESE duration
150	50	100	3 Hours

Continuous Internal Evaluation (CIE) Pattern:

Attendance	10 marks
Regular class work/tutorials/assignments	15 marks
Continuous Assessment Test (Minimum 2 numbers)	25 marks

End semester pattern:- There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

COURSE LEVEL ASSESSMENT QUESTIONS

Part -A

Course Outcome 1 (CO1): Understand the basic chemical bonds, crystal structures (BCC, FCC, and HCP), and their relationship with the properties.

1. What are the attributes of atomic and crystalline structures into the stress - strain curve?
2. Explain the significance of long range and short range order of atomic arrangement on mechanical strength.
3. What is the difference between an allotrope and a polymorphism?
4. Draw the (112) and (111) planes in simple cubic cell.

Course Outcome 2 (CO2): Analyze the microstructure of metallic materials using phase diagrams and modify the microstructure and properties using different heat treatments.

1. What is the driving force for recrystallisation and grain growth of metallic crystals?
2. What is the driving force for the formation of spheroidite.
3. What is tempered martensite?
4. Why 100 % pure metals are weak in strength?

Part -B

Course Outcome 3 (CO3): How to quantify mechanical integrity and failure in materials

1. A small hole is drilled through a steel plate ahead of a crack, whether it can stop the crack's progress until repairs can be made. Explain in detail and derive the equation for the principle.
2. Draw and explain S-N curves for ferrous and non-ferrous metals. Explain different methods to improve fatigue resistance.
3. Explain different stages of creep; Give an application of creep phenomenon. What is superplasticity?

Course Outcome 4 (CO4): Apply the basic principles of ferrous and non-ferrous metallurgy for selecting materials for specific applications.

1. What are the classification, compositions and applications of high speed steel? identify 18:4:1
2. Describe the composition, properties, and use of Bronze and Gun metal.
3. Explain the importance of all the non-ferrous alloys in automotive applications. Elaborate on the composition, properties and typical applications of any five non-ferrous alloys.

Course Outcome 5 (CO5): Define and differentiate engineering materials on the basis of structure and properties for engineering applications.

1. Carbon is allowed to diffuse through a steel plate 15 mm thick. The concentrations of carbon at the two faces are 0.65 and 0.30kgC/m^3Fe, which are maintained constant. If the pre-exponential and activation energy are $6.2x10^{-7} m^2/s$ and 80,000 J/mol, respectively, compute the temperature at which the diffusion flux is 1.43×10^{-9} kg/m^2-s.
2. Explain the fundamental effects of alloying elements in steel on polymorphic transformation temperatures, grain growth, eutectoid point, retardation of the transformation rates, formation and stability of carbides.
3. Describe the kind of fracture which may occur as a result of a loose fitting key on a shaft.

SYLLABUS

MODULE - 1

Earlier and present development of atomic structure - Primary bonds: - characteristics of covalent, ionic and metallic bond - properties based on atomic bonding: - Secondary bonds: - classification, application. *(Brief review only).*

Crystallography: - SC, BCC, FCC, HCP structures, APF - theoretical density simple problems - Miller Indices: - crystal plane and direction - Modes of plastic deformation: - Slip and twinning -Schmid's law - Crystallization: Effects of grain size, Hall - Petch theory, simple problems.

MODULE - II

Classification of crystal imperfections - forest of dislocation, role of surface defects on crack initiation- Burgers vector –Frank Read source - Correlation of dislocation density with strength and nano concept - high and low angle grain boundaries– driving force for grain growth and applications - Polishing and etching - X – ray diffraction, simple problems –SEM and TEM - Diffusion in solids, fick's laws, mechanisms, applications of diffusion in mechanical engineering, simple problems.

MODULE - III

Phase diagrams: - need of alloying - classification of alloys - Hume Rothery`s rule - equilibrium diagram of common types of binary systems: five types - Coring - lever rule and Gibb`s phase rule - Reactions- Detailed discussion on Iron-Carbon equilibrium diagram with microstructure and properties -Heat treatment: - TTT, CCT diagram, applications - Tempering- Hardenability, Jominy end quench test, applications- Surface hardening methods.

MODULE - IV

Strengthening mechanisms - cold and hot working - alloy steels: how alloying elements affecting properties of steel - nickel steels - chromium steels - high speed steels -cast irons - principal non ferrous alloys.

MODULE - V

Fatigue: - creep -DBTT - super plasticity - need, properties and applications of composites, super alloy, intermetallics, maraging steel, Titanium - Ceramics:- structures, applications.

Text Books

1. Callister William. D., Material Science and Engineering, John Wiley, 2014
2. Higgins R.A. - Engineering Metallurgy part - I – ELBS,1998

Reference

1. Avner H Sidney, Introduction to Physical Metallurgy, Tata McGraw Hill,2009
2. Anderson J.C. *et.al*., Material Science for Engineers, Chapman and Hall,1990
3. Clark and Varney, Physical metallurgy for Engineers, Van Nostrand,1964
4. Dieter George E, Mechanical Metallurgy, Tata McGraw Hill, 1976
5. Raghavan V, Material Science and Engineering, Prentice Hall,2004
6. Reed Hill E. Robert, Physical metallurgy principles, 4^{th} edition, Cengage Learning,2009
7. Myers Marc and Krishna Kumar Chawla, Mechanical behavior of materials, Cambridge University press,2008
8. Van Vlack -Elements of Material Science - Addison Wesley,1989
9. https://nptel.ac.in/courses/113/106/113106032

MODEL QUESTION PAPER

METALLURGY & MATERIAL SCIENCE - MET 205

Max. Marks : 100 **Duration : 3 Hours**

Part – A

Answer all questions.

Answer all questions, each question carries 3 marks

1. What is a slip system? Describe the slip systems in FCC, BCC and HCP metals
2. NASA's *Parker Solar Probe* will be the first-ever mission to "touch" the Sun. The spacecraft, about the size of a small car, will travel directly into the Sun's atmosphere about 4 million miles from the earth surface. Postulate the coolant used in the parker solar probe with chemical bonds.
3. What is the driving force for grain growth during heat treatment
4. What are the roles of surface imperfections on crack initiation
5. Explain the difference between hardness and hardenability.
6. What is tempered martensite? Explain its structure with sketch.
7. Postulate, why cast irons are brittle?
8. How are properties of aluminum affected by the inclusion of (a) copper and (b) silicon as alloying elements?
9. What is the grain size preferred for creep applications? Why. Explain thermal fatigue?
10. Explain fracture toughness and its attributes into a screw jack?

PART -B

Answer one full question from each module.

MODULE – 1

11. **a.** Calculate the APF of SC, BCC and FCC (7 marks).

    b. What is slip system and explain why FCC materials exhibit ductility and BCC and HCP exhibit brittle nature with details of slip systems (7 marks).

OR

12. Explain the effect of: (i) Grain size; (ii) Grain size distribution and (iii) Grain orientation (iv) Grain shape on strength and creep resistance with neat sketches. Attributes of Hall-Petch equation and grain boundaries (14 marks).

