

2023-24
B. TECH. (ODD SEMESTER) EXAMINATION
MECHANICAL ENGINEERING
HIGHER MATHEMATICS
(AMS2310)

Maximum Marks: 60

Credits: 04

Duration: Two Hours

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

- | Q.No. | Question | C.O. M.M. |
|-------|--|-------------|
| 1(a) | Find the analytic function $f(z) = u + iv$ if $u - v = \frac{\cos x + \sin x - e^{-y}}{2 \cos x - e^y - e^{-y}}$ and $f\left(\frac{\pi}{2}\right) = 0$. | [CO1], [06] |
| 1(b) | Attempt any <i>three</i> from the following: | [CO1] [09] |
| | (i) Show that the function $\frac{x}{x^2+y^2} - \frac{iy}{x^2+y^2}$ satisfies CR-equations at the origin. | |
| | (ii) Show that the function $u = e^{-2xy} \sin(x^2 - y^2)$ is harmonic. | |
| | (iii) Evaluate the integral $\oint_C \frac{\cos \pi z}{z^2-1} dz$ around the rectangle with vertices $-2 - i, 2 - i, 2 + i, -2 + i$ using Cauchy's integral formula. | |
| | (iv) Evaluate $f(2)$ and $f(3)$ if $f(a) = \oint_C \frac{2z^2 - z - 2}{z-a} dz$, where $C: z = 2.5$. | |
| 2(a) | Obtain the Laurent series expansion of the function $f(z) = \frac{z^2+1}{z(z^2+3z-10)}$ for the annular regions (i) $ z < 2$ (ii) $2 < z < 5$ | [CO2] [07] |
| 2(b) | Evaluate the following integrals using residue method. | [CO2] [08] |
| | (i) $\oint_C \frac{z \cos z}{(z-\frac{\pi}{2})^3} dz$, where $C: z-1 = 1$ | |
| | (ii) $\oint_C \frac{e^z-1}{z(z-1)(z-i)^2} dz$, where $C: z = 2$. | |
| | OR | |
| 2(b') | Evaluate the real integral $\int_0^\infty \frac{\cos ax}{x^2+1} dx$ using contour integration. | |

Contd. on 20

- 3(a) Attempt any *two* from the following: [CO3] [08]
- (i) If $\vec{F} = \nabla(x^3 + y^3 + z^3 - 3xyz)$, find $\text{div } \vec{F}$ and $\text{curl } \vec{F}$.
 - (ii) Show that for an incompressible fluid which is moving irrotationally, $\text{div grad } \varphi = 0$, where φ is the velocity potential.
 - (iii) Find the directional derivative of $f = 5x^2y - 5y^2z + \frac{5}{2}z^2x$ at the point $(1,1,1)$, in the direction of the line $\frac{x-1}{2} = \frac{y-3}{-2} = z$.

3(b) If $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$ and $r = |\vec{r}|$, show that $\text{div} (\text{grad } r^n) = n(n+1)r^{n-2}$. [CO3] [07]

4(a) Determine whether $\vec{F} = (y^2 \cos x + z^3)\hat{i} + (2y \sin x - 4)\hat{j} + (3xz^2 + 2)\hat{k}$ is a conservative field. If so, find its scalar potential. Also, compute the work done in moving the particle from $(0,1,-1)$ to $(\frac{\pi}{2}, -1, 2)$. [CO4] [07]

4(b) Verify divergence theorem for $\vec{F} = 4xz\hat{i} - y^2\hat{j} + yz\hat{k}$ taken over the cube bounded by the planes $x = 0, x = 1, y = 0, y = 1, z = 0, z = 1$. [CO4] [08]

OR

4(b') Verify Stoke's theorem for the vector field $\vec{F} = (3x - y)\hat{i} - 2yz^2\hat{j} - 2y^2z\hat{k}$ where S is the surface of the sphere $x^2 + y^2 + z^2 = 16, z > 0$.

2023-24

**B.TECH. (AUTUMN SEMESTER) EXAMINATION
MECHANICAL / AUTOMOBILE ENGINEERING
EXPERIMENTAL METHODS AND ANALYSIS
MEA2420 / AEA2420**

