2024-25
B. TECH. (ODD) SEMESTER EXAMINATION
HIGHER MATHEMATICS
(AMS2310)

Maximum Marks: 60 **Duration: Two Hours**

Note: (i) Answer all the questions
(ii) Programmable calculator is not allowed

Q. No.	Questions	CO	M.M.
1(a)	Answer any two of the following:	[CO1]	[15]
	(i) If $u - v = (x - y)(x^2 + 4xy + y^2)$ and $f(z) = u + iv$ is an analytic function of $z = x + iy$ find $f(z)$ in term of z.		
	(ii) If $f(z)$ is an analytic function of z, prove that $\left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}\right)\|f(z)\|^2 = 4\|f'(z)\|^2$		
	(iii) Use Cauchy's integral formula to evaluate $\int_C \frac{3z^2+7z+1}{(z+1)}dz$, where C is the circle		
	(a) $\|z\| = 1.5$ (b) $\|z + i\| = 1.$		
2(a)	Evaluate the following integral, using Cauchy's residue theorem $\int_C \frac{(3z^2+2)}{(z-1)(z^2+9)}dz,$ where $C: \|z - 2\| = 2.$	[CO2]	[07]
2(b)	Find the Laurent series of the function $f(z) = \frac{7z^2+9z-18}{(z^3-9z)}$ about the point $z = 3$ in the regions (i) $0 < \|z - 3\| < 3$ (ii) $3 < \|z - 3\| < 6$	[CO2]	[08]
	OR		
2(b')	Evaluate the contour integral $\int_0^{2\pi} \frac{d\theta}{2 + \cos\theta}$	[CO2]	[08]
3(a)	Show that the vector field $\vec{A} = (x^2 - yz)\hat{\imath} + (y^2 - zx)\hat{\jmath} + (z^2 - xy)\hat{k}$ is irrotational and find the scalar potential $\emptyset$.	[CO3]	[08]

Contd...2.

3(b) Find the directional derivative of $\emptyset(x,y,z) = x^2yz + 4xz^2$ at (1, -2, 1) in the direction of $2\hat{\imath} - \hat{\jmath} - 2\hat{k}$. Find the greatest rate of increase of $\emptyset$. [CO3] [07]

OR

3(b') Prove that $div(r^n \vec{r}) = (n+3)r^n$, where $\vec{r} = x\hat{\imath} + y\hat{\jmath} + z\hat{k}$. Hence show that $\frac{\vec{r}}{r^3}$ is solenoidal. [CO3] [07]

4(a) Evaluate $\iint_S (yz\hat{\imath} + zx\hat{\jmath} + xy\hat{k}).\overrightarrow{ds}$ where S is the surface of the sphere $x^2 + y^2 + z^2 = a^2$ in the first octant. [CO4] [07]

4(b) Use Divergence theorem to evaluate $\iint_S \vec{F}.ds$ where $F = 4x\hat{\imath} - 2y^2\hat{\jmath} + z^2\hat{k}$ and S is the surface bounding the region $x^2 + y^2 = 4, z = 0$ and $z = 3$. [CO4] [08]

OR

4(b') Verify Green's theorem for $\int_C (xy + y^2)\,dx + x^2dy$, where C is bounded by $y = x$ and $y = x^2$ [CO4] [08]

2024-25
B. TECH. (ODD) SEMESTER EXAMINATION
HIGHER MATHEMATICS
(AMS2312)

Maximum Marks: 60 **Duration: Two Hours**

Note: (i) Answer all the questions
(ii) Programmable calculator is not allowed

Q. No.	Questions	CO	M.M.
1(a)	Derive the polar form of Cauchy-Riemann equation. If $w = \log z$ find $\frac{dw}{dz}$ and determine where w is non-analytic.	[CO1]	[08]
1(b)	Answer any two from the following:	[CO1]	[12]
	(i) Construct the analytic function whose imaginary part is $e^{-x}(x\cos y + \sin y)$ and $f(0) = 1$.		
	(ii) Evaluate $\int_0^{2+i} (\bar{z})^2\, dz$ along (a) the line $x = 2y$ (b) a line parallel to the imaginary axis from $z = 2$ to $z = 2 + i$.		
	(iii) State Cauchy's Integral theorem. If $f(a) = \int_C \frac{3z^2+7z+1}{(z-a)} dz$, where C is $\lvert z\rvert = 2$ find (i) $f(3)$ (ii) $f(1-i)$.		
2(a)	Determine the nature of singularities of the following function: (i) ze^{1/z^2} (ii) $\frac{z-\sin z}{z^3}$	[CO2]	[03]
2(b)	Expand $f(z) = \frac{1}{(z^2-3z+2)}$ in the regions (i) $\lvert z\rvert < 1$. (ii) $\lvert z\rvert > 2$. (iii) $0 < \lvert z-1\rvert < 1$.	[CO2]	[09]
	OR		
2(b')	Using Residue theorem, evaluate $\int_C \frac{z^2+4}{z^3+2z^2+2z} dz$, where C is the circle (i) $\lvert z\rvert = 1$. (ii) $\lvert z+1-i\rvert = 1$. (iii) $\lvert z+1+i\rvert = 1$.	[CO2]	[09]
2(c)	By integrating around a unit circle, evaluate $\int_0^{2\pi} \frac{\cos 3\theta\, d\theta}{5-4\cos\theta}$.	[CO2]	[08]

Contd.... 2.