MODULE – 2

13. **a**. Describe step by step procedure for metallographic specimen preparation? Name different types etchants used for specific metals and methods to determine grain size (7 marks).

b. Carbon is allowed to diffuse through a steel plate 15 mm thick. The concentrations of carbon at the two faces are 0.65 and 0.30 kgC/m^3Fe, which are maintained constant. If the pre-exponential and activation energy are $6.2x10^{-}7m^2/s$ and 80,000 J/mol, respectively, compute the temperature at which the diffusion flux is $1.43 \times 10^{-}9\ kg/m^2$-s (7 marks).

OR

14. a. Explain the fundamental differences of SEM and TEM with neat sketches (7 marks).

b. A beam of X-rays wavelength 1.54Å is incident on a crystal at a glancing angle of $8^o35'$ when the first order Bragg's reflection occurs calculate the glancing angle for third order reflection (7 marks).

MODULE – 3

15. Postulate with neat sketches, why 100% pure metals are weaker? What are the primary functions of alloying? Explain the fundamental rules governing the alloying with neat sketches and how is it accomplished in substitution and interstitial solid solutions (14 marks).

OR

16. Draw the isothermal transformation diagram of eutectoid steel and then sketch and label (1) A time temperature path that will produce 100% pure coarse and fine pearlite (2) A time temperature path that will produce 50% martensite and 50% bainite (3) A time temperature path that will produce 100% martensite (4) A time temperature path that will produce 100% bainite (14 marks).

MODULE – 4

17. Explain the effect of, polymorphic transformation temperature, formation and stability of carbides, grain growth, displacement of the eutectoid point, retardation of the transformation rates, improvement of corrosion resistance on adding alloy elements to steel (14 marks).

OR

18. Give the composition, microstructure, properties and applications of (i) Gray iron and SG iron. (ii) White iron and Gray iron. (iii) Malleable iron and Gray iron. (iv) Gray iron and Mottled iron, (v) SG iron and Vermicullar Graphite Iron (14 marks).

MODULE – 5

19. a A small hole is drilled through a steel plate ahead of a crack, whether it can stop the crack's progress until repairs can be made or not? Explain in detail and derive the equation (7 marks).

b What is ductile to brittle transition in steel DBTT? What are the factors affecting ductile to brittle transition? Narrate with neat sketch (7 marks).

OR

20. Classify ceramics with radius ratio with neat sketches. Explain with an example for each of the AX, AmXp, AmBmXp type structures in ceramics with neat sketch (14 marks).

COURSE CONTENT AND LECTURE SCHEDULES.

Module	TOPIC	No. of hours	Course outcomes
1.1	Earlier and present development of atomic structure; attributes of ionization energy and conductivity, electronegativity; correlation of atomic radius to strength; electron configurations; - Primary bonds: - characteristics of covalent, ionic and metallic bond: attributes of bond energy, cohesive force, density, directional and non-directional - properties based on atomic bonding:- attributes of deeper energy well and shallow energy well to melting temperature, coefficient of thermal expansion - attributes of modulus of elasticity in metal cutting process -Secondary bonds:- classification- hydrogen bond and anomalous behavior of ice float on water, application- specific heat, applications. (Brief review only).	2	CO1
1.2	Crystallography:- Crystal, space lattice, unit cell- SC, BCC, FCC, atomic packing factor and HCP structures - short and long range order - effects of crystalline and amorphous structure on mechanical properties.	2	CO1 CO2
1.3	Coordination number and radius ratio; theoretical density; simple problems - Polymorphism and allotropy.	1	
1.4	Miller Indices: - crystal plane and direction - Attributes of miller indices for slip system, brittleness of BCC, HCP and ductility of FCC - Modes of plastic deformation: - Slip and twinning.	1	CO5
1.5	Schmid's law, equation, critical resolved shear stress, correlation of slip system with plastic deformation in metals and applications.	1	
1.6	Mechanism of crystallization: Homogeneous and heterogeneous nuclei formation, under cooling, dendritic growth, grain boundary irregularity - Effects of grain size, grain size distribution, grain shape, grain orientation on dislocation/strength and creep resistance - Hall - Petch theory, simple problems.	2	CO2
2.1	Classification of crystal imperfections: - types of point and dislocations.	1	CO2
2.2	Effect of point defects on mechanical properties - forest of dislocation, role of surface defects on crack initiation - Burgers vector.	1	
2.3	Dislocation source, significance of Frank-Read source in metals deformation - Correlation of dislocation density with strength and nano concept, applications.	3	CO2
2.4	Significance high and low angle grain boundaries on dislocation – driving force for grain growth and applications during heat treatment.		
2.5	Polishing and etching to determine the microstructure and grain size- Fundamentals and crystal structure determination by X – ray diffraction, simple problems –SEM and TEM.	2	CO2 CO5
2.6	Diffusion in solids, fick's laws, mechanisms, applications of diffusion in mechanical engineering, simple problems.	1	

3.1	Phase diagrams: - Limitations of pure metals and need of alloying - classification of alloys, solid solutions, Hume Rothery`s rule - equilibrium diagram of common types of binary systems: five types.	2	CO2 CO5
3.2	Coring - lever rule and Gibb`s phase rule - Reactions: - monotectic, eutectic, eutectoid, peritectic, peritectoid.	1	
3.3	Detailed discussion on Iron-Carbon equilibrium diagram with microstructure and properties changes in austenite, ledeburite, ferrite, cementite, special features of martensite transformation, bainite, spheroidite etc.	3	CO2 CO5
3.4	Heat treatment: - Definition and necessity – TTT for a eutectoid iron–carbon alloy, CCT diagram, applications - annealing, normalizing, hardening, spheroidizing.		
3.5	Tempering:- austermpering, martempering and ausforming - Comparative study on ductility and strength with structure of pearlite, bainite, spherodite, martensite, tempered martensite and ausforming.	1	CO2
3.6	Hardenability, Jominy end quench test, applications- Surface hardening methods:- no change in surface composition methods :- Flame, induction, laser and electron beam hardening processes- change in surface composition methods :carburizing and Nitriding; applications.	2	CO2
4.1	Cold working: Detailed discussion on strain hardening; recovery; re-crystallization, effect of stored energy; re- crystallization temperature - hot working, Bauschinger effect and attributes in metal forming.	1	
4.2	Alloy steels:- Effects of alloying elements on steel: dislocation movement, polymorphic transformation temperature, alpha and beta stabilizers, formation and stability of carbides, grain growth, displacement of the eutectoid point, retardation of the transformation rates, improvement in corrosion resistance, mechanical properties	1	CO4
4.3	Nickel steels, Chromium steels etc. – change of steel properties by adding alloying elements: - Molybdenum, Nickel, Chromium, Vanadium, Tungsten, Cobalt, Silicon, Copper and Lead - High speed steels - Cast irons: Classifications; grey, white, malleable and spheroidal graphite cast iron etc, composition, microstructure, properties and applications - Principal Non ferrous Alloys: - Aluminum, Copper, Magnesium, Nickel, study of composition, properties, applications, reference shall be made to the phase diagrams whenever necessary.(Topic 4.3 may be considered as a assignment).	4	CO4 CO5
4.4	Fatigue: - Stress cycles – Primary and secondary stress raisers - Characteristics of fatigue failure, fatigue tests, S-N curve.	1	CO3
4.5	Factors affecting fatigue strength: stress concentration, size effect, surface roughness, change in surface properties, surface residual stress - Ways to improve fatigue life – effect of temperature on fatigue, thermal fatigue and its applications in metal cutting.	2	