Maximum Marks: 60

Credits: 04

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 | | | | | | | | | | | | | | | | | | | | | |
|------------|--|------|-----------|------|--|--|---|---|---|---|---|------|------|------|---|------|------|------|---|------|------|------|--|--|
| Q1. (a) i. | A ship has two turbo engines operating independently. The probability that an engine is available when needed is 0.90. What is the probability that neither is available when needed? | CO1 | [1.0 x 3] | | | | | | | | | | | | | | | | | | | | | |
| ii. | Find the value of 'z' if the area under a standard normal curve to the left of z is 0.0526. | | | | | | | | | | | | | | | | | | | | | | | |
| iii. | Using Poisson distribution find the value of $p(4;6.5)$. | | | | | | | | | | | | | | | | | | | | | | | |
| (b) | Attempt any two of the following: | CO1 | [2.0 x 2] | | | | | | | | | | | | | | | | | | | | | |
| i. | It is known that 90% of chromium plated watches are corrosion resistant. For the ten randomly selected chromium plated watches, what is the probability that 7 may not be found corrosion resistant? | | | | | | | | | | | | | | | | | | | | | | | |
| ii. | In a certain assembly plant, two machines, M1 & M2 make 40% & 60% respectively, of the products. From past experience 2% & 3% of the products made by each machine respectively, are defective. What is the probability that if a product is randomly selected it is defective? | | | | | | | | | | | | | | | | | | | | | | | |
| iii. | Let X be that no. of cash registers being used at a particular time for location-1 and Y the no. of cash registers being used at the same time for location-2. The joint probability function is given by | | | | | | | | | | | | | | | | | | | | | | | |
| | <table border="1"> <thead> <tr> <th colspan="2" rowspan="2"></th> <th colspan="3">y</th> </tr> <tr> <th>0</th> <th>1</th> <th>2</th> </tr> </thead> <tbody> <tr> <th rowspan="3">x</th> <th>0</th> <td>0.12</td> <td>0.04</td> <td>0.04</td> </tr> <tr> <th>1</th> <td>0.08</td> <td>0.19</td> <td>0.05</td> </tr> <tr> <th>2</th> <td>0.06</td> <td>0.12</td> <td>0.30</td> </tr> </tbody> </table> | | | y | | | 0 | 1 | 2 | x | 0 | 0.12 | 0.04 | 0.04 | 1 | 0.08 | 0.19 | 0.05 | 2 | 0.06 | 0.12 | 0.30 | | |
| | | | | y | | | | | | | | | | | | | | | | | | | | |
| | | 0 | 1 | 2 | | | | | | | | | | | | | | | | | | | | |
| x | 0 | 0.12 | 0.04 | 0.04 | | | | | | | | | | | | | | | | | | | | |
| | 1 | 0.08 | 0.19 | 0.05 | | | | | | | | | | | | | | | | | | | | |
| | 2 | 0.06 | 0.12 | 0.30 | | | | | | | | | | | | | | | | | | | | |
| | Find the expected no. of cash registers used at location-2. | | | | | | | | | | | | | | | | | | | | | | | |
| (c) | Attempt any two of the following: | CO2 | [4.0 x 2] | | | | | | | | | | | | | | | | | | | | | |
| i. | A 3D printer is used to make paperweight of 100 grams. The mass production of the item shows that mean is 100grams with standard deviation 5 grams. What percentage of the products may be made between 90 to 110 grams? | | | | | | | | | | | | | | | | | | | | | | | |
| ii. | On a railway reservation counter, on average, 20 people arrives each hour. Find the probabilities that in a 30-minute period 5 people may arrive; and in another 30-minute period nobody shall arrive at the reservation counter. | | | | | | | | | | | | | | | | | | | | | | | |

contd... 2.

- iii. The probability that a patient recover from a delicate heart operation is 0.9. Of the next 100 patients having this operation, what is the probability that between 84 to 94 inclusive survive.

- Q2. (a) i. Find $P(t > -2.567)$ when $\nu = 17$ CO1 [1.0 x 3]
 ii. Find $\chi_{0.95}^2$ when $\nu = 25$
 iii. Find $F_{0.95}$ with $\nu_1 = 10$ and $\nu_2 = 12$

- (b) i. A maker of certain brand of low fat cereal bars claim that the average saturated fat content is 0.5 grams with a variance of 0.09 grams. In a random sample of 8 cereal bars of this brand, what is the probability that mean of the sample may be more than 0.52 grams? CO2 [2.0 x 2]
 ii. A manufacturing firm claims that the batteries used in cars will last on average of 4 years with standard deviation of 0.5 years. What is the probability that variance of 9 such batteries may be more than 0.9 years?

- (c) The following measurements were recorded for the drying time, in hours, of a certain brand of latex paint: CO2 [8.0]

3.4, 2.5, 4.8, 2.9, 3.6,
 2.8, 3.3, 5.6, 3.7, 2.8,
 4.4, 4.0, 5.2, 3.0, 4.8.

Assuming that the measurements represent a random sample from a normal population, find a 95% confidence interval for mean drying time and its variances.

OR

- (c') An EV firm manufactures batteries with the backup of driving time approximately normally distributed with mean 8 hours and a standard deviation of 0.4 hours. If a random sample of 30 such batteries has shown driving time of 7.5 hours. Will the claim of the manufacturer is correct that the batteries have a backup of not less than 8 hours driving time? Comment on the decision. CO2 [8.0]

- Q3. (a) Define briefly the following performance characteristics of instruments: CO3 [3.0]
 i. Tolerance
 ii. Time constant in first order instruments
 iii. Hysteresis in instruments

- (b) i. A pressure transducer has an input range of 0 to 10^4 Pa and an output range of 4 to 20 mA at a standard ambient temperature of 20 °C. If the ambient temperature is increased to 30 °C, the range changes to 4.2 to 20.8 mA. Quantify this environmental effect as zero drift and sensitivity drift. CO3 [2.0 x 2]
 ii. Define Operational Transfer Function (OTF) of the measurement system with the help of a diagram.