3(a) Answer any two from the following: [CO3] [10]

(i) Prove that $r^n\vec{r}$ is irrotational for every n and solenoidal only for $n = -3$.

(ii) Find the directional derivative of $\emptyset(x, y, z) = xy^2 + yz^3$ at the point $P(2, -1, 1)$ in the direction of $\overrightarrow{PQ}$ where Q is the point (3,1,3).

(iii) Compute the work done in moving a particle in the force field $\vec{F} = 3x^2\hat{\imath} + (2xz - y)\hat{\jmath} + z\hat{k}$ along a curve C defined by $x^2 = 4y,\ 3x^3 = 8z$ from $x = 0$ to $x = 2$.

3(b) Find $\iint_S \vec{F}.\hat{n}\ ds$ if $\vec{F} = (x + y^2)\hat{\imath} - 2x\hat{\jmath} + 2yz\hat{k}$, where S is the surface in the plane $2x + y + 2z = 6$ in the first octant. [CO3] [06]

3(c) Evaluate the integral using Green's theorem $\int_C (2x^2 - y^2)\,dx + (x^2 + y^2)dy$, where C is the boundary in the xy -plane of the area enclosed by the x-axis and the semicircle $x^2 + y^2 = a^2$ in the upper half of xy -plane. [CO3] [04]

ODD 2024-25
B.TECH. ([redacted] SEMESTER) EXAMINATION
MECHANICAL / AUTOMOBILE ENGINEERING
EXPERIMENTAL METHODS AND ANALYSIS
(MEA2420 / MEA2422/ AEA2420 / AEA2422)

Maximum Marks: 60 **Credits: 03** **Duration: Two Hours**

Answer all the questions.
Assume suitable data if missing.
Statistical Tables are allowed.
Notations used have their usual meaning.

Q.No.	Question	CO	MM

Q 1. **(i)** If P(A) = 0.3, P(B) = 0.4, and P(A ∩ B) = 0.1, what is P(A | B)? CO1 [1]

A. 0.25 B. 0.3 C. 0.1 D. 0.5

(ii) An automobile engineering firm records the number of defects per car produced. The probabilities for the number of defects are given below: CO1 [1]

Number of Defects (X)	0	1	2	3
Probability (P(X))	0.2	0.3	0.4	0.1

What is the estimated mean number of defects per car?

(iii) If X is a binomial random variable with n = 5 and p = 0.2, what is P(X = 2)? CO1 [1]

(iv) A continuous random variable X that can assume values between x = 2 and x = 5 has a density function given by $f(x) = 2(1+x)/27$. Find $P(X<4)$. CO1 [3]

(v) A new fuel injector design has a 90% success rate in performance tests. If 20 fuel injectors are tested, what is the probability that more than 18 injectors will pass the test? CO1 [3]

(vi) Let X denote the number of times an engine malfunctions: 1, 2, or 3 times on any given day. Let Y denote the number of times a maintenance team is called on an emergency call. Their joint probability distribution is given below: CO1 [6]

f(x,y)	**x=1**	**x=2**	**x=3**
y=1	0.10	0.05	0.15
y=2	0.20	0.25	0.10
y=3	0.05	0.10	0.00

a) Evaluate the marginal distribution of X.
b) Evaluate the marginal distribution of Y.
c) Find E(Y|X=3)

OR

The lifespan of a certain type of bearing is normally distributed with a mean of 1000 hours and a standard deviation of 100 hours.

a) What is the probability that a bearing lasts less than 900 hours?
b) What is the maximum possible lifespan for 95% of the bearings?

Q 2. **(i)** If you are testing the hypothesis H0: μ = 10 against Ha: μ ≠ 10 using a sample of size 25, which distribution will you use for the test statistic? CO2 [1]

A) Normal distribution
B) t-distribution

contd .... 2.

