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06MAT41

Fourth Semester B.E. Degree Examination, May/June 2010
Engineering Mathematics - IV

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. Use of statistical tables is permitted.

PART – A

1 a. Find the y(0.1) correct to 6 decimal places by Taylor series method when $dy/dx = xy + 1$, $y(0) = 1.0$. (Consider upto 4th degree term). **(06 Marks)**

b. Using Runge-Kutta method of order 4, compute y(0.2) for the equation, $y' = y - \frac{2x}{y}$, $y(0) = 1.0$ (Take $h = 0.2$). **(07 Marks)**

c. Given that $y' = x^2(1+y)$ and $y(1) = 1.0$, $y(1.1) = 1.233$, $y(1.2) = 1.548$ and $y(1.3) = 1.979$, compute y(1.4) by Adams-Bashforth method. Apply correct formula twice. **(07 Marks)**

2 a. Show that Z^n is analytic. Hence find its derivative. **(06 Marks)**

b. Find a bilinear transformation which maps the points 0, 1, i in the Z-plane onto 1 + i, –i, 2 – i in the W plane. **(07 Marks)**

c. Find the analytic function u + iv, where u is given to be $u = e^x[(x^2 - y^2)\cos y - 2xy \sin y]$. **(07 Marks)**

3 a. Derive Couchy's integral formula in the form

$$f(a) = \frac{1}{2\pi i}\int_c \frac{f(z)dz}{z-a}$$ **(06 Marks)**

b. Expand $f(z) = \frac{7z^2 + 9z - 18}{z^3 - 9z}$ in the Laurent series that is valid for

i) $|z| > 3$ ii) $0 < |z-3| < 3$. **(07 Marks)**

c. Evaluate $\int_c \tan z\, dz$, where c is $|z| = 2.5$ **(07 Marks)**

4 a. Find the series solution of $\frac{d^2y}{dx^2} + xy = 0$. **(06 Marks)**

b. Express $x^4 + 3x^3 - x^2 + 5x - 2$ in terms of Legendre's polynomials. **(07 Marks)**

c. Reduce the differential equation $x\frac{d^2y}{dx^2} + \alpha\frac{dy}{dx} + k^2xy = 0$ to Bessel's equation. Obtain the solution. **(07 Marks)**

PART – B

5 a. Fit a curve of the form $y = ab^x$ for the data given below: **(06 Marks)**

x :	2	4	6	8	10	12
y :	1.8	1.5	1.4	1.1	1.1	0.9

b. Find the coefficient of correlation for the following data: **(07 Marks)**

x :	55	56	58	59	60	60	62
y :	35	38	39	38	44	43	45

c. In a certain college 25% of boys and 10% of girls are studying mathematics. The girls constitute 60% of the student body.

i) What is the probability that mathematics is being studied?

ii) If a student is selected a random and is found to be studying mathematics, find the probability that the student is a girl. **(07 Marks)**

6 a. Suppose a random variable X takes the values –3, –1, 2 and 5 with respective probabilities $\frac{2k-3}{10}, \frac{k-2}{10}, \frac{k-1}{10}, \frac{k+1}{10}$. Find the value of k and i) find $P[-3 < X < 4]$ and ii) $P[X \leq 2]$. **(06 Marks)**

b. Suppose that the student IQ scores form a normal distribution with mean 100 and standard deviation 20. Find the percentage of students whose i) score is less than 80 ii) score falls between 90 and 140, iii) Score more than 120. **(07 Marks)**

c. Obtain mean and variance of binomial distribution function. **(07 Marks)**

7 a. A sample of 1000 days is taken from meteorological records of a certain district and 120 of them are found to be foggy. What are the probable 99% confidence limits to the proportion of foggy days in the district? **(06 Marks)**

b. The following table gives the number of bus accidents that occurred during the various days of the week. Find whether the accidents are uniformly distributed over the week, using χ^2 test. **(07 Marks)**