5.1	Fracture: – Brittle and ductile fracture – Griffith theory of brittle fracture – Stress concentration, stress raiser – Effect of plastic deformation on crack propagation - transgranular, intergranular fracture - Effect of impact loading on ductile material and its application in forging, applications - Mechanism of fatigue failure.	2	CO3
5.2	Structural features of fatigue: - crack initiation, growth, propagation - Fracture toughness (definition only), applications - Ductile to brittle transition temperature (DBTT) in steels and structural changes during DBTT, applications.	1	
5.3	Creep: - Creep curves – creep tests - Structural change:- deformation by slip, sub-grain formation, grain boundary sliding - Mechanism of creep deformation - threshold for creep, prevention against creep - Super plasticity: need and applications	2	CO3
5.4	Composites: - Need of development of composites; fiber phase; matrix phase; only need and characteristics of PMC, MMC, and CMC.	2	CO3 CO5
5.5	Modern engineering materials: - only fundamentals, need, properties and applications of, intermetallics, maraging steel, super alloys, Titanium- Ceramics:-coordination number and radius ratios- AX, A_mX_p, $A_mB_mX_p$ type structures – applications.	3	

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
			2	0	0	2
EST 200	DESIGN AND ENGINEERING					

Preamble:

The purpose of this course is to

i) introduce the undergraduate engineering studentsthe fundamental principles of design engineering,

ii) make them understand the steps involved in the design process and

iii) familiarize them with the basic tools used and approaches in design.

Students are expected to apply design thinking in learning as well as while practicing engineering, which is very important and relevant for today. Case studies from various practical situations will help the students realize that design is not only concerned about the function but also many other factors like customer requirements, economics, reliability, etc. along with a variety of life cycle issues.

The course will help students to consider aesthetics, ergonomics and sustainability factors in designs and also to practice professional ethics while designing.

Prerequisite:

Nil. The course will be generic to all engineering disciplines and will not require specialized preparation or prerequisites in any of the individual engineering disciplines.

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Explain the different concepts and principles involved in design engineering.
CO 2	Apply design thinking while learning and practicing engineering.
CO 3	Develop innovative, reliable, sustainable and economically viable designs incorporating knowledge in engineering.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	1					1			1		
CO 2		2				1		1				2
CO 3			2			1	1		2	2		1

Assessment Pattern

Continuous Internal Evaluation (CIE) Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination (ESE) Pattern: There will be two parts; Part A and Part B.
Part A : 30 marks
part B : 70 marks
Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions.
Part B contains 2 case study questions from each module of which student should answer any one. Each question carry 14 marks and can have maximum 2 sub questions.

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	5	5	10
Understand	10	10	20
Apply	35	35	70
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1): Appreciate the different concepts and principles involved in design engineering.

1. State how engineering design is different from other kinds of design

2. List the different stages in a design process.

3. Describedesign thinking.

4. State the function of prototyping and proofing in engineering design.

5. Write notes on the following concepts in connection with design engineering 1) Modular Design, 2) Life Cycle Design , 3) Value Engineering, 4) Concurrent Engineering, and 5) Reverse Engineering

6. State design rights.

Course Outcome 2 (CO2) Apply design thinking while learning and practicing engineering.

1. Construct the iterative process for design thinking in developing simple products like a pen, umbrella, bag, etc.

2. Show with an example how divergent-convergent thinking helps in generating alternative designs and then how to narrow down to the best design.

3. Describe how a problem-based learning helps in creating better design engineering solutions.

4. Discuss as an engineer, how ethics play a decisive role in your designs

Course Outcome 3(CO3): Develop innovative, reliable, sustainable and economically viable designs incorporating different segments of knowledge in engineering.

1. Illustratethe development of any simple product by passing through the different stages of design process

2. Show thegraphical design communication with the help of detailed 2D or 3D drawings for any simple product.

3. Describe how to develop new designs for simple products through bio-mimicry.

Model Question paper

Reg No.:_______________ Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD/FOURTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: EST 200

Course Name: DESIGN AND ENGINEERING

Max. Marks: 100Duration: 3 Hours

PART A

Answer all questions, each question carries 3 marks

Use only hand sketches

(1)Write aboutthe basic design process.

(2) Describe how to finalize the design objectives.

(3) State the role of divergent-convergent questioning in design thinking.

(4) Discuss how to perform design thinking in a team managing the conflicts.

(5) Show how engineering sketches and drawings convey designs.

(6)Explain the role of mathematics and physics in design engineering process.

(7) Distinguish between project-based learning and problem-based learning in design engineering.

(8) Describe how concepts like value engineering , concurrent engineering and reverse engineering influence engineering designs?

(9) Show how designs are varied based on the aspects of production methods, life span, reliability and environment?

(10) Explain how economics influence the engineering designs?

(10x3 marks =30 marks)

Part B

Answer any ONE question from each module. Each question carry 14 marks

Module 1

(11) Show the designing of a wrist watch going through the various stages of the design process. Use hand sketches to illustrate the processes.

or

(12)Find the customer requirements for designing a new car showroom. Show how the design objectives were finalized considering the design constraints?

Module 2

(13)Illustrate the design thinking approach for designing a bag for college students within a limited budget. Describe each stage of the process and the iterative procedure involved. Use hand sketches to support your arguments.

or

(14)Construct a number of possible designs and then refine them to narrow down to the best design for a drug trolley used in hospitals. Show how the divergent-convergent thinking helps in the process. Provide your rationale for each step by using hand sketches only.

Module 3

(15) Graphically communicate the design of a thermo flask used to keep hot coffee. Draw the detailed 2D drawings of the same with design detailing, material selection, scale drawings, dimensions, tolerances, etc. Use only hand sketches.

or

(16)Describe the role of mathematical modelling in design engineering. Show how mathematics and physics play a role in designing a lifting mechanism to raise 100 kg of weight to a floor at a height of 10 meters in a construction site.

Module 4

(17) Show the development of a nature inspired design for a solar poweredbus waiting shed beside a highway. Relate between natural and man-made designs. Use hand sketches to support your arguments.

or

(18)Show the design of a simple sofa and then depict how the design changes when considering 1) aesthetics and 2) ergonomics into consideration. Give hand sketches and explanations to justify the changes in designs.

Module 5

(19)Examine the changes in the design of a foot wear with constraints of 1) production methods, 2) life span requirement, 3) reliability issues and 4) environmental factors. Use hand sketches and give proper rationalization for the changes in design.

or

(20)Describe the how to estimate the cost of a particular design using ANY of the following: i) a website, ii) the layout of a plant, iii) the elevation of a building, iv) anelectrical or electronic system or device and v) a car.

Show how economics will influence the engineering designs. Use hand sketches to support your arguments.