C) Chi-square distribution
D) F-distribution

(ii) What is the z-score for a value of 70 in a normal distribution with mean 50 and standard deviation 10? CO2 [1]
A) 1.5 B) 2.0 C) 2.5 D) 3.0

(iii) For f-distribution find $f_{0.05}$ at $\nu_1 = 11$, & $\nu_2 = 21$. CO2 [1]

(iv) A new insulating material has a thermal conductivity of 0.03 W/m·K with a standard deviation of 0.005 W/m·K. What is the probability that the mean thermal conductivity of 40 samples tested will be greater than 0.032 W/m·K? CO2 [3]

(v) A mechanical engineer is studying the variability in the tensile strength of a new alloy. It is known that the population variance of the tensile strength for this alloy is $\sigma^2=50$ (in MPa^2). Assume the sample variances are continuous measurements. Find the probability that a random sample of 20 specimens will have a sample variance s^2 less than 80 MPa^2. CO2 [3]

(vi) An automobile engineer is tasked with developing an algorithm to monitor engine temperatures to detect potential overheating issues. The data consists of engine temperature measurements taken at regular intervals for two different car models. CO2 [6]

Data Collected:
Car Model A: [85, 87, 88, 90, 86, 85, 88, 89, 91, 92]
Car Model B: [78, 80, 83, 85, 79, 78, 81, 84, 86, 88]

a) Calculate the mean and standard deviation of engine temperatures for each car model.
b) Find the probability that the ratio of the variances of Car Model A to Car Model B is 4 times higher, assuming that both samples are taken from the same normal population of variance σ^2. Also show it on the distribution curve.

OR

An automobile manufacturer claims that the average fuel efficiency of their new car model is 25 miles per gallon (mpg) with a standard deviation of 2 mpg. To test this claim, a random sample of 30 cars was tested, and the average fuel efficiency was found to be 24.5 mpg. Test the hypothesis that the true mean fuel efficiency is 25 mpg against the alternative that it is not 25 mpg. Use a P-value in your answer. Also show it on the distribution curve.

Q 3. (i) **Define** briefly the following performance characteristics of instruments: CO3 [3]

a) Impedance loading
b) Operational transfer function.
c) Active type of instruments.

(ii) A thermocouple used between 0 and 500 °C has the following input–output characteristics: CO3 [3]

Input T °C	0	100	200	300	500
Output E µV	0	5268	10 777	16 325	27 388

a) Find the equation of the ideal straight line.

Contd....3.

b) Find the non-linearity at 100 °C in μV and as a percentage of f.s.d.

(iii) An analogue-to-digital converter has an input range of 0 to 10 V. Calculate the resolution error both as a voltage and as a percentage of f.s.d., if the output digital signal is 8-bit binary. CO3 [3]

(iv) Formulate the system equation for "Liquid in glass thermometer" relating the output signal in the form of displacement of liquid in the capillary tube and the input temperature of the fluid, surrounding the bulb of thermometer. Also state the parameters which should be changed in order to reduce the settling time. [6]

OR

A measuring element with a time constant of 0.4 s and a static sensitivity of 0.05 mV/°C is used to measure the temperature of a medium, which changes from 20 to 60 °C. Taking the output as zero at 20 °C.

a) Find the time taken for the output voltage to reach 80 % of the steady state value, if the temperature change occurs suddenly.

b) Suggest and explain a method of reducing the time constant to 0.1 s.

Q 4. (i) **Fill** in the blanks: CO4 [3]

a) In semiconductor strain gauges, _____ term is large thus giving large gauge factors.

b) The _____ in a laser jet printer is an array of photoconductive pixels which correspond to the bitmap image page.

c) _____ is an example of a pneumatic type amplifier.

(ii) A McLeod gage is available which has a total capillary, bulb and tube volume V_B of 150 cm^3 and a capillary diameter of 0.3 mm. Calculate the gage reading for a pressure of 30 μm. CO4 [2]

(iii) Explain the working of **Knudsen Gage** with the help of a neat diagram. CO4 [5]

OR

Explain the working of **Eddy current dynamometer** with the help of a neat diagram.

(iv) Derive the differential governing equation for a **pointer-scale indicator**. CO4 [5]

OR for

Derive an expression for the output voltage a differential reluctance displacement sensor in an **inductive push-pull bridge**.

Mechanical

(4799/4800/4817/4818)

2024-25

B.TECH. (ODD SEMESTER) EXAMINATION

MECHANICAL/~~AUTOMOBILE~~ ENGINEERING

MECHANICS OF SOLIDS

MEC2112/AEC2112/MEC2110/AEC2110

Maximum Marks: 60 **Credits: 04** **Duration: Two Hours**

Answer all questions.
Assume suitable data if missing.
Notations used have their usual meaning.
Take units in SI system if not specified.