Days	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Total
No. of accidents	14	16	8	12	11	9	14	84

c. The life X of certain computer is approximately normally distributed with mean 800 hours and standard deviation 40 hours. If a random sample of 30 computers has an average life of 788 hours, test the hypothesis that $\mu = 800$ hours against the alternate hypothesis $\mu \neq 800$ hours at i) 0.5% and 1% level of significance. **(07 Marks)**

8 a. A fair coin is tossed 4 times. Let X denote the number of heads occurring and let Y denote the longest string of heads occurring. Find the joint distribution function of X and Y. **(06 Marks)**

b. A man's gambling luck follows a pattern. If he wins a game the probability of winning the next game is 0.6. However, if he loses a game, the probability of losing the next game is 0.7. There is an even chance that he wins the first game.
i) Find the transition matrix of the Markov process. ii) Find the probability that he wins the third game. iii) Find out how often, in the long run, he wins. **(07 Marks)**

c. Explain: i) Transient state ii) Absorbing state and iii) Recurrent state by means of an example each. **(07 Marks)**

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06ME42B

Fourth Semester B.E. Degree Examination, May/June 2010
Mechanical Measurements and Metrology

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. What is metrology? State its objectives. **(06 Marks)**

b. Define the following:
i) Line standard ii) End standard iii) Wavelength standard. **(09 Marks)**

c. What is wringing? Build the following dimensions using M-112 set:
i) 33.4565 ii) 87.1025. **(05 Marks)**

2 a. Distinguish between tolerance and allowance. **(04 Marks)**

b. Explain the principles of interchangeability and selective assembly. **(06 Marks)**

c. Determine the actual dimensions for a hole-shaft pair designated as $28H_7/f_8$. Dimension 28 falls in the range of 18 to 30 mm. Fundamental deviation for f shaft is $-5.5D^{0.41}$, $IT_7 = 16i$ and $IT_8 = 25i$. Tolerance unit $i = 0.45(D)^{1/3} + 0.001D$ (microns). **(10 Marks)**

3 a. Sketch and explain the following comparators:
i) Zeiss optimeter ii) Solex comparators. **(12 Marks)**

b. With a neat figure, explain the principle of sine bar. **(04 Marks)**

c. Build the following angles:
i) 49° 36′ 48″ ii) 35° 32′ 36″ **(04 Marks)**

4 a. Explain how the straightness can be measured by using an autocollimator. **(08 Marks)**

b. Explain the 3 wire method of measuring the effective diameter of a screw thread. **(08 Marks)**

c. Briefly explain the working of a tool-maker's microscope. **(04 Marks)**

PART – B

5 a. With a suitable example, explain the generalized measurement system. **(06 Marks)**

b. Define the following terms:
i) Accuracy ii) Precision iii) Calibration iv) Hysteresis. **(08 Marks)**

c. With a block diagram, distinguish between primary and secondary transducers. **(06 Marks)**

6 a. What is the requirement of an intermediate modifying device? Explain the inherent problems, with a mechanical system. **(08 Marks)**

b. With a neat figure, explain the ballast circuit. **(06 Marks)**

c. Explain the working of a CRO. **(06 Marks)**

7 a. Sketch and explain the working of a platform balance. **(06 Marks)**

b. With a neat figure, explain the prony brake dynamometer. **(08 Marks)**

c. Discuss the working of McLeod gauge. **(06 Marks)**

8 a. What is a thermocouple? State and explain the laws of thermocouple. **(08 Marks)**

b. Discuss the construction and working of an optical pyrometer. **(08 Marks)**

c. What is a strain gauge? **(04 Marks)**

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06ME43

Fourth Semester B.E. Degree Examination, May/June 2010
Applied Thermodynamics

Time: 3 hrs. Max. Marks:100

Note: *1. Answer any FIVE full questions, selecting at least TWO questions from each part.*
2. Use of standard thermodynamic data book, psychrometric chart, steam tables, Mollier chart etc. permitted.