(5x14 marks =70 marks)

Syllabus

Module 1

Design Process:- Introduction to Design and Engineering Design, Defining a Design Process-:Detailing Customer Requirements, Setting Design Objectives, Identifying Constraints, Establishing Functions, Generating Design Alternatives and Choosing a Design.

Module 2

Design Thinking Approach:-Introduction to Design Thinking, Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. Design Thinking as Divergent-Convergent Questioning. Design Thinking in a Team Environment.

Module 3

Design Communication (Languages of Engineering Design):-Communicating Designs Graphically, Communicating Designs Orally and in Writing. Mathematical Modeling In Design, Prototyping and Proofing the Design.

Module 4

Design Engineering Concepts:-Project-based Learning and Problem-based Learning in Design.Modular Design and Life Cycle Design Approaches. Application of Bio-mimicry,Aesthetics and Ergonomics in Design. Value Engineering, Concurrent Engineering, and Reverse Engineering in Design.

Module 5

Expediency, Economics and Environment in Design Engineering:-Design for Production, Use, and Sustainability. Engineering Economics in Design. Design Rights. Ethics in Design

Text Books

1) YousefHaik, SangarappillaiSivaloganathan, Tamer M. Shahin, Engineering Design Process, Cengage Learning 2003, Third Edition, ISBN-10: 9781305253285,

2) Voland, G., Engineering by Design, Pearson India 2014, Second Edition, ISBN 9332535051

Reference Books

1.Philip Kosky, Robert Balmer, William Keat, George Wise, Exploring Engineering, Fourth Edition: An Introduction to Engineering and Design, Academic Press 2015, 4th Edition, ISBN: 9780128012420.

2. Clive L. Dym, Engineering Design: A Project-Based Introduction, John Wiley & Sons, New York 2009, Fourth Edition, ISBN: 978-1-118-32458-5

3. Nigel Cross, Design Thinking: Understanding How Designers Think and Work, Berg Publishers 2011, First Edition, ISBN: 978-1847886361

4. Pahl, G., Beitz, W., Feldhusen, J., Grote, K.-H., Engineering Design: A Systematic Approach, Springer 2007, Third Edition, ISBN 978-1-84628-319-2

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1: Design Process**	
1.1	Introduction to Design and Engineering Design. *What does it mean to design something? How Is engineering design different from other kinds of design? Where and when do engineers design? What are the basic vocabularyin engineering design? How to learn and do engineering design.*	1
1.2	*Defining a Design Process*-: Detailing Customer Requirements. *How to do engineering design? Illustrate the process with an example. How to identify the customer requirements of design?*	1
1.3	*Defining a Design Process*-: Setting Design Objectives, Identifying Constraints, Establishing Functions. *How to finalize the design objectives? How to identify the design constraints? How to express the functions a design in engineering terms?*	1
1.4	*Defining a Design Process*-: Generating Design Alternatives and Choosing a Design. *How to generate or create feasible design alternatives? How to identify the "best possible design"?*	1
1.5	Case Studies:- Stages of Design Process. *Conduct exercises for designing simple products going through the different stages of design process.*	1
2	**Module 2: Design Thinking Approach**	
2.1	Introduction to Design Thinking *How does the design thinking approach help engineers in creating innovative and efficient designs?*	1
2.2	Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. *How can the engineers arrive at better designs utilizing the iterative design thinking process (in which knowledge acquired in the later stages can be applied back to the earlier stages)?*	1
2.3	Design Thinking as Divergent-Convergent Questioning. *Describe how to create a number of possible designs and then how to refine and narrow down to the 'best design'.*	1
2.4	Design Thinking in a Team Environment. *How to perform design thinking as a team managing the conflicts ?*	1
2.5	Case Studies: Design Thinking Approach. *Conduct exercises using the design thinking approach for*	1

	designing any simple products within a limited time and budget	
3	**<u>Module 3: Design Communication</u> (Languages of Engineering Design)**	
3.1	Communicating Designs Graphically. *How do engineering sketches and drawings convey designs?*	1
3.2	Communicating Designs Orally and in Writing. *How can a design be communicated through oral presentation or technical reports efficiently?*	1
	First Series Examination	
3.3	Mathematical Modelling in Design. *How do mathematics and physics become a part of the design process?*	1
3.4	Prototyping and Proofing the Design. *How to predict whether the design will function well or not?*	1
3.5	Case Studies: Communicating Designs Graphically. *Conduct exercises for design communication through detailed 2D or 3D drawings of simple products with design detailing, material selection, scale drawings, dimensions, tolerances, etc.*	1
4	**<u>Module 4: Design Engineering Concepts</u>**	
4.1	Project-based Learning and Problem-based Learning in Design. *How engineering students can learn design engineering through projects?* *How students can take up problems to learn design engineering?*	1
4.2	Modular Design and Life Cycle Design Approaches. *What is modular approach in design engineering? How it helps?* *How the life cycle design approach influences design decisions?*	1
4.3	Application of Bio-mimicry, Aesthetics and Ergonomics in Design. *How do aesthetics and ergonomics change engineering designs?* *How do the intelligence in nature inspire engineering designs? What are the common examples of bio-mimicry in engineering?*	1
4.4	Value Engineering, Concurrent Engineering, and Reverse Engineering in Design. *How do concepts like value engineering , concurrent engineering and reverse engineering influence engineering designs?*	1
4.5	Case Studies: Bio-mimicry based Designs. *Conduct exercises to develop new designs for simple*	1

	products using bio-mimicry and train students to bring out new nature inspired designs.	
5	**Module 5: Expediency, Economics and Environment in Design Engineering**	
5.1	Design for Production, Use, and Sustainability. *How designs are finalized based on the aspects of production methods, life span, reliability and environment?*	1
5.2	Engineering Economics in Design. *How to estimate the cost of a particular design and how will economics influence the engineering designs?*	1
5.3	Design Rights. *What are design rights and how can an engineer put it into practice?*	1
5.4	Ethics in Design. *How do ethics play a decisive role in engineering design?*	1
5.5	Case Studies: Design for Production, Use, and Sustainability. *Conduct exercises using simple products to show how designs change with constraints of production methods, life span requirement, reliability issues and environmental factors.*	1
Second Series Examination		

Code.	Course Name	L	T	P	Hrs	Credit
HUT 200	Professional Ethics	2	0	0	2	2

Preamble: To enable students to create awareness on ethics and human values.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the core values that shape the ethical behaviour of a professional.
CO 2	Adopt a good character and follow an ethical life.
CO 3	Explain the role and responsibility in technological development by keeping personal ethics and legal ethics.
CO 4	Solve moral and ethical problems through exploration and assessment by established experiments.
CO 5	Apply the knowledge of human values and social values to contemporary ethical values and global issues.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO 1								2			2	
CO 2								2			2	
CO 3								3			2	
CO 4								3			2	
CO 5								3			2	

Assessment Pattern

Bloom's category	Continuous Assessment Tests		End Semester Exam
	1	2	
Remember	15	15	30
Understood	20	20	40
Apply	15	15	30

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	:	10 marks
Continuous Assessment Tests (2 Nos)	:	25 marks
Assignments/Quiz	:	15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

<u>Course Level Assessment Questions</u>

Course Outcome 1 (CO1):
1. Define integrity and point out ethical values.
2. Describe the qualities required to live a peaceful life.
3. Explain the role of engineers in modern society.