Q.No.	Questions	[MM] (CO)
1(a)	If the hydrostatic part of stress tensor is 10 MPa and deviatoric part is $\begin{bmatrix} 0 & 20 & 30 \\ 20 & 10 & -30 \\ 30 & -30 & 20 \end{bmatrix}$ MPa, obtain the stress tensor.	[02] (CO1)
1(b)	In case of plane stress situation, the stress tensor is $\begin{bmatrix} 4 & -4 \\ -4 & -2 \end{bmatrix}$ GPa. Evaluate the principal stresses and maximum shear stress. Also, draw the Mohr's circle.	[06] (CO1)
1(c)	The stress tensor at a point is $\begin{bmatrix} a & b & c \\ d & 4 & 5 \\ e & f & 6 \end{bmatrix}$ MPa. Obtain the values of a, b, c, d, e and f, if the stress vector on a plane with normal $\{n\} = \frac{1}{\sqrt{3}}\begin{Bmatrix} 1 \\ 1 \\ 1 \end{Bmatrix}$ is $\{T^n\} = \frac{1}{\sqrt{3}}\begin{Bmatrix} 6 \\ 11 \\ 14 \end{Bmatrix}$.	[07] (CO1)
2(a)	If the twisting moment in a homogeneous shaft of uniform circular cross-section is constant then, is the statement "the cross-section remains plane" an assumption or a realistic situation?	[02] (CO2)
2(b)	Write any two uses of shafts.	[02] (CO2)
	OR	
2(b')	Write any two methods of strain measurement.	[02] (CO2)
2(c)	A homogeneous rod of uniform cross-section is confined between two rigid smooth walls at its ends. The temperature of rod is raised by ΔT. If the rod is allowed to expand in transverse direction ($i.e., \sigma_{yy} = \sigma_{zz} = 0$), evaluate the axial stress (σ_{xx}) developed in terms of material properties α and E.	[05] (CO2)
	OR	
2(c')	A cube is confined by rigid walls on all of its six faces. If the temperature is raised by $10^oC, \alpha = 0.001\ /^oC, E = 50GPa$ and $\nu = 0.25$, find the stress components σ_{xx}, σ_{yy} and σ_{zz}.	[05] (CO2)
2(d)	The strain components in $x-y$ coordinate is $\epsilon_{xx} = 0.025$, $\epsilon_{yy} = 0.025$ and $\gamma_{xy} = 0.05$ for a plane strain situation. Find the strain components in new coordinate system $x'-y'$. Unit vectors in x' and y' directions are $\hat{\imath}' = \frac{3}{5}\,\hat{\imath} + \frac{4}{5}\,\hat{\jmath}$ and $\hat{\jmath}' = -\frac{4}{5}\,\hat{\imath} + \frac{3}{5}\,\hat{\jmath}$, respectively with $\hat{\imath}$ and $\hat{\jmath}$ being unit vectors in x and y directions, respectively.	[06] (CO2)
	OR	

Contd....2.

2(d') The displacement field for a two-dimensional body is given as [06] (CO2)

$$u = (2y^3 + xy^2 + y) \times 10^{-2},$$
$$v = (3x^3 + 4x^2y + 3x) \times 10^{-2}.$$

Obtain the strain components at location $x = 1, y = 1$.

3(a) The beam (Fig. 3(a)) is pinned at *A* and rests on a surface at *B* that exerts a uniform distributed loading on the beam over its *0.6 m* length. Determine the reactions at the ends *A* and *B*. [03] (CO3)

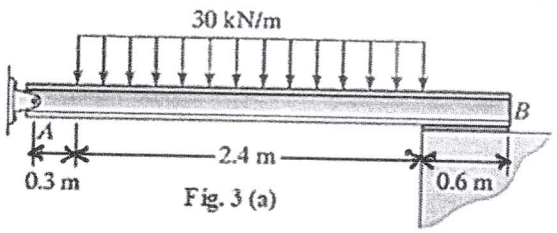


Fig. 3 (a)

3(b) For the beam shown in Fig. 3 (a) draw the shear force and bending moment diagrams. [03] (CO3)

3 (c) For a cantilever beam of length *2a,* subjected to a concentrated load *P* at the free end (*acting downwards*) and an anti-clockwise moment *Pa/2* at the midspan, determine the slope and deflection at the free end, using the Moment-Area Method. [6] (CO3)

OR

3 (c') The beam is subjected to the load shown in Fig. 3(c'). Using discontinuity functions, determine the equation of the elastic curve. *EI* is constant. [06] (CO3)

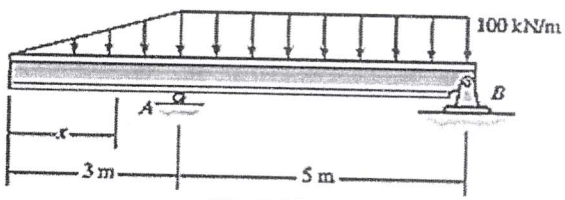


Fig. 3 (c')

3(d) The shear force diagram for a shaft is shown in Fig. 3(d). Determine the smallest diameter *d* if the allowable bending stress is $\sigma_{allow} = 180\ MPa$. [03] (CO3)

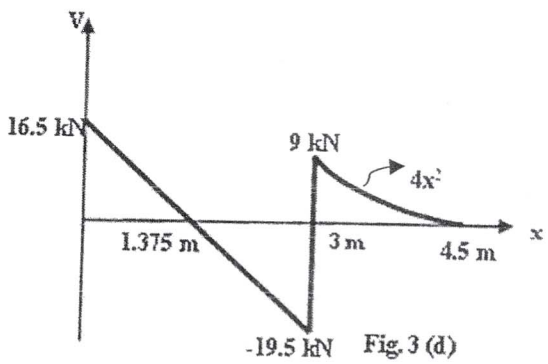


Fig. 3 (d)