- (c) Attempt any two (02) of the following: CO3 [4.0 x 2]

- i. **Explain the compensation technique** for improving the dynamic characteristics of first order instruments with the help of a neat diagram. **Derive** the governing equation for the compensated system.

- ii. An unmanned submarine is equipped with temperature and depth measuring instruments and has radio equipment that can transmit the output readings of these instruments back to the surface. The submarine is initially floating on the surface of the sea with the instrument output readings in steady state. The depth measuring instrument is approximately zero order and the temperature transducer first order with a time constant of 50 seconds. The water temperature on the sea surface, T_0 is 20°C and the temperature T_x at a depth of 'x' meters is given by the relation, $T_x = T_0 - 0.01x$. If the submarine starts diving at time zero, and thereafter goes down at a velocity of 0.5 m/sec, **find the temperature and depth measurements** reported after 200 seconds of travel.

- iii. **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.

Q 4. (a) Fill in the blanks:

CO4 [3.0]

- i. In semiconductor strain gauges, _____ term is large thus giving large gauge factors.
- ii. Two commonly used LED materials are _____ and _____.
- iii. Pirani gage is a device that measures the pressure through the change in _____ of the gas.

(b) i. What are **dynamometers** used to measure? **Name** three (03) types of dynamometers. CO4 [2.0 x 2]

- ii. A **Knudsen gage** is to be designed to operate at a maximum pressure of $1.0 \mu\text{m Hg}$. For this application the spacing of the vane and plate is to be less than 0.3 times the mean free path at this pressure. **Calculate** the force on the vanes at pressures 1.0 and $0.01 \mu\text{m Hg}$, when the gas temperature is 20°C and the temperature difference is 50.0 K .

(c) Attempt any two (02) of the following:

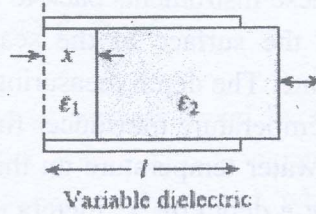
CO4 [4.0 x 2]

- i. Why **Automatic Reference Junction Compensation** is employed in thermocouples? An iron-constantan thermocouple is to be used to measure temperatures between 100 and 300°C . The e.m.f. values are given as $E_{100,0} = 5269 \mu\text{V}$ and $E_{300,0} = 16327 \mu\text{V}$. The e.m.f. is $12500 \mu\text{V}$ relative to a reference junction of 20°C and the corresponding reference junction

contd...4.

circuit voltage is $1000 \mu\text{V}$. Assume a linear e.m.f. vs temperature characteristics to estimate the measured junction temperature.

- ii. Derive a relation for the capacitance in the capacitive transducer shown in the figure below with variable dielectric.



- iii. Explain the working of Counter type analog to digital convertor with the help of a neat diagram.

B.TECH. (ODD SEMESTER) EXAMINATION
MECHANICAL/AUTOMOBILE ENGINEERING
MECHANICS OF SOLIDS
MEC2110/AEC2110

Maximum Marks: 60

Credits: 04

Duration: Two Hours

Answer all questions.

Assume suitable data if missing.

Notations used have their usual meaning.

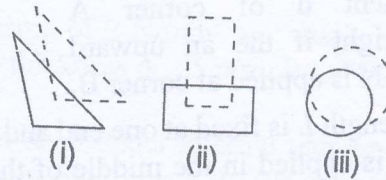
Take units in SI system if not specified.

Q.No.

Questions

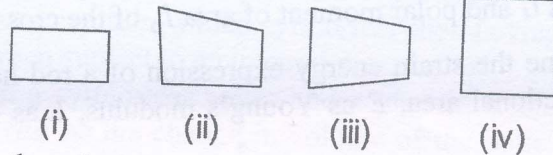
[MM]
(CO)

1(a) In the given figures, motion of three different bodies are shown. The solid line represents initial position and dashed line represents final position of the same body. Which one of the three bodies undergoes rigid body translation only.



[01]
(CO1)

1(b) A square shape deforms into four different shapes as shown. Which one is not a case of uniform strain? (There may be more than one answers.)



[01]
(CO1)

1(c) How many independent components are there in stress tensor if body moments are present?

[01]

1(d) Draw a free-body diagram of a bicycle, isolating it from the road and the rider.

(CO1)

[02]

1(e) If the motion of a body is given as

(CO1)

[04]

(CO1)

$$u = 0.01 \sin\left(\frac{\pi x}{2L}\right) + 0.005 \cos\left(\frac{\pi y}{2L}\right)$$
$$v = 0.02 \cos\left(\frac{\pi x}{2L}\right) + 0.03 \sin\left(\frac{\pi y}{2L}\right)$$

where, L is a constant. Determine if the body is in a state of uniform strain or not. Also, Find the strain components at location $x = L/2$ and $y = L$.

1(f) Consider a body in a state of plane stress such that $\sigma_{xx} = x^2 \text{ N/m}^2$ and $\sigma_{yy} = y^2 \text{ N/m}^2$. If the body is in equilibrium in the absence of body force, determine σ_{xy} .

