CBCS SCHEME

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17MAT41

Fourth Semester B.E. Degree Examination, June/July 2023
Engineering Mathematics – IV

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Find the value of y at x = 0.1 and 0.2 from $\frac{dy}{dx} = x^2y - 1$, y(0) = 1 upto third degree term by using Taylor's series method. **(06 Marks)**

b. Using the modified Euler's method, solve the initial value problem $\frac{dy}{dx} = \frac{y-x}{y+x}$, y(0) = 1 at the point x = 0.1. Take h = 0.1 and carryout two iterations. **(07 Marks)**

c. Solve the differential equation $\frac{dy}{dx} = x - y^2$ at x = 0.8 by using Adam – Bashforth method, given that y(0) = 0, y(0.2) = 0.02, y(0.4) = 0.0795 and y(0.6) = 0.1762. Apply corrector twice. **(07 Marks)**

OR

2 a. Find the approximate solution of $\frac{dy}{dx} = 2y + 3e^x$, y(0) = 0 at the points x = 0.1 and x = 0.2 by using Taylor's series method. **(06 Marks)**

b. Using Runge – Kutta method of fourth order, solve $\frac{dy}{dx} = \frac{y^2 - x^2}{y^2 + x^2}$ with y(0) = 1 at x = 0.2 by taking h = 0.2. **(07 Marks)**

c. If $y' = 2e^x - y$, y(0) = 2, y(0.1) = 2.010, y(0.2) = 2.040 and y(0.3) = 2.090, find y(0.4) using Milne's predictor – corrector formula. Apply corrector formula twice. **(07 Marks)**

Module-2

3 a. Obtain the solution of the equation : $2\frac{d^2y}{dx^2} = 4x + \frac{dy}{dx}$ by computing the values of the dependent variable corresponding to the value x = 1.4 of the independent variable by applying Milne's method using the following data :

x	1	1.1	1.2	1.3
y	2	2.2156	2.4649	2.7514
y'	2	2.3178	2.6725	3.0657

(07 Marks)

b. If $x^3 + 2x^2 - 4x + 5 = aP_0(x) + bP_1(x) + cP_2(x) + dP_3(x)$, find a, b, c, d. **(07 Marks)**

c. If α and β are two distinct roots of $J_n(x) = 0$, then prove that $\int_0^1 x\, J_n(\alpha x) J_n(\beta x) dx = 0$ if $\alpha \neq \beta$. **(06 Marks)**

OR

4 a. Using the Runge – Kutta method, find y(0.2) and y'(0.2), given that y satisfies the differential equation $\frac{d^2y}{dx^2} = x\left(\frac{dy}{dx}\right)^2 - y^2$ and the initial conditions y(0) = 1, y'(0) = 0, h = 0.2. **(07 Marks)**

b. Prove the Rodrigues' formula : $P_n(x) = \frac{1}{2^n n!}\frac{d^n}{dx^n}(x^2-1)^n$. **(07 Marks)**

c. Prove that $J_{1/2}(x) = \sqrt{\frac{2}{\pi x}}\sin x$. **(06 Marks)**

Module-3

5 a. Derive Cauchy – Riemann equations in polar form. **(07 Marks)**

b. By using Cauchy's Residue theorem, evaluate the integral $\int_C \frac{z^2}{(z-1)^2(z+2)}dz$ where C is the circle $|z| = 5/2$. **(07 Marks)**

c. Find the bilinear transformation which maps z = –1, i, 1 into w = 1, i, –1, respectively. **(06 Marks)**