4(a) Rigid bars *AB* and *BC* are pin connected at *B*. If the spring at *D* has a stiffness *k*, determine the critical load P_{cr} that can be applied to the bars. [07] (CO4)

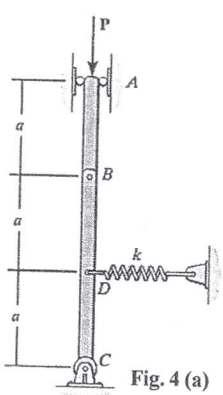


Fig. 4 (a)

4(b) Derive the relationship for the *Volumetic Strain* in a closed-ended cylindrical pressure vessel of inner radius *r,* thickness *t*, subjected to an internal pressure *p*. [04] (CO4)

OR

Contd.... 3.

4(b') A spherical steel pressure vessel has an inner radius of 1000 *mm* and a wall thickness of 10 *mm*. (i) Compute the maximum tangential stresses induced by an internal pressure of 0.80 *MPa*. (ii) Determine the change in the diameter of the sphere due to the applied pressure. Assume $E = 200\ GPa$, $\upsilon = 0.25$ and $r_i \approx r_o \approx r$. **[04] (CO4)**

4(c) A thick-walled, closed-ended cylinder of inner radius a and outer radius b is subjected to an internal pressure p_i only. The cylinder is made of a material with permissible tensile strength σ_{all} and shear strength τ_{all}. Calculate the allowable value of p_i. Given: $a = 0.8\ m$, $b = 1.2\ m$, $\sigma_{all} = 100\ MPa$, $\tau_{all} = 60\ MPa$. **[04] (CO4)**

2024-25

B. TECH. (ODD SEMESTER) EXAMINATION
MECHANICAL ENGINEERING
KINEMATICS OF MACHINES
MEC2122/ MEC2120

Maximum Marks: 60 **Credits: 03** **Duration: 2.0 Hours**

Note:

(i) **Attempt all questions. Assume suitable data, if missing.**

(ii) **Symbols used have their usual meanings.**

Q. No.	Question	CO	M.M.
1.(a)	Explain the terms Lower pair and Compound chain.	CO-1	(01)
1.(b)	What are the uses of a pantograph?	CO-1	(01)
1.(c)	Determine the mobility (degrees of freedom) of the mechanism shown in Fig 1.	CO-1	(02)

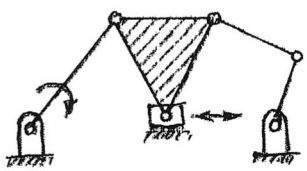


Fig. 1

1.(d)	In a Davis steering mechanism, the distance between the pivots of the front axle is 1.2 *m* and wheel base is 3 *m*. When the automotive vehicle is moving along a straight path, find the inclination of the track arms to the longitudinal axis of the vehicle.	CO-1	(03)
1.(e)	Describe Hart's mechanism with a neat sketch and prove that the tracing point describes a straight-line path.	CO-1	(08)
	OR		
1.(e')	In a Hook's joint, the angle between the two shafts is 15^{o} . Find the angles turned by the driving shaft when the velocity of the driven shaft is maximum, minimum and equal to that of the driving shaft. Also, determine when the driven shaft will have the maximum acceleration and retardation.	CO-1	(08)
2.(a)	What is an acceleration image?	CO-2	(01)
2.(b)	What are centripetal and tangential components of acceleration?	CO-2	(01)
2.(c)	State and prove the Arnold Kennedy theorem.	CO-2	(02)
2.(d)	Locate all the instantaneous centres of the slider crank mechanism as shown in Fig. 2. The lengths of crank *OB* and connecting rod *AB* are 100 *mm* and 400 *mm* respectively.	CO-2	(03)

Contd...2.

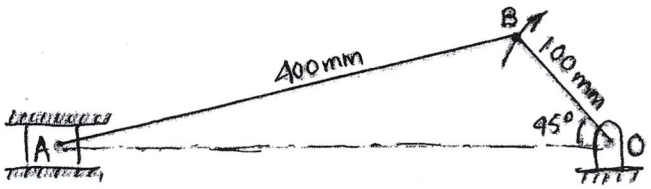


Fig. 2

2.(e) In the mechanism shown in **Fig. 3**, the crank *OA* drives the sliders *B* and *D* in straight paths through connecting links *AB* and *CD*. The lengths of the links are *OA = 150 mm*. *AB* = 300 *mm*, *AC* = 100 *mm* *CD* = 450 *mm* The crank *OA* rotates at 60 *rpm* in clockwise direction. Determine the linear velocity of sliders *B* and *D*, and angular velocity of link *CD*. CO-2 (08)