PART – A

1 a. Explain : i) enthalpy of formation ; ii) Enthalpy of combustion ; iii) Stoichiometric air, iv) Combustion efficiency. **(10 Marks)**

b. Methane (CH_4) is burned with atmospheric air. The analysis of the products on a dry basis is as follows : CO_2 = 10% , O_2 = 2.37% , CO = 0.53% and N_2 = 87.10%. Determine the combustion equation and calculate : i) Air fuel ratio on mole and mass basis ; ii) The percent theoretical air. **(10 Marks)**

2 a. Describe diesel cycle with P – V and T – S diagrams and derive an expression for efficiency in terms of compression ratio, cut off ratio and ratio of specific heats. **(10 Marks)**

b. The minimum pressure and temperature of the air standard Carnot cycle are 1 bar and 15°C respectively. The pressure after isothermal compression is 3.5 bar and the pressure after isentropic compression is 10.5 bar. Determine : i) Efficiency ; ii) Mean effective pressure and iii) Power developed if the Carnot engine makes 2 cycles/s. Take for air R = 0.287 kJ/kg K and γ = 1.4. **(10 Marks)**

3 a. Derive an expression for work ratio in terms of minimum and maximum cycle temperature, ratio of specific heats and pressure ratio for a simple gas turbine cycle. **(05 Marks)**

b. Write short notes on rocket propulsion. **(05 Marks)**

c. In a gas turbine plant the intake temperature and pressure are 18°C and 1 bar respectively. Air is compressed to a pressure of 4.2 bar by a compressor. The isentropic efficiency of compressor is 84%. Gas is heated to 650°C in the combustion chamber, where there is a pressure drop of 0.086 bar. The expansion of gas then occurs to atmospheric pressure in the turbine. The thermal efficiency of plant is 18%. Draw the T-S diagram and find the isentropic efficiency of the turbine. Neglect mass of fuel and take properties of gas as that of air. Take γ = 1.4 for air. **(10 Marks)**

4 a. With h – s diagram, explain the effects of the following on Rankine cycle performance : i) Increasing the pressure of steam ; ii) Super heating of steam. **(06 Marks)**

b. Explain with T – S diagram the ideal regenerative Rankine cycle. **(05 Marks)**

c. Steam at 20 bar, 360°C is expanded in a steam turbine to a pressure of 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. Assuming the turbine and feed pump efficiencies as 60% and 90% respectively, determine per kg of steam, the net work, the heat transferred to the working fluid and the Rankine efficiency of the cycle. **(09 Marks)**

PART – B

5 a. Define the following with respect to a reciprocating air compressor : i) Isothermal efficiency ; ii) Isentropic efficiency and iii) Mechanical efficiency. **(06 Marks)**

b. Derive an expression for volumetric efficiency of compressor in terms of clearance ratio, pressure ratio and index of compression. **(05 Marks)**

c. In a two stage reciprocating air compressor, 1.5 kg/min of air is compressed from 1 bar to 25 bar and the index of compression is 1.2. If the work of compression is minimum and the air is cooled in the intercooler so that its temperature is brought back to initial temperature of 15°C, determine : i) Heat rejected during compression ; ii) Heat rejected in the intercooler and iii) The power required to drive the compressor. Take for air C_P = 1 kJ/kg K and C_v = 0.714 kJ/kg K. **(09 Marks)**

6 a. Derive an expression for the maximum C.O.P of a vapour absorption refrigeration system in terms of generator, condenser and evaporator temperatures. **(05 Marks)**

b. With a neat diagram, explain steam jet refrigeration. **(05 Marks)**

c. A food storage locker requires a refrigeration system of 2520 kJ/min capacity at an evaporator temperature of - 8°C and a condenser temperature of 30°C. The refrigerant R – 12, is sub coded by 5°C before entering the expansion valve and the vapour is superheated to 6°C before leaving the evaporator. The compression of refrigerant is by reversible adiabatic process. A two cylinder, vertical single acting compressor with stroke equal to 1.5 times the bore is used and it runs at 900 RPM. Determine : i) Mass of refrigerant to be circulated ; ii) Theoretical power required ; iii) COP ; iv) Heat removed through condenser and v) Theoretical bore and stroke of compressor. Take the liquid refrigerant specific heat as 1.235 kJ/kg K and vapour refrigerant specific heat as 0.733 kJ/kg K. The properties of refrigerant, R – 12 are as given below :