OR

6 a. Find the analytic function f(z) = u + i v in terms of z whose imaginary part is $e^x[(x^2-y^2)\cos y - 2xy\sin y]$. **(07 Marks)**

b. State and prove Cauchy's integral formula. **(07 Marks)**

c. Discuss the transformation $w = z^2$. **(06 Marks)**

Module-4

7 a. Derive the expressions for mean and variance of binomial distribution. **(07 Marks)**

b. The mean weight of 500 students at a certain school is 50kgs and the standard deviation is 6kgs. Assuming that the weights are normally distributed, find the expected number of students weighing :
i) between 40 and 50kgs
ii) more than 60kgs, given that A(1.6667) = 0.4525. **(07 Marks)**

c. Alpha particles are emitted by a radioactive source at an average rate of 5 in a 20 minutes interval. Using Poisson distribution, find the probability that there will be :
i) Exactly two emissions
ii) At least two emissions, in a randomly chosen 20 minutes interval. **(06 Marks)**

OR

8 a. The probability density function P(x) of a variate X is given by the following table :

x	–2	–1	0	1	2	3
P(x)	0.1	K	0.2	2K	0.3	K

Determine the value of K and find the mean, variance and standard deviation. Also find $P(-1 < x \leq 2)$. **(07 Marks)**

b. In a certain town the duration of a shower is exponentially distributed with mean equal to 5 minutes. What is the probability that a shower will last for :
i) Less than 10 minutes
ii) 10 minutes or more? **(07 Marks)**

c. The joint probability distribution of two random variables X and Y is given. Find the marginal distribution of X and Y and evaluate cov(x, y) and $\rho(x, y)$.

X \ Y	1	3	9
2	$\frac{1}{8}$	$\frac{1}{24}$	$\frac{1}{12}$
4	$\frac{1}{4}$	$\frac{1}{4}$	0
6	$\frac{1}{8}$	$\frac{1}{24}$	$\frac{1}{12}$

(06 Marks)

Module-5

9 a. Results extracts revealed that in a certain school, over a period of 5 years, 725 students had passed and 615 students had failed. Test whether success and failure are in equal proportion. **(06 Marks)**

b. Two types of batteries are tested for their length of life and the following results are obtained

Battery	n_1	$\overline{x_1}$	σ^2
A	10	560 hrs	100
B	10	500 hrs	121

Test whether there is a significant difference in two means. (Given $t_{0.05} = 2.101$ for 18 df). **(07 Marks)**

c. Find the fixed probability vector of the regular stochastic matrix :

$$A = \begin{bmatrix} \frac{1}{2} & \frac{1}{4} & \frac{1}{4} \\ \frac{1}{2} & 0 & \frac{1}{2} \\ 0 & 1 & 0 \end{bmatrix}.$$

(07 Marks)

OR

10 a. Define :

i) Null hypothesis

ii) Significance level

iii) Type I and Type II errors. **(06 Marks)**

b. The number of accidents per day (x) over a period of 400 days is given below. Test Poisson distribution is a good fit or not. $\left(\chi^2_{0.05} = 9.49 \text{ for } 4\text{d.f}\right)$.

x	0	1	2	3	4	5
f	173	168	37	18	3	1

(07 Marks)

c. A student's study habits are as follows. If he studies one night, he is 70% sure not to study the next night. On the other hand, if he does not study one night, he is 60% sure not to study the next night. In the long run, how often does he study? **(07 Marks)**

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17MATDIP41

Fourth Semester B.E. Degree Examination, June/July 2023
Additional Mathematics - II

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Find the Rank of the Matrix $A = \begin{bmatrix} 1 & 2 & 3 & 2 \\ 2 & 3 & 5 & 1 \\ 1 & 3 & 4 & 5 \end{bmatrix}$ by elementary row transformations. **(07 Marks)**

b. Solve the following system of equations by Gauss – Elimination method.
$x + y + z = 9$, $x - 2y + 3z = 8$, $2x + y - z = 3$. **(07 Marks)**

c. Find the Eigen values and the Corresponding Eigen Vectors for the matrix
$A = \begin{bmatrix} 8 & -6 & 2 \\ -6 & 7 & -4 \\ 2 & -4 & 3 \end{bmatrix}$. **(06 Marks)**