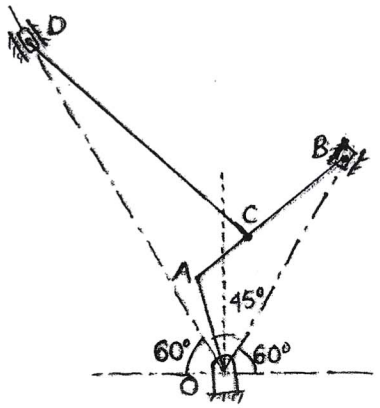


Fig. 3

OR

2.(e') One cylinder of a rotary engine is shown in the configuration diagram shown in Fig. 4. *OA* is the fixed crank, 200 *mm* long. *OP* is the connecting rod and is 520 *mm* long. The line of stroke is along *AR* and at the instant is inclined at 30° to the vertical. The body of the engine consisting of cylinders rotates at a uniform speed of 400 *rpm* about the fixed centre *A*. Determine the acceleration of piston (slider) inside the cylinder and angular acceleration of the connecting rod. CO-2 (08)

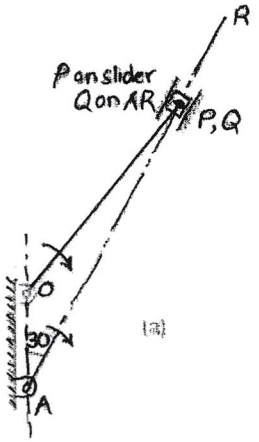


Fig. 4

contd ... 3.

3. (a)	What do you mean by precision or accuracy points in the design of mechanisms?	CO-3	(01)
3. (b)	What is structural error?	CO-3	(01)
3. (c)	Define type synthesis and number synthesis.	CO-3	(02)
3. (d)	Find the three accuracy points using chebyshev's spacing, if a four-bar mechanism is to generate a function $y = x^2$ over the range $1 \leq x \leq 10$.	CO-3	(03)
3. (e)	Describe the procedure to design a four-link mechanism by relative pole method when three positions of the input $(\theta_1, \theta_2, \theta_3)$ and the output link (ϕ_1, ϕ_2, ϕ_3) are known.	CO-3	(08)
4. (a)	Name the parameters on which the direction of axial thrust in a pair of meshing helical gears depend upon.	CO-4	(01)
4. (b)	What is the significance of contact ratio in a gear drive?	CO-4	(01)
4. (c)	What is an epicyclic gear train? In what manner, does it differ from a simple or compound gear train?	CO-4	(02)
4. (d)	Show that for a rack and pinion arrangement with 20° pressure angle and addendum coefficient, $a_r = 1$, the minimum number of teeth required on pinion to avoid interference is 18.	CO-4	(03)
4. (e)	Two mating gears have 20 and 40 involute teeth of module 10 mm and 20° pressure angle. If the addendum on each wheel is such that the path of contact is maximum and interference is just avoided find the path of contact, arc of contact and contact ratio. Also find the addendum for each gear.	CO-4	(08)

OR

4. (e')	An epicyclic gear consists of three gears A, B and C as shown in Fig. 5. The gear A has 72 internal teeth and gear C has 32 external teeth. The gear B meshes with both A and C and is carried on an arm EF which rotates about the centre of A at 18 r.p.m.. If the gear A is fixed, determine the speed of gears B and C.	CO-4	(08)

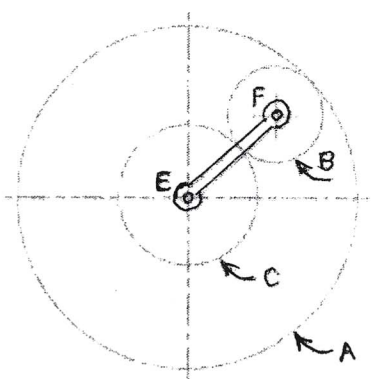


Fig. 5

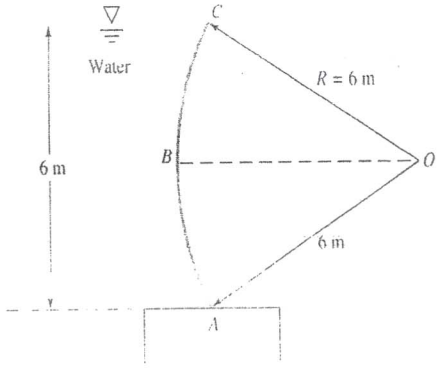
2024-2025
B.Tech.(Odd Semester) Examination
(Mechanical Engineering)
Fluid Mechanics-I (MEC2312/MEC2310)

Maximum Marks: 60 **Duration: Two Hours**

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.
Moody's chart is allowed.