Course Outcome 2 (CO2)
1. Derive the codes of ethics.
2. Differentiate consensus and controversy.
3. Discuss in detail about character and confidence.

Course Outcome 3(CO3):
1. Explain the role of professional's ethics in technological development.
2. Distinguish between self interest and conflicts of interest.
3. Review on industrial standards and legal ethics.

Course Outcome 4 (CO4):
1. Illustrate the role of engineers as experimenters.
2. Interpret the terms safety and risk.
3. Show how the occupational crimes are resolved by keeping the rights of employees.

Course Outcome 5 (CO5):
1. Exemplify the engineers as managers.
2. Investigate the causes and effects of acid rain with a case study.
3. Explorate the need of environmental ethics in technological development.

Model Question paper

QP CODE: **Reg No:______________**

PAGES:3 **Name :______________**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD/FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: HUT 200
Course Name: PROFESSIONAL ETHICS

Max. Marks: 100 **Duration: 3 Hours**

(2019-Scheme)

PART A

(Answer all questions, each question carries 3 marks)

1. Define empathy and honesty.
2. Briefly explain about morals, values and ethics.
3. Interpret the two forms of self-respect.
4. List out the models of professional roles.
5. Indicate the advantages of using standards.
6. Point out the conditions required to define a valid consent?
7. Identify the conflicts of interests with an example?
8. Recall confidentiality.
9. Conclude the features of biometric ethics.
10. Name any three professional societies and their role relevant to engineers.

(10x3 = 30 marks)

PART B

(Answer one full question from each module, each question carries 14 marks)

MODULE I

11. a) Classify the relationship between ethical values and law?

b) Compare between caring and sharing. (10+4 = 14 marks)

Or

12. a) Exemplify a comprehensive review about integrity and respect for others.

b) Discuss about co-operation and commitment. (8+6 = 14 marks)

MODULE II

13.a) Explain the three main levels of moral developments, deviced by Kohlberg.

b) Differentiate moral codes and optimal codes. (10+4 = 14 marks)

Or

14. a) Extrapolate the duty ethics and right ethics.

b) Discuss in detail the three types of inquiries in engineering ethics (8+6 = 14 marks)

MODULE III

15.a) Summarize the following features of morally responsible engineers.

(i) Moral autonomy **(ii)** Accountability

b)Explain the rights of employees (8+6 = 14 marks)

Or

16. a) Explain the reasons for Chernobyl mishap ?

b) Describe the methods to improve collegiality and loyalty. (8+6 = 14 marks)

MODULE IV

17.a) Execute collegiality with respect to commitment, respect and connectedness.

b) Identify conflicts of interests with an example. (8+6 = 14 marks)

Or

18. a) Explain in detail about professional rights and employee rights.

b) Exemplify engineers as managers.

MODULE V

19.a) Evaluate the technology transfer and appropriate technology.

b) Explain about computer and internet ethics. (8+6 = 14 marks)

Or

20. a) Investigate the causes and effects of acid rain with a case study.

b) Conclude the features of ecocentric and biocentric ethics. (8+6 = 14 marks)

Syllabus

Module 1 – Human Values.

Morals, values and Ethics – Integrity- Academic integrity-Work Ethics- Service Learning- Civic Virtue- Respect for others- Living peacefully- Caring and Sharing- Honestly- courage-Cooperation commitment- Empathy-Self Confidence -Social Expectations.

Module 2 - Engineering Ethics & Professionalism.

Senses of Engineering Ethics - Variety of moral issues- Types of inquiry- Moral dilemmas –Moral Autonomy – Kohlberg's theory- Gilligan's theory- Consensus and Controversy-Profession and Professionalism- Models of professional roles-Theories about right action –Self interest-Customs and Religion- Uses of Ethical Theories.

Module 3- Engineering as social Experimentation.

Engineering as Experimentation – Engineers as responsible Experimenters- Codes of Ethics- Plagiarism- A balanced outlook on law - Challenges case study- Bhopal gas tragedy.

Module 4- Responsibilities and Rights.

Collegiality and loyalty – Managing conflict- Respect for authority- Collective bargaining- Confidentiality- Role of confidentiality in moral integrity-Conflicts of interest- Occupational crime- Professional rights- Employee right- IPR Discrimination.

Module 5- Global Ethical Issues.

Multinational Corporations- Environmental Ethics- Business Ethics- Computer Ethics -Role in Technological Development-Engineers as Managers- Consulting Engineers- Engineers as Expert witnesses and advisors-Moral leadership.

Text Book

1. M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi,2012.
2. R S Naagarazan, A text book on professional ethics and human values, New age international (P) limited ,New Delhi,2006.

Reference Books

1. Mike W Martin and Roland Schinzinger, Ethics in Engineering,4th edition, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi,2014.
2. Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey,2004.
3. Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics- Concepts and cases, Wadsworth Thompson Learning, United states,2005.
4. http://www.slideword.org/slidestag.aspx/human-values-and-Professional-ethics.

Course Contents and Lecture Schedule

SL.No	Topic	No. of Lectures 25
1	**Module 1 – Human Values.**	
1.1	Morals, values and Ethics, Integrity, Academic Integrity,Work Ethics	1
1.2	Service Learning, Civic Virtue, Respect for others, Living peacefully	1
1.3	Caring and Sharing, Honesty, Courage, Co-operation commitment	2
1.4	Empathy, Self Confidence, Social Expectations	1
2	**Module 2- Engineering Ethics & Professionalism.**	
2.1	Senses of Engineering Ethics, Variety of moral issues, Types of inquiry	1
2.2	Moral dilemmas, Moral Autonomy, Kohlberg's theory	1
2.3	Gilligan's theory, Consensus and Controversy,Profession& Professionalism, Models of professional roles, Theories about right action	2
2.4	Self interest-Customs and Religion, Uses of Ethical Theories	1
3	**Module 3- Engineering as social Experimentation.**	
3.1	Engineering as Experimentation, Engineers as responsible Experimenters	1
3.2	Codes of Ethics,Plagiarism, A balanced outlook on law	2
3.3	Challenger case study, Bhopal gas tragedy	2
4	**Module 4- Responsibilities and Rights.**	
4.1	Collegiality and loyalty, Managing conflict, Respect for authority	1
4.2	Collective bargaining, Confidentiality, Role of confidentiality in moral integrity, Conflicts of interest	2
4.3	Occupational crime, Professional rights, Employee right, IPR Discrimination	2
5	**Module 5- Global Ethical Issues.**	
5.1	Multinational Corporations, Environmental Ethics, Business Ethics, Computer Ethics	2
5.2	Role in Technological Development, Moral leadership	1
5.3	Engineers as Managers, Consulting Engineers, Engineers as Expert witnesses and advisors	2

CODE MCN201	SUSTAINABLE ENGINEERING	CATEGORY	L	T	P	CREDIT
			2	0	0	NIL

Preamble: Objective of this course is to inculcate in students an awareness of environmental issues and the global initiatives towards attaining sustainability. The student should realize the potential of technology in bringing in sustainable practices.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the relevance and the concept of sustainability and the global initiatives in this direction
CO 2	Explain the different types of environmental pollution problems and their sustainable solutions
CO 3	Discuss the environmental regulations and standards
CO 4	Outline the concepts related to conventional and non-conventional energy
CO 5	Demonstrate the broad perspective of sustainable practices by utilizing engineering knowledge and principles

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1						2	3					2
CO 2						2	3					2
CO 3						2	3					2
CO 4						2	3					2
CO 5						2	3					2

Assessment Pattern

Mark distribution

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	20	20	40
Understand	20	20	40
Apply	10	10	20
Analyse			
Evaluate			
Create			

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the relevance and the concept of sustainability and the global initiatives in this direction

1. Explain with an example a technology that has contributed positively to sustainable development.
2. Write a note on Millennium Development Goals.