OR

2 a. Solve the system of equations by Gauss Elimination
$2x + y + 4z = 12$, $4x + 11y - z = 33$, $8x - 3y + 2z = 20$. **(07 Marks)**

b. Using Caley – Hamilton theorem, find the inverse matrix $A = \begin{bmatrix} 2 & 4 \\ 7 & 3 \end{bmatrix}$. **(07 Marks)**

c. Test for Consistency and solve $5x + 3y + 7z = 5$, $3x + 26y + 2z = 9$, $7x + 2y + 10z = 5$. **(06 Marks)**

Module-2

3 a. Solve $\frac{d^3y}{dx^3} + 6\frac{d^2y}{dx^2} + 11\frac{dy}{dx} + 6y = 0$. **(07 Marks)**

b. Solve $y'' + 3y' + 2y = 12x^2$. **(07 Marks)**

c. Solve $\frac{d^2y}{dx^2} + y = \tan x$, by the method of Variation of parameters. **(06 Marks)**

OR

4 a. Solve $y'' - 4y' + 13y = \cos 2x$. **(07 Marks)**

b. Solve $6y'' + 17y' + 12y = e^{-x}$. **(07 Marks)**

c. Solve $y'' - 5y' + 6y = e^{3x}$ by the method of Undetermined coefficients. **(06 Marks)**

Module-3

5 a. Find L[Cos t Cos 2t Cos 3t]. **(07 Marks)**

b. Find L[t^2 Sin at]. **(07 Marks)**

c. If $f(t) = t^2$, $0 < t < 2$ and $f(t + 2) = f(t)$ for $t > 2$, find L[f(t)]. **(06 Marks)**

OR

6 a. Express $f(t) = \begin{cases} t & , \quad 0 < t < 4 \\ 5 & , \quad t > 4 \end{cases}$ in terms of Heaviside unit step function and hence find L[f(t)]. **(07 Marks)**

b. Find the $L\left[\int_0^\infty \left(\frac{\cos 6t - \cos 4t}{t}\right)dt\right]$. **(07 Marks)**

c. Find $L[t^n]$, where n is a positive integer. **(06 Marks)**

Module-4

7 a. Find $L^{-1}\left[\frac{s^3 + 6s^2 + 12s + 8}{s^6}\right]$. **(07 Marks)**

b. Find $L^{-1}\left[\frac{1}{s(s+1)(s+2)(s+3)}\right]$. **(07 Marks)**

c. Solve $\frac{d^2y}{dx^2} + k^2y = 0$, given that $y(0) = 2$, $y'(0) = 0$. by using Laplace Transform. **(06 Marks)**

OR

8 a. Find $L^{-1}\left[Log\left(\frac{s^2+4}{s(s+4)(s-4)}\right)\right]$. **(07 Marks)**

b. Find $L^{-1}\left[\frac{e^{-\pi s}}{s^2+1} + \frac{s\, e^{-2\pi s}}{s^2+4}\right]$. **(07 Marks)**

c. Find $L^{-1}\left[\frac{1}{s(s^2+a^2)}\right]$ by using Convolution theorem. **(06 Marks)**

Module-5

9 a. If A and B are events with $P(A \cup B) = \frac{7}{8}$, $P(A \cap B) = \frac{1}{4}$, $P(A \cap \overline{B}) = \frac{1}{3}$. Find P(A), P(B) and $P(\overline{A} \cap B)$. **(07 Marks)**

b. A problem is given to four students A, B, C, D whose chances of solving it are 1/2 , 1/3 , 1/4 , 1/5 respectively. Find the probability that the problem is solved. **(07 Marks)**

c. The probability of conducting an examination on time is 95%. If there is no delay in admissions and 60% if there is a delay. If the probability that there will be a delay in admission is 20%, find the probability of holding the examination on time. **(06 Marks)**

OR

10 a. Find the probability that a Leap year selected at random will contain 53 Sundays. **(07 Marks)**

b. A student 'A' can solve 75% of the problems given in the book and a student 'B' can solve 70%. What is the probability that A or B can solve a problem chose at random. **(07 Marks)**

c. A box contains 500 IC chips of which 100 are manufactured by Company X and the rest by Company Y. It is estimated that 10% of the chips made by Company X and 5% made by Company Y are defective. If a randomly selected chip is found to be defective, find the probability that it came from Company X. **(06 Marks)**