Q.No.	Question	MM	COs
1(a)	A torpedo-shaped object **900 mm** diameter is to move in air at **60 m/s** and its drag is to be estimated from tests in water on a half scale model. Determine the necessary speed of the model and the drag of the full scale object if that of the model is **1.14kN**. (Viscosity: air $1.86x10^{-5}$ *Pa-s*, water $1.01x10^{-3}$ *Pa-s*. Density: air $1.20\ kg/m^3$, water $1000\ kg/m^3$).	8	CO1
1(b)	Gate ABC is a circular arc, sometimes called a Tainter gate, which can be raised and lowered by pivoting about point O. For the position shown, determine the hydrostatic force of the water on the gate (**See Fig.1**).	7	CO1

Figure.1



2(a)	Find the acceleration of a fluid particle at the point $r = 2a$, $\theta = \pi/2$ for a 2-dimensional flow given by $$V_r = -u\left(1 - \frac{a^2}{r^2}\right)\cos\theta, \quad V_\theta = u\left(1 + \frac{a^2}{r^2}\right)\sin\theta$$	7	CO2
2(b)	A *300 mm* diameter circular cylinder is rotated about its axis in a stream of water having a uniform velocity of *5 m/s*. Estimate the rotational speed when	8	CO2

Contd....2.

both the stagnation points coincide. Estimate the lift force experienced by the cylinder under such condition. Density of water may be assumed to be ***1000 kg/m³***.

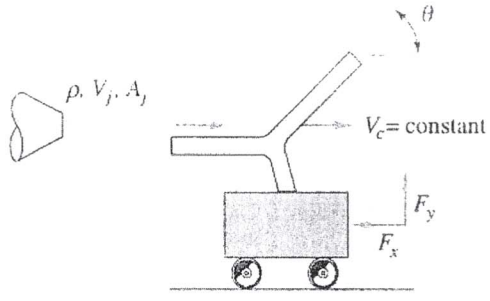
OR

2'(b)	A line source discharging a flow at ***0.6 m²/s*** per unit length is located at **(-1,0)** and a sink of volume flow rate ***1.2 m²/s*** is located at **(2,0)**. For a dynamic pressure of ***10 N/m²*** at the origin, determine the velocity and dynamic pressure at **(1,1).**	**8**	**CO2**
3(a)	i. Give Physical interpretation of Reynolds Transport Theorem. ii. Using Differential analysis, to develop the mass conservation equation.	**5**	**CO3**
3(b)	Derive the Euler's equation in streamline coordinates. Also demonstrate the application of normal part of Euler's equation in Manometry and Bend losses.	**10**	**CO3**

OR

3'(b)	In Fig. 2 the jet strikes a vane which moves to the right at constant velocity V_c on a frictionless cart. Compute (a) the force F_x required to restrain the cart and, (b) the power P delivered to the cart. Also find the cart velocity for which, (c) the force F_x is a maximum and, (d) the power P is a maximum.	**10**	**CO3**

Figure.2



4(a)	What are major and minor losses in pipe flow. Derive the equation of friction factor in case of laminar pipe flow. (Relationship with Re)	**5**	**CO4**
4(b)	Discuss in detail the flow measuring devices with neat sketches. Derive the equation for coefficient of discharge for Venturimeter.	**10**	**CO4**

contd.... 3.

OR

4'(b) The parallel galvanized iron pipe system shown in figure 3 delivers water at ***20°C*** with a total flow rate of ***0.036 m^3/s***. If the pump is wide open and not running, with a loss coefficient ***k = 1.5***, determine, the overall pressure drop and the flow rate in each pipe. (Take ***ρ = 998 kg/m^3*** and ***μ = 0.001 kg/m·s***. For galvanized iron, ***ε = 0.15 mm***.) **10** **CO4**

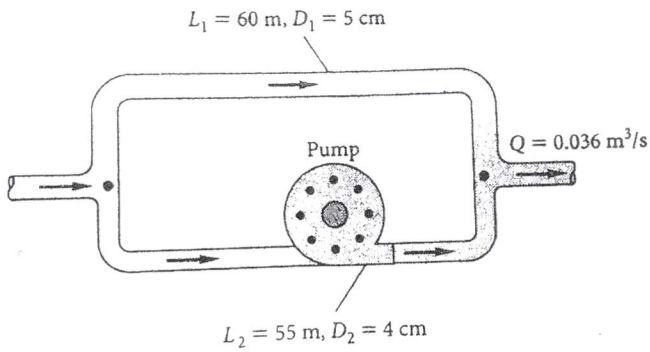


Figure.3

2024-25
B. TECH. (MECHANICAL)
ODD SEMESTER EXAMINATION
Material Science
MEC2430/MEC2432

Maximum Marks: 60 **Credits: 03** **Duration: Two Hours**

Answer all the questions.
Assume suitable data, if missing.
Notations used have their usual meaning.