Saturation temperature °C	Specific volume m^3/kg, v_g	Enthalpy, kJ/kg		Entropy, kJ/kg K	
		Liquid	Vapour	Liquid	Vapour
- 8	0.07313	411.30	569.81	4.1598	4.7577
30	0.02433	447.88	586.52	4.2870	4.7443

(10 Marks)

7 a. Define and then obtain an expression for the following in terms of partial pressures of water vapour and air.
i) Specific humidity ; ii) Degree of saturation. **(06 Marks)**

b. Draw the figure of a psychrometric chart showing the following processes starting from a common point '0'.
i) Sensible heating ; ii) Heating and humidifying process and iii) Cooling and humidifying process. **(06 Marks)**

c. Saturated air leaving the cooling section of an air conditioned system at 14°C DBT at a rate of 50 m^3/min is mixed adiabatically with the outside air at 32°C DBT and 60% RH at a rate of 20 m^3/min. Assuming that mixing process occurs at a pressure of 1 bar, determine the specific humidity, the RH, the DBT and the volume flow rate of mixture. **(08 Marks)**

8 a. Describe the following as applied to I.C. engines :
i) Morse test and ii) Energy balance. **(08 Marks)**

b. The following data refer to the test conducted on two stroke diesel engine, run for 20 minutes at full load. Mean effective pressure = 3 bar, speed = 350 RPM, net brake load = 650 N, fuel consumption = 1.52 kg, cooling water = 160 kg, water inlet temperature = 30°C and water outlet temperature = 52°C, air fuel ratio = 32, room temperature = 25°C, exhaust gas temperature = 300°C, cylinder bore = 200 mm, stroke = 280 mm, brake drum diameter = 100 cm, calorific valve fuel = 44000 kJ/kg, steam formed per kg of fuel in the exhaust = 1.35 kg, specific heat of steam in exhaust = 2.09 kJ/kg K, specific heat of dry exhaust gas = 1 kJ/kg K, the pressure of exhaust = 1 bar. Determine : i) Indicated power ; ii) Brake power ; iii) Mechanical efficiency and also write the energy balance on minute basis and percentage. **(12 Marks)**

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06ME44

Fourth Semester B.E. Degree Examination, May/June 2010
Kinematics of Machines

Time: 3 hrs. Max. Marks:100

Note: *1. Answer any FIVE full questions, selecting at least TWO questions from each part.*
2. Graphical solutions are to be drawn only in the answer book or in the graph sheets selecting suitable scale if required.

PART – A

1 a. Define with suitable examples :
i) Higher pair ii) Kinematic chain iii) Mechanism. **(06 Marks)**

b. Explain with the help of neat sketches :
i) Four bar mechanism ii) Parallel crank mechanism iii) Elliptical trammel. **(14 Marks)**

2 Explain with the help of neat sketches :
a. Whitworth quick return motion mechanism **(08 Marks)**
b. Roberts mechanism. **(04 Marks)**
c. Pantograph mechanism. **(08 Marks)**

3 For the configuration of a slider crank mechanism shown in the Fig. Q(3), find :
i) The acceleration of slider at B,
ii) The acceleration of point E
iii) The angular acceleration of link AB.
The crank rotates at 20 rad/sec counter clock wise. **(20 Marks)**
Given : OA = 480 mm ; AB = 1600 mm ; AE = 450 mm.

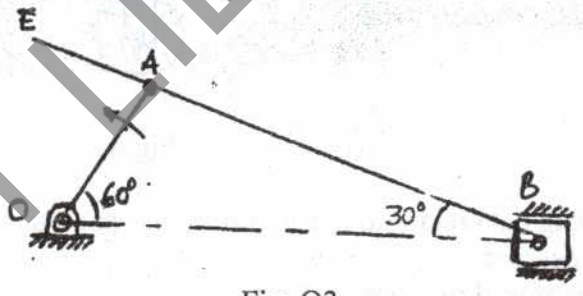

Fig. Q3

4 a. In a four bar mechanism, the crank AB is 300 mm long, BC = CD = 360 mm, and AD the fixed link is 600 mm long. The crank makes and angle of 60° with the fixed link, and it rotates uniformly at 100 rpm. Locate all the instantaneous centers and find the angular velocity of link BC. **(10 Marks)**

b. A reciprocating engine mechanism has connecting rod 200 mm long and crank 50 mm long. By using KLEIN's construction, determine the velocity and acceleration of piston, and angular acceleration of connecting rod, when the crank has turned through 45° from IDC clockwise and is rotating at 240 rpm. **(10 Marks)**