[06]

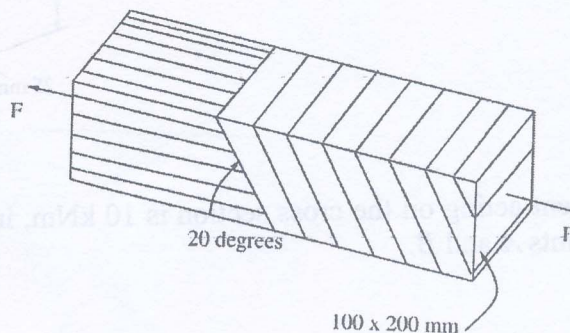
(CO1)

OR

1(f) Two pieces of wood are to be glued together using a lap joint as shown. The shear strength of the glue is 10 N/mm^2 . Find the maximum permissible load F , so that the joint will not fail in shear.

[06]

(CO1)



- 2(a) Choose the correct option
- (i) Total strain = Thermal Strain + Mechanical Strain
 - (ii) Thermal Strain = Total Strain + Mechanical Strain
 - (iii) Total Strain = Mechanical Strain - Thermal Strain
 - (iv) It depends upon the problem

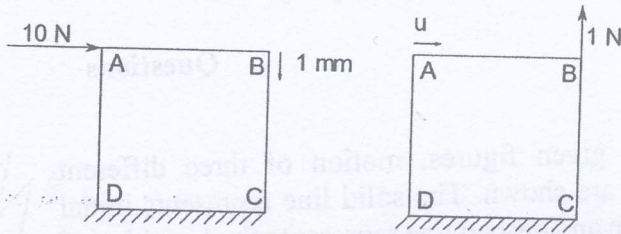
[01]
(CO2)

- 2(b) State whether the following statements are correct or not. If incorrect, re-write the correct statement.

[01+01]
(CO2)

- (i) Plane strain problem means that there is no force in out-of-plane direction.
- (ii) In case of plane stress problems, the in-plane forces may vary in the direction of normal to the plane

- 2(c) If a 10 N force is applied at corner A of square ABCD as shown, the corner B displaces by 1 mm downwards. What would be the displacement u of corner A towards right if the an upward force of 1 N is applied at corner B.



[02]
(CO2)

- 2(d) A rod of length L is fixed at one end and is applied by a torque T_1 at other end. Another torque T_2 is applied in the middle of the rod. Determine the angle by which the end (where T_1 is being applied) will twist in terms of applied toques, length L , shear modulus G and polar moment of area I_p of the cross-section.

[05]
(CO2)

- 2(e) Determine the strain energy expression of a rod hanging under gravity. (Take: A as cross-sectional area, E as Young's modulus, L as length, and $\rho g A$ as force per unit length)

[05]
(CO2)

OR

- 2(e') Derive the critical buckling load expression for the buckling of a column with both ends pinned.

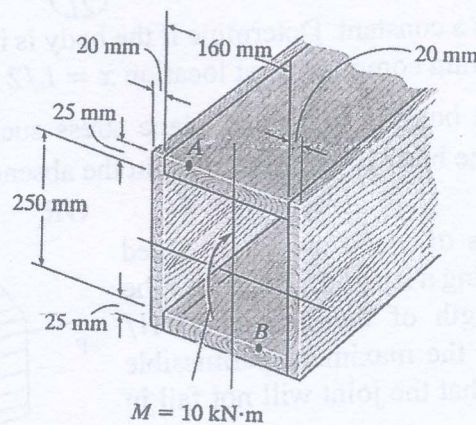
[05]
(CO2)

- 3(a) What does the area of the shear force diagram represent? If the shear force in a beam is maximum at a certain point, what can be said about the bending moment?

[01+01]
(CO3)

- 3(b) A box beam is constructed from four pieces of wood, glued together as shown. Determine the second moment of area of the box beam.

[02]
(CO3)



- 3(c) If the moment acting on the cross section is 10 kNm, in question 3 (b) determine the stress at points A and B.

[02]
(CO3)

3(d) For steel structures, why are I section beams preferred to other shapes?

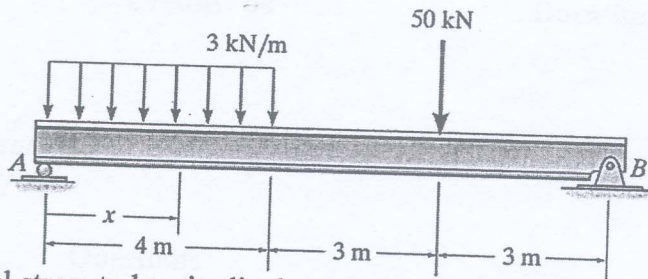
[01]
(CO3)

3(e) A simply supported beam, 8 m long, carries two concentrated loads of 80 kN and 60 kN at distances of 3 m and 6 m from the left end, respectively. Calculate the slopes and deflections at the ends under the loads. $E = 200 \text{ GPa}$ and $I = 3 \times 10^{-4} \text{ m}^4$.

[8]
(CO3)

OR

3(e)' Determine the equation of the elastic curve for the beam subjected to the load shown in figure.



[8]
(CO3)

4(a) What is the ratio of circumferential stress to longitudinal stress in a thin cylinder subjected to internal hydrostatic pressure?