Q.No.	Questions	COs	M. M.
1(a)	Answer the followings: i. What are total number of effective atoms in HCP unit cell? ii. What are the total number of slip systems in BCC crystal structure? iii. State the relation between dislocation glide and Burger's vector in edge dislocation.	CO1	1X3
1(b)	Answer **ANY THREE** of the followings: i. Write and plot miller indices of all planes in FCC having maximum planer density. ii. Derive the relation of interplanar distance for cubic crystal systems. iii. Explain the conditions for the formation of substitutional alloy. iv. Differentiate between edge and screw dislocations with neat diagram.	CO1	2X3
1(c)	Calculate the equilibrium concentration of vacancies per cubic meter for copper at 1000°C. The energy for vacancy formation is 0.9 eV/atom; the atomic weight and density for copper at the above temperature are 63.5 g/mol and 8.4 g/cm^3, respectively.	CO1	6
2(a)	i. State the conditions for zero degree of freedom for solder phase diagram. ii. What is the name of heat treatment process for eutctoid steel that gives fine pearlite structure? iii. Write the invariant reaction that exist at 725°C in Fe-C phase diagram.	CO2	1X3

Contd....2.

2(b)	Answer **ANY TWO** of the followings: i. Explain and label an isomorphous phase diagram. ii. Explain the microstructure development of hypo-eutectic solder from melting temperature to room temperature with a neat diagram. iii. Determine the mass fraction and composition of phases present at 182 ^{0}C in a sample of Lead and Tin with 70 wt.% Tin in it.	CO2	2X2
2(c)	For a 79.65 wt. % Fe, 0.35 wt. % C, an alloy is at a temperature just below the eutectoid temperature. Determine the fraction of total ferrite and cementite phases, the fraction of the proeutectoid ferrite and pearlite, and the fraction of the eutectoid ferrite. **(Sketch the required portion of phase diagram)**	CO2	8
	OR		
2(c')	Explain annealing, noramalizing and quenching of steel with TTT diagram.	CO2	8
3(a)	Write True or False for the following statements: (i) Precipitation hardening of Aluminum alloys and the treating of steel to form tempered martensite are same phenomena. (ii) Glass is a type of ceramic. (iii)Substitutional diffusion is faster than interstitial diffusion.	CO3	1X3
3(b)	Explain Solution Heat Treatment and Precipitation Heat Treatment of Aluminum-Copper alloys.	CO3	2
3(c)	Discuss ceramics and composites and write down their applications.	CO3	2
3(d)	A sheet of steel 1.5 mm thick has nitrogen atmospheres on both sides at 1200°C and is permitted to achieve a steady-state diffusion condition. The diffusion coefficient for nitrogen in steel at this temperature is 6×10^{-11} m^2/s, and the diffusion flux is found to be 1.2×10^{-7} kg/m^2-s. Also, it is known that the concentration of nitrogen in the steel at the high-pressure surface is 4 kg/m^3. How far into the sheet from this high-pressure side will the concentration be 2.0 kg/m^3? Assume a linear concentration profile.	CO3	3
3(e)	For a steel alloy it has been determined that a carburizing heat treatment of 10-h duration will raise the carbon concentration to 0.45 wt% at a point 2.5 mm from the surface. Estimate the time necessary to achieve the same concentration at a 5.0-mm position for an identical steel and at the same carburizing temperature.	CO3	5

Contd.... 3.

OR

3(e')	An FCC iron-carbon alloy initially containing 0.35 wt. % C is exposed to an oxygen-rich and virtually carbon-free atmosphere at 1400 K (1127°C). Under these circumstances the carbon diffuses from the alloy and reacts at the surface with the oxygen in the atmosphere; that is, the carbon concentration at the surface position is maintained essentially at 0 wt% C. At what position will the carbon concentration be 0.15 wt% after a 10-h treatment? The value of diffusion co-efficient (D) at 1400 K is 6.9×10^{-11} m^2/s.	CO3	5

z	erf(z)
0.40	0.4284
0.45	0.4755

4(a)	Answer the followings: i. Energy absorbed per unit volume upto facture is called …….. ii. Time-dependent and permanent deformation of materials when subjected to a constant load or stress is called….. … iii. Under particular environmental conditions, some normally active metals and alloys lose their chemical reactivity and become extremely inert- This phenomenon is termed …….	CO4	1X3
4(b)	With the help of sketch, explain the effect of mean stress on stress-cycle (S-N) curve.	CO4	2
4(c)	Compute engineering stress, if engineering strain and true stress are 0.1 and 450 N/mm^2, respectively.	CO4	2
4(d)	Derive relationship between true strain and engineering strain.	CO4	3
4(e)	Draw and explain creep curve of strain versus time at constant load and at constant elevated temperature. Further explain, with the help of a sketch, the effect of temperature and stress on creep behaviour.	CO4	5

OR

4(e')	What is the magnitude of the maximum stress that exists at the tip of an internal crack having a radius of curvature of 2.5×10^{-4} mm and a crack length of 2.5×10^{-2} mm when a tensile stress of 170 MPa is applied? Explain energy balance on the crack.	CO4	5