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17ME42

Fourth Semester B.E. Degree Examination, June/July 2023
Kinematics of Machinery

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Define : (i) Kinematic chain (ii) Inversion (iii) Mechanism (iv) Degree of freedom (v) Machine. **(10 Marks)**

b. With neat sketch, explain Oldham's coupling mechanism. **(10 Marks)**

OR

2 a. With neat sketch, explain the Crank and Slotted lever quick return motion mechanism. **(10 Marks)**

b. With neat sketch, explain the elliptical trammels. Prove that it generates on ellipse. **(10 Marks)**

Module-2

3 a. Explain the types of instantaneous centres. **(08 Marks)**

b. Locate all the instantaneous centres of the slider crank mechanism as shown in Fig. Q3 (b). The lengths of crank OB and connecting rod AB are 100 mm and 400 mm respectively. If the crank rotates clockwise with an angular velocity of 10 rad/s. Find
(i) Velocity of the slider A and
(ii) Angular velocity of connecting rod AB.

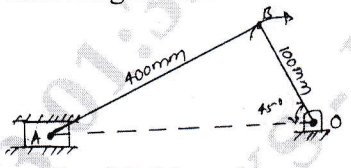

Fig. Q3 (b) **(12 Marks)**

OR

4 An I.C. Engine mechanism as shown in Fig. Q4 in which crank AB rotates at 600 rpm. The length of crank AB is 0.5 m and connecting rod is 2 m long. When the crank is turned 45° from inner dead centre (I.D.C). Find (i) Velocity of piston P (ii) Angular velocity of, connecting rod BP (iii) Velocity of point D on the connecting rod which is at a distance of 0.5 m from B.

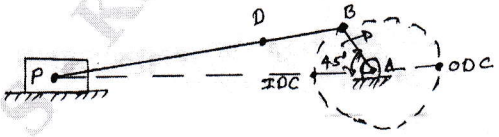

Fig. Q4 **(20 Marks)**

Module-3

5 a. Derive the equation for four bar mechanism using Freudenstein's equation. **(10 Marks)**

b. Determine the Chebyshev spacing for function $y = \log_{10} x$ in the interval $1 \leq x \leq 5$ where 3 precision points are required to be considered. **(10 Marks)**

OR

6 The Four bar mechanism ABCD is shown in Fig. Q6 which is driven by link 2 at $\omega_2 = 45$ rad/s, counterclockwise. Find the angular velocities of links 3 and 4, by using complex number method. AB = 100 mm, CD = 300 mm, AD = 250 mm.

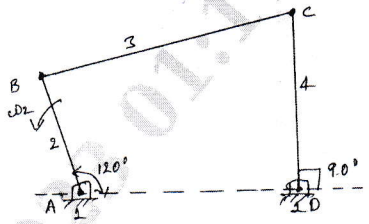

Fig. Q6 **(20 Marks)**

Module-4

7 a. Derive the expression for the length of path of contact. **(10 Marks)**

b. A pinion having 30 teeth drives a gear having 80 teeth. The profile of the gears is involute with 20° pressure angle, 12 mm module and 10 mm addendum. Find the length of path of contact, arc of contact and the contact ratio. **(10 Marks)**

OR

8 a. Explain the types of gear trains. **(08 Marks)**

b. An epicyclic gear consists of three gears A, B and C as shown in Fig. Q8 (b). The gear A has 72 teeth (internal) and gear C has 32 teeth (external). The gear B meshes with both A and C and is carried on an arm EF which rotates about the centre A at 18 rpm. If the gear A is fixed, determine the speed of gear B and C.