Course Outcome 2 (CO2): Explain the different types of environmental pollution problems and their sustainable solutions

1. Explain the 3R concept in solid waste management?
2. Write a note on any one environmental pollution problem and suggest a sustainable solution.
3. In the absence of green house effect the surface temperature of earth would not have been suitable for survival of life on earth. Comment on this statement.

Course Outcome 3(CO3): Discuss the environmental regulations and standards

1. Illustrate Life Cycle Analysis with an example of your choice.
2. "Nature is the most successful designer and the most brilliant engineer that has ever evolved". Discuss.

Course Outcome 4 (CO4): Outline the concepts related to conventional and non-conventional energy

1. Suggest a sustainable system to generate hot water in a residential building in tropical climate.
2. Enumerate the impacts of biomass energy on the environment.

Course Outcome 5 (CO5): Demonstrate the broad perspective of sustainable practices by utilizing engineering knowledge and principles

1. Suggest suitable measures to make the conveyance facilities used by your institution sustainable.

Model Question paper

Part A

(Answer all questions. Each question carries 3 marks each)

1. Define sustainable development.
2. Write a short note on Millennium Development Goals.
3. Describe carbon credit.
4. Give an account of climate change and its effect on environment.
5. Describe biomimicry? Give two examples.
6. Explain the basic concept of Life Cycle Assessment.
7. Name three renewable energy sources.

8. Mention some of the disadvantages of wind energy.
9. Enlist some of the features of sustainable habitat.
10. Explain green engineering.

Part B

(Answer one question from each module. Each question carries 14 marks)

11. Discuss the evolution of the concept of sustainability. Comment on its relevance in the modern world.

OR

12. Explain Clean Development Mechanism.
13. Explain the common sources of water pollution and its harmful effects.

OR

14. Give an account of solid waste management in cities.
15. Explain the different steps involved in the conduct of Environmental Impact Assessment.

OR

16. Suggest some methods to create public awareness on environmental issues.
17. Comment on the statement, "Almost all energy that man uses comes from the Sun".

OR

18. Write notes on:
    a. Land degradation due to water logging.
    b. Over exploitation of water.
19. Discuss the elements related to sustainable urbanisation.

OR

20. Discuss any three methods by which you can increase energy efficiency in buildings.

Syllabus

Sustainability- need and concept, technology and sustainable development-Natural resources and their pollution, Carbon credits, Zero waste concept. Life Cycle Analysis, Environmental Impact Assessment studies, Sustainable habitat, Green buildings, green materials, Energy, Conventional and renewable sources, Sustainable urbanization, Industrial Ecology.

Module 1

Sustainability: Introduction, concept, evolution of the concept; Social, environmental and economic sustainability concepts; Sustainable development, Nexus between Technology and Sustainable development; Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs), Clean Development Mechanism (CDM).

Module 2

Environmental Pollution: Air Pollution and its effects, Water pollution and its sources, Zero waste concept and 3 R concepts in solid waste management; Greenhouse effect, Global warming, Climate change, Ozone layer depletion, Carbon credits, carbon trading and carbon foot print, legal provisions for environmental protection.

Module 3

Environmental management standards: ISO 14001:2015 frame work and benefits, Scope and goal of Life Cycle Analysis (LCA), Circular economy, Bio-mimicking, Environment Impact Assessment (EIA), Industrial ecology and industrial symbiosis.

Module 4

Resources and its utilisation: Basic concepts of Conventional and non-conventional energy, General idea about solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from oceans and Geothermal energy.

Module 5

Sustainability practices: Basic concept of sustainable habitat, Methods for increasing energy efficiency in buildings, Green Engineering, Sustainable Urbanisation, Sustainable cities, Sustainable transport.

Reference Books

1. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
2. Bradley. A.S; Adebayo,A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning
3. Environment Impact Assessment Guidelines, Notification of Government of India, 2006
4. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998
5. ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-Rating System, TERI Publications - GRIHA Rating System
6. Ni bin Chang, Systems Analysis for Sustainable Engineering: Theory and Applications, McGraw-Hill Professional.
7. Twidell, J. W. and Weir, A. D., Renewable Energy Resources, English Language Book Society (ELBS).
8. Purohit, S. S., Green Technology - An approach for sustainable environment, Agrobios Publication

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Sustainability	
1.1	Introduction, concept, evolution of the concept	1
1.2	Social, environmental and economic sustainability concepts	1
1.3	Sustainable development, Nexus between Technology and Sustainable development	1
1.4	Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs)	1
1.5	Clean Development Mechanism (CDM)	1
2	Environmental Pollution	
2.1	Air Pollution and its effects	1
2.2	Water pollution and its sources	1
2.3	Zero waste concept and 3 R concepts in solid waste management	1
2.4	Greenhouse effect, Global warming, Climate change, Ozone layer depletion	1
2.5	Carbon credits, carbon trading and carbon foot print.	1
2.6	Legal provisions for environmental protection.	1
3	Environmental management standards	
3.1	Environmental management standards	1
3.2	ISO 14001:2015 frame work and benefits	1
3.3	Scope and Goal of Life Cycle Analysis (LCA)	1
3.4	Circular economy, Bio-mimicking	1
3.5	Environment Impact Assessment (EIA)	1
3.6	Industrial Ecology, Industrial Symbiosis	1
4	Resources and its utilisation	
4.1	Basic concepts of Conventional and non-conventional energy	1
4.2	General idea about solar energy, Fuel cells	1
4.3	Wind energy, Small hydro plants, bio-fuels	1
4.4	Energy derived from oceans and Geothermal energy	1
5	Sustainability Practices	
5.1	Basic concept of sustainable habitat	1
5.2	Methods for increasing energy efficiency of buildings	1
5.3	Green Engineering	1
5.4	Sustainable Urbanisation, Sustainable cities, Sustainable transport	1

MEL201	COMPUTER AIDED MACHINE DRAWING	CATEGORY	L	T	P	Credits	Year of Introduction
		PCC	0	0	3	2	2019

Preamble: To introduce students to the basics and standards of engineering drawing related to machines and components.

To make studentsfamiliarize with different types of riveted and welded joints, surface roughness symbols; limits, fits and tolerances.