[01]
(CO4)

4(b) A thin walled water pipe carries water under a pressure of 2 N/mm^2 and discharges water into a tank. Diameter of the pipe is 25 mm and thickness is 2.5 mm. What is the longitudinal stress induced in the pipe?

[01]
(CO4)

4(c) The circumferential stress in a cylindrical steel boiler shell under internal pressure is 80 MPa. Young's modulus of elasticity and Poisson's ratio are 200 GPa and 0.28 respectively. Determine the magnitude of circumferential strain in the boiler shell.

[02]
(CO4)

4(d) Determine the maximum shear stress induced in a thin-walled cylindrical shell having an internal diameter 'D' and thickness 't' when subject to an internal pressure 'p'.

[02]
(CO4)

4(e) Circumferential and longitudinal strains in a cylindrical boiler under internal steam pressure are ϵ_1 and ϵ_2 respectively. What will be the change in volume of the boiler cylinder per unit volume?

[01]
(CO4)

4(f) A compound cylinder is formed by shrinking a tube of 250 mm internal diameter and 25 mm wall thickness onto another tube of 250 mm external diameter and 25 mm wall thickness, both tubes being made of same material. The stress setup at the junction owing to shrinkage is 10 MN/mm^2 . The compound tube is then subjected to an internal pressure of 80 MN/mm^2 . Compare the hoop stress distribution now obtained with that of a single cylinder of 300 mm external diameter and 50 mm thickness subjected to the same internal pressure.

[08]
(CO4)

OR

4(f)' A closed cylindrical shell with an internal diameter of 500 mm and an external diameter of 600 mm measures 2 m in length and experiences an internal pressure of 10 MPa. Illustrate the radial and hoop stress distribution throughout the thickness. Calculate the change in internal volume and thickness. The material properties are $E = 200 \text{ GPa}$ and $\nu = 0.3$.

[08]
(CO4)

2023-24

B. TECH. (AUTUMN SEMESTER) EXAMINATION
MECHANICAL ENGINEERING
KINEMATICS OF MACHINES
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.

<u>Q. No.</u>	<u>Question</u>	<u>CO</u>	<u>M.M.</u>
1.(a)	What do you understand by the terms machine and mechanism?	CO-1	(01)
1.(b)	Differentiate between completely constrained motion and incompletely constrained motion.	CO-1	(01)
1.(c)	Define simple and compound chains.	CO-1	(01)
1.(d)	What is Kutzbach's criterion for degrees of freedom of plane mechanisms? In what way is Grubler's criterion different from it?	CO-1	(02)
1.(e)	Show that all the lower pairs can be thought of as combination of revolute (R) and prismatic (P) pairs.	CO-1	(02)
1.(f)	Draw a neat sketch of Davis Steering Gear Mechanism and show that $\tan \alpha = \frac{c}{2b}$, where α is the inclination of slotted steering arms with the vertical line, c is the distance between pivots of front wheel and b is the wheel base.	CO-1	(08)

OR

1.(f)	Derive an expression for the ratio of angular velocities of the shafts of a Hook's joint. Also sketch a polar velocity diagram for the joint and mark its salient features.	CO-1	(08)
2.(a)	State the law of proportionality for finding relative velocities of points on a rotating link.	CO-2	(01)
2.(b)	What is velocity image?	CO-2	(01)
2.(c)	What is the number of instantaneous centres in a mechanism with 6 numbers of links?	CO-2	(01)
2.(d)	State the rules for locating the instantaneous centres for various types of motions in a mechanism.	CO-2	(02)
2.(e)	Derive the expression for Coriolis component of acceleration.	CO-2	(02)
2.(f)	In the mechanism shown in Fig. 1, the dimensions of various links are as under: $AB = 30 \text{ mm}$, $BC = 45 \text{ mm}$, $CD = 40 \text{ mm}$, $AD = 65 \text{ mm}$, $CE = 40 \text{ mm}$ and $\angle DAB = 75^\circ$	CO-2	(08)

contd.....2.

The crank AB rotates at 600 rpm in counterclockwise direction. Determine the linear velocity of slider E , angular velocity of link CE , the linear acceleration of slider E and angular acceleration of link BC .

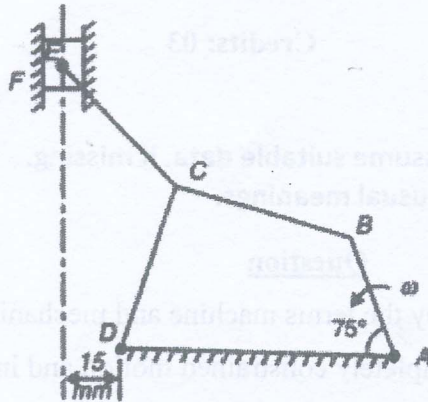


Fig. 1

OR

2.(f) In the mechanism shown in Fig. 2, the dimensions of various links are as follows: CO-2 (08)

$OA = 25 \text{ mm}$, $AB = 80 \text{ mm}$, $BC = 20 \text{ mm}$, $CD = 33 \text{ mm}$, $DE = 20 \text{ mm}$

If the crank OA is inclined at 45° and revolves at uniform speed of 120 rpm in counter clockwise direction, determine the angular velocities of links AB , BC and CD . Also find the linear velocity of slider B .