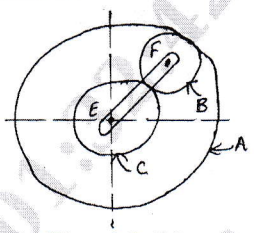

Fig. Q8 (b) **(12 Marks)**

Module-5

9 A cam is to be designed for a knife edge follower with the following data:

(i) Cam lift = 40 mm during 90° of cam rotation with simple harmonic motion.

(ii) Dwell for the next 30°.

(iii) During the next 60° of cam rotation, the follower returns to its original position with simple harmonic motion.

(iv) Dwell during remaining 180°

Draw the profile of the cam when the line of stroke of the follower passes through the axis of the cam shaft. The radius of the base circle of the cam is 40 mm. Determine the maximum velocity and acceleration of the follower during its ascent and descent, if the cam rotates at 240 rpm. **(20 Marks)**

OR

10 a. Explain the types of followers. **(08 Marks)**

b. Derive the expression for the displacement, velocity and acceleration for tangent cam when the roller has contact with straight flanks. **(12 Marks)**

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17ME43

Fourth Semester B.E. Degree Examination, June/July 2023
Applied Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note:* 1. *Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of steam table and thermodynamic data handbook is permitted.

Module-1

1 a. What is an air standard efficiency? Derive an expression for air standard efficiency of an Otto cycle. **(07 Marks)**

b. In an air standard diesel cycle, the compression ratio is 16, and at the beginning of isentropic compression, the temperature is 15°C and the pressure is 0.1 MPa. Heat is added until the temperature at the end of the constant pressure process is 1480°C. Calculate:
(i) Cut-off ratio
(ii) The heat supplied per kg of air
(iii) The cycle efficiency
(iv) M.E.P. **(13 Marks)**

OR

2 a. With the help of line diagram and T-S diagram, explain inter cooling and reheating in gas turbine cycle. **(10 Marks)**

b. Air enters the compressor of an ideal air standard Brayton cycle at 100 kPa, 300 K with a volumetric flow rate of 6 m^3/s. The compressor pressure ratio is 10. The turbine inlet temperature is 1500 K. Determine:
(i) The thermal efficiency
(ii) The power output. **(10 Marks)**

Module-2

3 a. Discuss with help of T-S diagram the effect of boiler pressure condenser pressure on the performance of a Rankine cycle with P-V and T-S diagram. **(08 Marks)**

b. Steam at 20 bar, 360°C is expanded in a steam turbine to 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler.
(i) Assuming ideal process, find per kg of steam the net work and the cycle efficiency.
(ii) If the turbine and the pump have each 80% efficiency, find the percentage reduction in the net work and cycle efficiency. **(12 Marks)**

OR

4 a. With the help of schematic diagram and T-S diagram, explain reheat Rankine cycle and derive an expression for its thermal efficiency. **(08 Marks)**

b. A 40 MW steam power plant working on Rankine cycle operates between boiler pressure of 4 MPa and condenser pressure of 10 kPa. The steam leaves the boiler and enters the steam turbine at 400°C, the isentropic efficiency of the steam turbine is 85%. Determine:
(i) The cycle efficiency
(ii) The quality of exhaust steam from the turbine
(iii) The steam flow rate in kg per hour, consider pump work. **(12 Marks)**

Module-3

5 a. Explain the following terms with reference to a combustion process:
(i) Stoichiometric air
(ii) Enthalpy of formation
(iii) Enthalpy of combustion
(iv) Combustion efficiency **(08 Marks)**

b. The product of combustion of an unknown hydrocarbon C_XH_Y have the following composition as measured by an Orsat apparatus CO_2 = 8%, O_2 = 8.8%, CO = 0.9%, N_2 = 82.3%. Determine:
(i) Composition of the fuel
(ii) Air/fuel ratio
(iii) Percentage of excess air used **(12 Marks)**