To convey the principles and requirements of machine and production drawings.

To introduce the preparation ofdrawings of assembled and disassembled view of important valves and machine components used in mechanical engineering applications.

To introduce standard CAD packages for drafting andmodelingof engineering components.

Prerequisite: EST 110 - Engineering Graphics

Course Outcomes - At the end of the course students will be able to

CO1	Apply the knowledge of engineering drawings and standards to prepare standard dimensioned drawings of machine parts and other engineering components.
CO2	Preparestandard assembly drawings of machine components and valvesusing part drawings and bill of materials.
CO3	Apply limits and tolerances to components and choose appropriate fits for given assemblies
CO 4	Interpret the symbols of welded, machining and surface roughness on the component drawings.
CO 5	Prepare part and assembly drawings and Bill of Materials of machine components and valves using CAD software.

Mapping of course outcomes with program outcomes (Minimum requirements)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3									3		
CO2	3		2							3		
CO3	3	2										
CO4	3											
CO5	3				3					3		1

Assessment Pattern

Bloom's taxonomy	Continuous Assessment Tests	
	Test 1 PART A Sketching and Manual Drawing	Test 2 PART B CAD Drawing
Remember	25	20
Understand	15	15
Apply	30	20
Analyse	10	10
Evaluate	10	15
Create	10	20

Mark Distribution

Total Marks	CIE Marks	ESE marks	ESE duration
150	75	75	2.5 hours

Continuous Internal Evaluation (CIE) Pattern:

Attendance	15 marks
Regular class work/Drawing/Workshop Record/Lab Record and Class Performance	30 marks
Continuous Assessment Test (minimum two tests)	30 marks

End semester examination pattern

End semester examination shall be conducted on Sketching and CAD drawing on based complete syllabus

The following general guidelines should be maintained for the award of marks

Part A Sketching – 15 marks
Part B CAD drawing – 50marks
Viva Voce – 10 marks.

Conduct of University Practical Examinations

The Principals of the concerned Engineering Colleges with the help of the Chairmen/Chairperson will conduct the practical examination with the approval from the University and bonafide work / laboratory record, hall ticket, identity card issued by college are mandatory for appearing practical University examinations. No practical examination should be conducted without the presence of an external examiner appointed by the University.

END SEMSTER EXAMINATION

MODEL QUESTION PAPER

MEL 201: COMPUTER AIDED MACHINE DRAWING

Duration : 2.5 hours Marks : 75

Note :

1. All dimensions in mm
2. Assume missing dimensions appropriately
3. A4 size answer booklet shall be supplied
4. Viva Voce shall be conducted for 10 marks

PART A (SKETCHING)
(Answer any TWO questions). **15 marks**

1. Sketch two views of a single riveted single strap butt joint. Take dimensions of the plate as 10mm. Mark the proportions in the drawing.

2. Show by means of neat sketches, any three methods employed for preventing nuts from getting loose on account of vibrations

3. Compute the limit dimensions of the shaft and the hole for a clearance fit based on shaft basis system if:

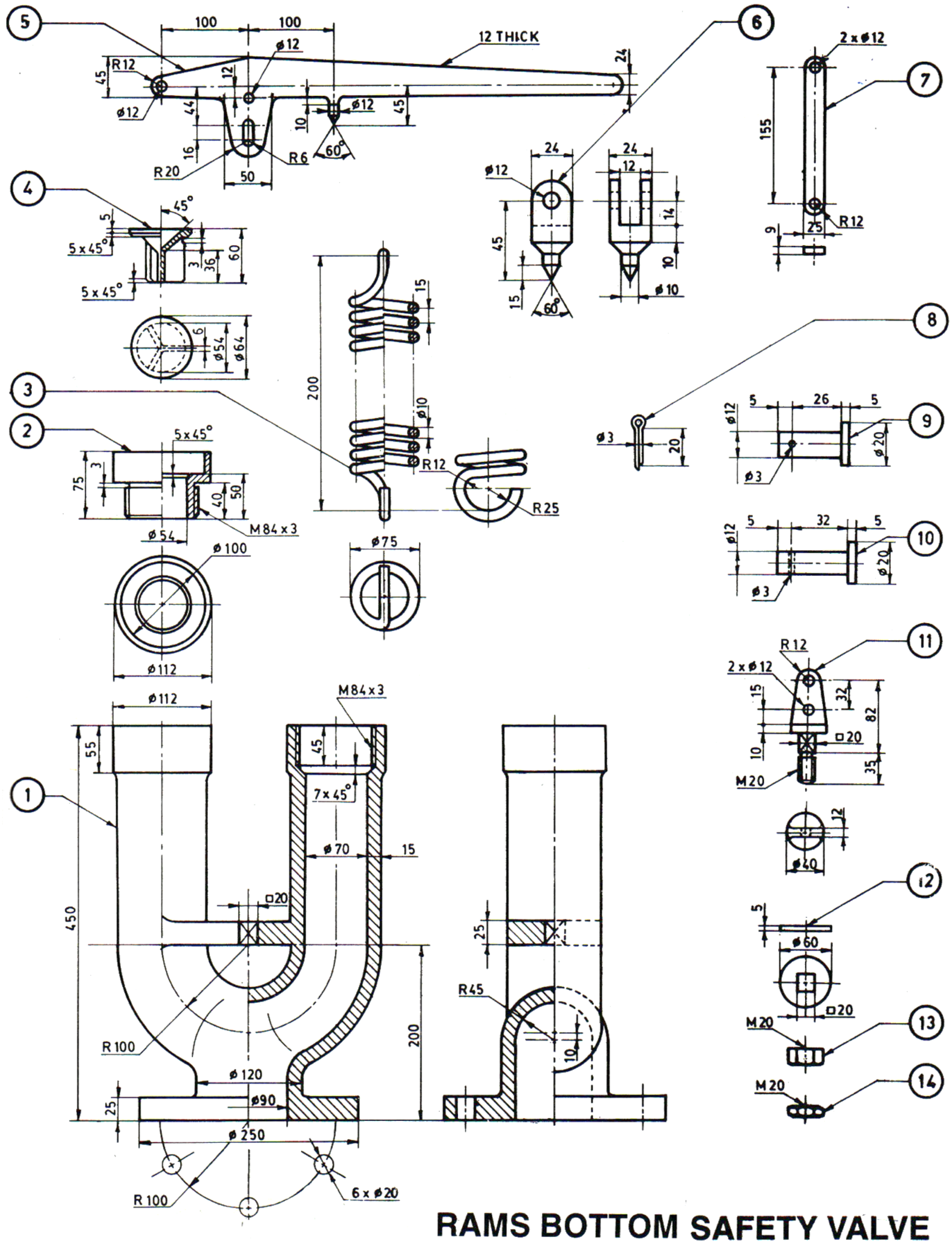
   Basic size= ϕ30 mm
   Minimum clearance = 0.007 mm
   Tolerance on hole = 0.021 mm
   Tolerance on shaft= 0.021 mm

   Check the calculated dimensions. Represent the limit dimensions schematically.