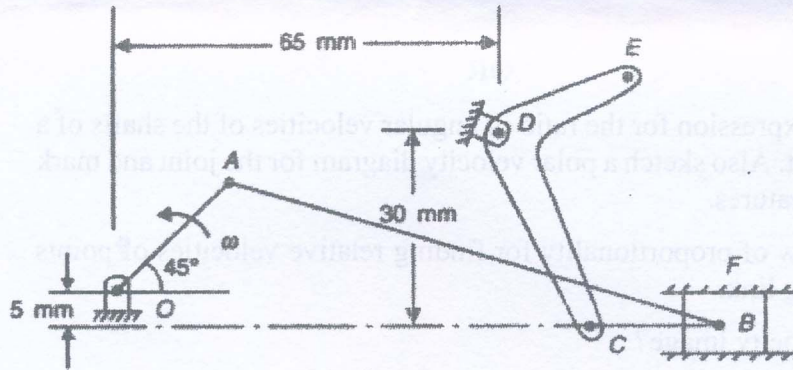


Fig. 2

3. (a) What is the pole of a coupler link of a four link mechanism? CO-3 (01)
3. (b) What are the types of dimensional synthesis? CO-3 (01)
3. (c) Define Qualitative synthesis. CO-3 (01)
3. (d) What is Chebyshev spacing? Write down the steps to obtain accuracy points according to Chebyshev's spacing by the graphical method? CO-3 (02)
3. (e) Explain the three-position synthesis of a slider crank mechanism. CO-3 (02)

contd.....3.

- 3. (f) Synthesize a four-bar mechanism to generate a function $y = \log_{10} x$ in the interval $1 \leq x \leq 10$. The input crank length is 50 mm. The input crank is to rotate from 45° to 105° while the output link moves from 135° to 225° . Use three accuracy points with Chebyshev's spacing. CO-3 (08)

- 4. (a) Name the standard tooth profiles which satisfy the law of gearing. CO-4 (01)
- 4. (b) What is a reverted gear train? Where is it used? CO-4 (01)
- 4. (c) What are the advantages and disadvantages of helical gears over spur gears? CO-4 (01)
- 4. (d) Explain the terms addendum and dedendum. CO-4 (02)
- 4. (e) What is pressure line and pressure angle of a gear? CO-4 (02)
- 4. (f) Define path of contact, arc of contact and contact ratio. With the help of neat sketches, derive their expressions. CO-4 (08)

OR

- 4. (f) An epicyclic gear train arrangement is shown in Fig. 3. Gear E is a fixed gear and gears C and D are compounded and mounted on one shaft. If the arm A makes 60 rpm in counterclockwise direction, determine the speed and direction of rotation of gears B and F. The number of teeth on different gears are as given below: CO-4 (08)

$$T_B = 25, T_C = 15, T_D = 50, T_E = 20 \text{ and } T_F = 30.$$

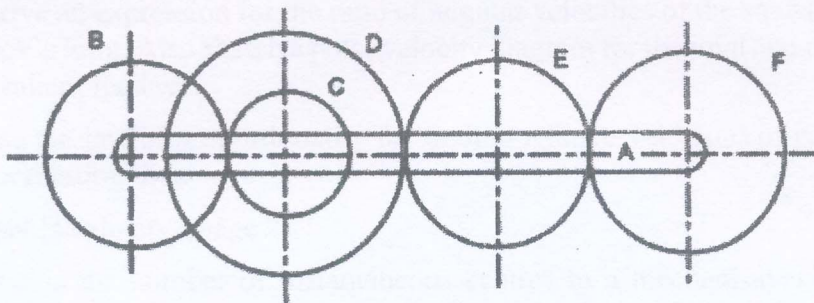


Fig. 3

2023-24
B.Tech. End Term Examination
(Mechanical Engineering)
Fluid Mechanics-MEC2310

Maximum Marks: 60

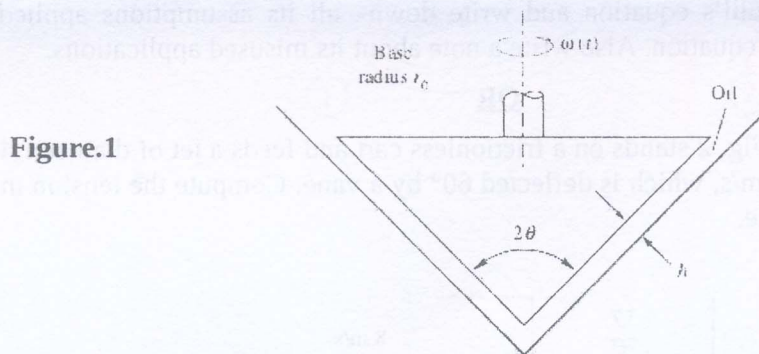
Duration: Two Hours

Answer all the questions.

Assume suitable data if missing.

Notations used have their usual meaning.