OR

6 a. Explain the phenomenon of knocking in SI engine. What are the different factors which influence the knocking? **(10 Marks)**

b. The following particulars refers to a 2-stroke diesel engine:
Bore = 10 cm, Stroke = 15 cm, Piston speed = 300 m/min, torque developed = 58 Nm, mechanical efficiency = 80%, indicated thermal efficiency = 40%, calorific value of fuel = 44 MJ/kg. Determine:
(i) Indicated power
(ii) Indicated mean effective pressure
(iii) Fuel consumption per kWh on brake power output. **(10 Marks)**

Module-4

7 a. With neat sketch, explain the working of a vapour absorption refrigeration system. **(08 Marks)**

b. A vapour compression refrigerator of 10 tonnes capacity using Freon-12 as the refrigerant has an evaporator temperature of −10°C and a condenser temperature of 30°C. Assuming simple saturation cycle, determine: (i) Mass flow rate of refrigerant in kg/min (ii) Power input (iii) COP. Take C_{PV} = 0.72 kJ/kgK. **(12 Marks)**

OR

8 a. Define the following:
(i) Dry bulb temperature
(ii) Dew point temperature
(iii) Relative humidity
(iv) Degree of saturation **(08 Marks)**

b. It is required to design an air conditioning plant for a office room with the following conditions: outdoor conditions 14°C DBT and 10°C WBT; required conditions 20°C DBT and 60% R.H.; amount of air circulation 0.30 m^3/min/person. Seating capacity of office 60. The required condition is achieved first by heating and then by adiabatic humidifying. Determine the following:
(i) Heating capacity of the coil in KW and the surface temperature required if the bypass factor of coil is 0.4.
(ii) The capacity of the humidifier. **(12 Marks)**

Module-5

9 a. Define the following with respect to compressor:
(i) Isothermal efficiency
(ii) Adiabatic efficiency
(iii) Mechanical efficiency
(iv) Volumetric efficiency **(08 Marks)**

b. A single acting reciprocating compressor with cylinder of 15 cm diameter and 18 cm stroke has a clearance volume of 4% of swept volume. It takes in air at 1 bar 25°C and delivers at 8 bar while running at 1200 rpm. The actual power input is 18 KW. Estimate:
(i) The power required to drive the unit
(ii) The isothermal efficiency
(iii) The mechanical efficiency when the mass flow rate is 4 kg/min. **(12 Marks)**

OR

10 a. Discuss the different shapes of nozzle. **(04 Marks)**

b. Discuss the following:
(i) Effect of friction in nozzle flow
(ii) Supersaturated flow through nozzle **(06 Marks)**

c. What is critical pressure ratio? Derive an expression for pressure ratio which gives maximum discharge through the nozzle. **(10 Marks)**

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17ME44

Fourth Semester B.E. Degree Examination, June/July 2023
Fluid Mechanics

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Explain the following fluid properties with relevant equations:
(i) Bulk modulus (ii) Capillarity
(iii) Kinematic viscosity (iv) Surface tension **(08 Marks)**

b. Define compressibility of a fluid. Derive an expression for compressibility of a fluid undergoing isentropic compression. **(04 Marks)**

c. A square plate of side 1m and weight 350 N slides down an inclined plane with a uniform velocity of 2 m/s. The inclined plane is laid on a slope of 6:8 and has an oil film of 1 mm thickness. Calculate the viscosity of oil. **(08 Marks)**

OR

2 a. Derive an expression for total pressure and centre of pressure on an inclined plane surface immersed in a static fluid. **(10 Marks)**

b. A wooden cylinder of specific gravity 0.6 and circular in cross section is required to float in oil of specific gravity 0.9. Find the L/D ratio for the cylinder to float with its longitudinal axis vertical in oil, where ℓ is the height of the cylinder and D is its diameter. **(10 Marks)**

Module-2

3 a. Derive the continuity equation in 3D Cartesian coordinates for steady incompressible flow. **(08 Marks)**

b. A fluid flow is given by $V = 10x^3 i - 8x^3 yj$. Find the shear strain rate and state whether the flow is rotational as irrotational. **(06 Marks)**

c. The velocity potential function is given by $\phi = -2\ell n(x^2 + y^2)$. Show that it represents a possible case of fluid flow. **(06 Marks)**