PART B (CAD DRAWING) **50 marks**

4. Draw any two assembled views of the Rams Bottom Safety Valve as per the details given in the figure using any suitable CAD software. Also prepare bill of materials and tolerance data sheet.

Item	Description	Qty	Material	Item	Description	Qty	Material
1	Body	1	C.I.	**8**	Split Pin	3	M.S.
2	Valve Seat	2	G.M.	**9**	Pin for Link	2	M.S.
3	Spring	1	Steel	**10**	Pin for Pivot	1	M.S.
4	Valve	2	G.M.	**11**	Shackle	1	M.S.
5	Lever	1	M.S.	**12**	Washer	1	M.S.
6	Pivot	1	M.S.	**13**	Nut	1	M.S.
7	Link	2	M.S.	**14**	Lock Nut	1	M.S.



RAMS BOTTOM SAFETY VALVE

SYLLABUS

Introduction to machine drawing, drawing standards, fits, tolerances, surface roughness, assembly and part drawings of simple assemblies and subassemblies of machine parts viz., couplings, clutches, bearings, I.C. engine components, valves, machine tools, etc; introduction to CAD etc.

Text Books:
1. N. D. Bhatt and V.M. Panchal, Machine Drawing, Charotar Publishing House.
2. P I Varghese and K C John, Machine Drawing, VIP Publishers.
Reference Books
1. Ajeet Singh, Machine Drawing Includes AutoCAD, Tata McGraw-hill.
2. P S Gill, Machine Drawing, Kataria& Sons.

Course content and drawing schedules.

No:	List of Exercises	Course outcomes	No. of hours
	PART –A (Manual drawing) *(Minimum 6 drawings compulsory)*		
1	**Temporary Joint:** Principles of drawing, free hand sketching, Importance of machine Drawing. BIScode of practice for Engineering Drawing, lines, types of lines, dimensioning, scales of drawing, sectional views, **Riveted joints.**	CO 1	**3**
2	**Fasteners:** Sketching of conventional representation of welded joints,Bolts and Nuts **or** Keys and Foundation Bolts.	CO 1	**3**
3	**Fits and Tolerances:** Limits, Fits – Tolerances of individual dimensions – Specification of Fits – basic principles of geometric & dimensional tolerances. **Surface Roughness:** Preparation of production drawings and reading of part and assembly drawings, surface roughness, indication of surface roughness, etc.	CO 2	**3**
4	Detailed drawing of Cotter joints, Knuckle joint and Pipe joints	CO 2	**3**
5	**Assembly drawings(2D):** Stuffing box and Screw jack	CO 1 CO3 CO4	**3**

	PART –B **(CAD drawing)** *(Minimum 6 drawings compulsory)*		
6	Introduction to drafting software like Auto CAD, basic commands, keyboard shortcuts. Coordinate and unit setting, Drawing, Editing, Measuring, Dimensioning, Plotting Commands, Layering Concepts, Matching, Detailing, Detailed drawings.	CO 1 CO 2 CO 3 CO5	**3**
7	Drawing of Shaft couplings and Oldham's coupling	CO 1 CO 2 CO 3 CO5	**3**
8	**Assembly drawings(2D)with Bill of materials:** Lathe Tailstock and Universal joint	CO 1 CO3 CO5	**3**
9	**Assembly drawings(2D)with Bill of materials:** Connecting rod and Plummer block	CO 1 CO3 CO5	**3**
10	**Assembly drawings(2D)with Bill of materials:** Rams Bottom Safety Valve **OR** steam stop valve	CO 1 CO3 CO5	**3**

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MEL203	MATERIALS TESTING LAB	PCC	0	0	3	2

Preamble:

The objective of this course is to give a broad understanding of common materials related to mechanical engineering with an emphasis on the fundamentals of structure-property-application and its relationships. A group of 6/7 students can conduct experiment effectively. A total of six experiments for the duration of 2 hours each is proposed for this course.

Prerequisite: A course on Engineering Mechanics is required

Course Outcomes:

After the completion of the course the student will be able to

CO 1	To understand the basic concepts of analysis of circular shafts subjected to torsion.
CO 2	To understand the behaviour of engineering component subjected to cyclic loading and failure concepts
CO 3	Evaluate the strength of ductile and brittle materials subjected to compressive, Tensile shear and bending forces
CO 4	Evaluate the microstructural morphology of ductile or brittle materials and its fracture modes (ductile /brittle fracture) during tension test
CO 5	To specify suitable material for applications in the field of design and manufacturing.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3				3							
CO 2	3	3	1		3				3	2	2	1
CO 3	3	3	3	1	3				3	2	3	2
CO 4	3	3	3	3	3	2	2	1	3	2	3	2
CO 5	3	3	3	1	3	2	2	1	3	2	3	2

Assessment Pattern

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance	:	15 marks
Continuous Assessment	:	30 marks
Internal Test (Immediately before the second series test)	:	30 marks

End Semester Examination Pattern:

The following guidelines should be followed regarding award of marks

(a) Preliminary work	: 15 Marks
(b) Implementing the work/Conducting the experiment	: 10 Marks
(c) Performance, result and inference (usage of equipments and troubleshooting)	: 25 Marks
(d) Viva voce	: 20 marks
(e) Record	: 5 Marks

General instructions:

Practical examination to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

A minimum of 10 experiments are to be performed.

SYLLABUS

LIST OF EXPERIMENTS

1. To conduct tension test on ductile material (mild steel/ tor-steel/ high strength steel) using Universal tension testing machine and Extensometer.

2. To conduct compression test on ductile material (mild steel/ tor-steel/ high strength steel) using Universal tension testing machine and Extensometer.

3. To conduct tension test on Brittle material (cast iron) using Universal tension testing machine and Extensometer.

4. To conduct shear test on mild steel rod.

5. To conduct microstructure features of mild steel/copper/ brass/aluminium using optical microscope, double disc polishing machine, emery papers and etchent.

6. To conduct fractography study of ductile or brittle material using optical microscope.

7. To conduct Hardness test of a given material. (Brinell, Vickers and Rockwell)
8. To determine torsional rigidity of mild steel/copper/brass rod.
9. To determine flexural rigidity of mild steel/ copper/brass material using universal testing machine.
10. To determine fracture toughness of the given material using Universal tension testing machine.
11. To study the procedure for plotting S-N curve using Fatigue testing machine.
12. To conduct a Toughness test of the given material using Izod and Charpy Machine.
13. To determine spring stiffness of close coiled/open coiled/series/parallel arrangements.
14. To conduct bending test on wooden beam.
15. To conduct stress measurements using Photo elastic methods.
16. To conduct strain measurements using strain gauges.
17. To determine moment of inertia of rotating bodies.
18. To conduct an experiment to Verify Clerk Maxwell's law of reciprocal deflection and determine young's Modulus of steel.
19. To determine the surface roughness of a polished specimen using surface profilometer.

Reference Books

1. G E Dieter. Mechanical Metallurgy, McGraw Hill,2013

2. Dally J W, Railey W P, Experimental Stress analysis , McGarw Hill,1991

3. Baldev Raj, Jayakumar T, Thavasimuthu M., Practical Non destructive testing, Narosa Book

Distributors,2015