Q.No	Question	MM	COs
1(a)	Give one word answer: i. Metacentre above the C.G implies stable or unstable situation. ii. Significance of Grashof number. iii. Dimensions of kinematic viscosity	1x3	CO1
1(b)	Define the following terms: I. Compressible flow II. Irrotational flow	2x2	CO1
1(c)	A solid cone of angle 2θ , base r_0 , and density ρ_c is rotating with initial angular velocity ω_0 inside a conical seat, as shown in Fig. 1. The clearance h is filled with oil of viscosity μ . Neglecting air drag, derive an analytical expression for the cone's angular velocity $\omega(t)$ if there is no applied torque.	8	CO1



2(a)	A two dimensional flow is described in the Lagrangian system as	1x3	CO2
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$$x = x_0 e^{kt} + y_0 (1 - e^{2kt})$$

$$y = y_0 e^{kt}$$

contd ... 2.

Find (a) the equation of path line of the particle and (b) the velocity components in Eulerian system, (c) and streamline.

- 2(b) I. The velocity potential function for a flow is given by $\Phi = x^2 - y^2$. Verify that the flow is incompressible and then determine the stream function for the flow. 2x2 CO2
- II. Prove that streamlines and equipotential lines are orthogonal.
- 2(c) A source with volume flow rate $0.2 \text{ m}^3/\text{s}$ and a vortex with strength $1 \text{ m}^2/\text{s}$ are located at the origin. Determine the equations for velocity potential and stream function. What should be the resultant velocity at $x = 0.9 \text{ m}$ and $y = 0.8 \text{ m}$? 8 CO2

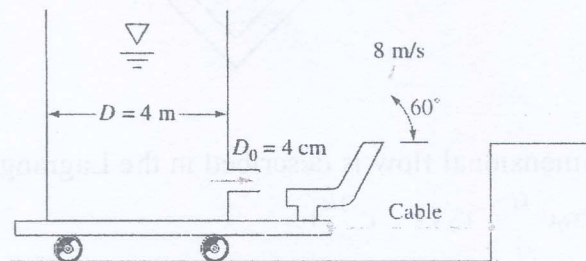
OR

- 2'(c) Find the stream function, velocity and stagnation point of the combination formed by doublet, irrotational vortex and uniform flow. Also find the drag and lift for this case. 8 CO2
- 3(a) i. Define the term Control volume 1x3 CO3
 ii. Define the term Motion pressure
 iii. Write the expression for pressure normal to the streamline, if the streamline is straight.
- 3(b) i. Give Physical interpretation of Reynolds Transport Theorem. 2x2 CO3
 ii. Differentiate between differential and integral approach.
- 3(c) Derive the Bernoulli's equation and write down all its assumptions applied while deriving the equation. Also write a note about its misused applications. 8 CO3

OR

- 3'(c) The water tank in Fig. 2 stands on a frictionless cart and feeds a jet of diameter 4 cm and velocity 8 m/s, which is deflected 60° by a vane. Compute the tension in the supporting cable. 8 CO3

Figure.2



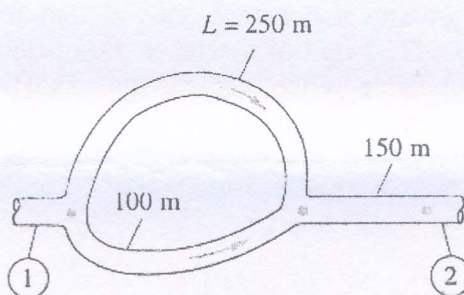
contd... 3.

- 4(a) i. Write the average velocity of laminar flow in a pipe. 1x3 CO4
ii. Write the flow rate as a function of pressure drop in laminar pipe flow.
iii. Coefficient of discharge for orificemeter.
- 4(b) i. Explain in brief the sudden expansion and contraction. 2x2 CO4
ii. Derive the equation for head loss in sudden expansion.
- 4(c) Derive the velocity profile of fully developed laminar flow in a circular pipe. Also find the friction factor for the case of laminar flow. 8 CO4

OR

- 4'(c) For the series-parallel system of Fig. 3, all pipes are 8-cm-diameter asphalted cast iron. If the total pressure drop $p_1 - p_2 = 750$ kPa, find the resulting flow rate Q m^3/h for water at $20^\circ C$. Neglect minor losses. ($\epsilon = 0.12$ mm) 8 CO4

Figure.3



2023-24

B.TECH. (AUTUMN SEMESTER) EXAMINATION

6608/6598

MECHANICAL ENGINEERING/AUTOMOBILE
MANUFACTURING TECHNOLOGY-I

MEC2410/AEC2410

*Answer all the questions.**Assume suitable data if missing.**Notations used have their usual meaning.**Draw neat sketches to support your answers.*