OR

4 a. A jet of water of diameter 75 mm moving with a velocity of 30 m/s, strikes a curved fixed plate tangentially at one end at an angle of 30° to the horizontal. The jet leaves the plate at an angle of 20° to horizontal. Find the force exerted by Jet on the plate in horizontal and vertical direction. **(04 Marks)**

b. Derive Euler's equation of motion for steady flow and deduce Bernoulli's equation. Also state the assumptions made. **(10 Marks)**

c. A horizontal venturimeter with inlet diameter 20 cm and throat diameter 10 cm is used to measure the flow of oil of specific gravity 0.8. The discharge of oil through venturimeter is 60 ℓt/s. Find the reading of oil mercury differential manometer. Take $C_d = 0.98$. **(06 Marks)**

Module-3

5 a. Derive an expression for velocity distribution (Hagen-Poiseullis flow equation) in circular pipe. Prove that maximum velocity is twice the average velocity of flow. **(10 Marks)**

b. A laminar flow is taking place in a pipe of diameter of 200 mm. The maximum velocity is 1.5 m/s. Find the mean velocity and the radius at which this occurs. Also calculate velocity at 4 cm from the wall of pipe. **(10 Marks)**

OR

6 a. Derive the Darcy-Weisbach equation for loss of head due to friction in a pipe. **(10 Marks)**

b. The rate of flow of water through a horizontal pipe is 0.25 m^3/s. The diameter of pipe which is 200 mm is suddenly enlarged to 400 mm. The pressure intensity in the smaller pipe is 11.772 N/cm^2. Determine:
(i) Loss of head due to sudden enlargement
(ii) Pressure intensity in the larger pipe
(iii) Power lost due to enlargement **(10 Marks)**

Module-4

7 a. Explain the terms:
(i) Boundary layer thickness (ii) Displacement thickness
(iii) Momentum thickness (iv) Energy thickness **(08 Marks)**

b. Write a short note on boundary layer separation and methods to control it. **(06 Marks)**

c. A flat plate 1.5 m × 1.5 m moves at 50 km/hr in stationary air of density 1.15 kg/m^3. If the coefficient of drag and lift are 0.15 and 0.75 respectively. Determine:
(i) Lift force (ii) Drag force (iii) Resultant force (iv) Power required to keep Plate in motion. **(06 Marks)**

OR

8 a. The rate of discharge Q of a centrifugal pump is dependent upon density of fluid ρ, pump speed N in rpm, diameter of impeller D, pressure P, viscosity of fluid μ, using Buckingham's π-theorem show that $Q = ND^3\phi\left[\frac{P}{\rho N^2D^2}, \frac{\mu}{\rho ND^2}\right]$. **(10 Marks)**

b. What is dimensional analysis? Explain the need of dimensional analysis. **(04 Marks)**

c. Explain: (i) Geometric similarity (ii) Kinematic similarity (iii) Dynamic similarity **(06 Marks)**

Module-5

9 a. Define stagnation properties. Obtain an expression for stagnation pressure of a compressible fluid in terms of Mach number and pressure. **(10 Marks)**

b. What is CFD? Mention the advantages, disadvantages of CFD. Also mention application of it. **(10 Marks)**

OR

10 a. Define the following terms:
(i) Sonic flow (ii) Subsonic flow (iii) Supersonic flow (iv) Mach number **(04 Marks)**

b. Derive an expression for velocity of sound wave in a fluid and show that speed of sound wave in a medium $C = \sqrt{\frac{K}{\rho}}$. **(10 Marks)**

c. Calculate the velocity and mach number of a supersonic air craft flying at an altitude of 1000 m where the temperature is 280 K. Sound of air craft is heard 2.15 seconds after the passage of aircraft on the head of an observer. Take $\gamma = 1.41$ and $R = 287$ J/kgK. **(06 Marks)**

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