Maximum Marks: 60

Credits: 04

Duration: Two Hours

Q.No.	Question	CO	MM
1(a)	i Bottom gating system may be preferred in castings because _____	CO1	01
	ii Cores are used to _____	CO1	01
	iii Cold shuts are caused due to _____	CO1	01
Answer any TWO of the following:			
1(b)	i Enumerate two methods used to promote directional solidification.	CO1	02
	ii Explain the role of shrinkage allowance in preventing cast defects.	CO1	02
	iii A spherical drop of molten metal of radius 2 mm was found to solidify in 10 seconds. How long will a similar drop of 4 mm radius take to solidify?	CO1	02
1(c)	Answer any TWO of the following:		
	i Determine the dimensions of a cylindrical side riser, to be used for casting an Aluminium cube, of side 15 cm using modulus method.	CO1	04
	ii Design a sprue for avoiding aspiration to deliver liquid iron at a rate of 20 kg/s, neglecting friction and orifice effects. Take the density of molten iron as 7800 kg/m^3 . The height of the pouring basin is 9 cm and the height of the sprue is 25 cm.	CO1	04
iii Differentiate between pressurized and unpressurised gating systems. Where is an unpressurised gating system used and why?	CO1	04	
2(a)	i The thermit welding develops heat due to chemical reaction between _____ & _____.	CO2	01
	ii In submerged arc welding, the arc is struck between: <ul style="list-style-type: none"> a. Consumable coated electrode and work piece b. Non-consumable electrode and work piece c. Consumable bare electrode and work piece d. Tungsten electrode and work piece 	CO2	01
iii	Name the different types of bonding forces acting on an adhesive joint.	CO2	01
2(b)	i In a welding process, if current is increased four times and the duration is reduced by half (other parameters remaining unchanged), then what is the order of change in the heat generated for such a welding process?	CO2	02
	ii What is Friction Stir Welding? Sketch figure also.	CO2	02
	iii What are the different types of solid & liquid phase welding? Write their temperature ranges.	CO2	02
2(c)	During a TIG welding process, the arc current and arc voltage were 50A	CO4	06

contd... 20

and 60V respectively when the welding speed was 150 mm/min. In another process, the TIG welding is carried out at a welding speed of 120 mm/min at the same arc voltage and heat input to the material. What should be the welding current for the second process so that weld quality remains the same?

OR

2(c') Two sheets of 1.5 mm thickness are to be spot welded by supplying a welding current of 8000 A for 0.15 sec. Maximum indentation allowed on the sheet material is 8% of sheet thickness. Density of the nugget material is 7500 kg/m³. Heat required for melting of the metal is 1300 kJ/kg. Calculate the melting efficiency. Take contact resistance as R= 300 μΩ

CO2 06

3(a) i What is the reason for centerburst in case of extrusion? CO3 01

ii Name the two important factors over which spring-back depends. CO3 01

iii Plot the stress-strain curve of a material showing elastic and plastic behaviour without strain hardening. CO3 01

3(b) Answer any THREE of the following:

i Derive the equation for the average flow stress of a material governed by the mentioned power law: CO3 02

$$\sigma_0 = K \times \epsilon^n$$

ii A metal disc of 20 mm diameter is to be punched from a sheet of 2 mm thickness. The punch and the die clearance is 3% of sheet thickness. Calculate the dimensions of the punch and die. CO3 02

iii Discuss the difference between lancing and nibbling with a neat diagram. CO3 02

iv Derive the expression of the length of contact in case of slab rolling. CO3 02

v The thickness of a metallic sheet is reduced from an initial value of 16 mm to a final value of 10 mm in one single pass rolling with a pair of cylindrical rollers each with a diameter of 400 mm. What is the bite angle in degrees? CO3 02

3(c) A cylindrical billet with a diameter of 40 mm and a length of 100 mm undergoes direct extrusion, resulting in a reduction to a diameter of 15 mm. The material deformation behaviour is described by Johnson's equation, where the constants are a = 0.80, b = 1.50, and the material has a strength coefficient of 750 MPa and a strain hardening coefficient, n = 0.15, Determine: CO3 06

- i. Extrusion ratio
- ii. True strain
- iii. Extrusion strain
- iv. Ram force

OR

3(c') Establish the relationship of forces in case of punching with and without shear.
A sheet of thickness 2 mm undergoes a blanking operation by a press of 24 kN capacity. Calculate the shear to be provided to carry out this operation. Also, find force and work done. Take penetration to be 40%, shear strength of the material as 145 MPa and perimeter of the blank to be 300 mm. CO3 06

- 4(a) i Which language or format is used for 3-D printing machine? CO4 01
 - ii Which is the correct sequence of operations in a powder metallurgy process?
 - a. Atomization/Blending & mixing/Compaction/Sintering CO4 01
 - b. Atomization/Blending & mixing/Sintering/Compaction
 - c. Blending & mixing/Compaction/Atomization/Sintering
 - d. Blending & mixing/ Atomization/Compaction/Sintering
 - iii What is "Sialon" in ceramics? CO4 01
- 4(b) Answer any **THREE** of the following:
- i What is a *Jigging Process*? CO4 02
 - ii Write down any four types of glasses based on their composition. CO4 02
 - iii Draw a neat sketch of plastic extrusion moulding machine and label it. CO4 02
 - iv List the steps in additive manufacturing process. CO4 02
- 4(c) Explain *Injection Blow Moulding* process for manufacturing of plastic bottles through a neat diagram. CO4 06
What is *Encapsulation* of plastic?

OR

- 4(c') Explain the following: Impregnation, Pultrusion, and thermoforming of plastics. Give neat diagrams wherever necessary. CO4 06