PART - B

5 The slider crank of a internal combustion engine mechanism includes a crank of 50 mm length and the connecting rod of 200 mm length. The crank speed of the engine is constant at 300 rpm. Determine the acceleration of the mass centre of the connecting rod by using complex number method, when the crank angle is 30°. The mass centre is located at 50 mm from the crank pin. **(20 Marks)**

6 a. State and derive law of gearing. **(08 Marks)**

b. Two 20° involute spur gears mesh externally and give a velocity ratio of 3. Module is 3 mm and the addendum is equal to 1.1 module. If the pinion rotates at 120 rpm, determine :

i) The minimum number of teeth on each wheel to avoid interference

ii) The number of pairs of teeth in contact. **(12 Marks)**

7 In an epicyclic gear train shown in Fig. Q7 the compound wheels A and B as well as internal wheels C and D rotate independently about the axis O. The wheels E and F rotate on the pins fixed to the arm a. All the wheels are of the same module. The number of teeth on the wheels are

$T_A = 52$, $T_B = 56$, $T_E = T_F = 36$.

Determine the speed of C if :

i) The wheel D is fixed and arm a rotates at 200 rpm clockwise

ii) The wheel D rotates at 20 rpm counter clockwise and the arm a rotates at 200 rpm clockwise. **(20 Marks)**

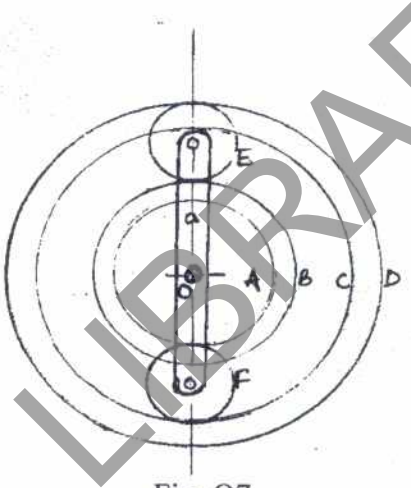

Fig. Q7

8 The following data relate to a cam profile in which the follower moves with UARM during ascent and descent.

Minimum radius of the cam = 25 mm

Roller diameter = 8 mm

Lift = 30 mm

Offset of follower axis = 10 mm towards right

Angle of ascent = 60°

Angle of descent = 90°

Angle of dwell between ascent and descent = 45°

Speed of the cam = 200 rpm

Draw the profile of the cam. **(20 Marks)**

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06ME45

Fourth Semester B.E. Degree Examination, May/June 2010
Manufacturing Processes – II

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. With a neat sketch, explain the various parameters which make up the tool signature of a single point cutting tool. **(08 Marks)**

b. Derive an expression for the shear angle in orthogonal cutting, in terms of rake angle and chip thickness ratio. **(08 Marks)**

c. Explain the functions of cutting fluids. **(04 Marks)**

2 a. Explain the factors which affect the machinbility of a material. **(08 Marks)**

b. A cast iron bar stock was turned at 50 m/min, for which the tool life was 3 hours. For the same material, at 40 m/min, the tool life was 5 hours. Find the value of constant c and n in the Taylor's tool life equation. Also, state the type of tool material based on the value of n. **(08 Marks)**

c. With neat sketches, explain flank and crater wear **(04 Marks)**

3 a. With the help of a neat sketch, explain the turret indexing mechanism. **(08 Marks)**

b. Explain the working of a hydraulic shaper mechanism, with a neat sketch. **(08 Marks)**

c. Compare shaper and planer in terms of their operation, type of workpiece and applications. **(04 Marks)**

4 a. Draw a neat diagram of a radial drilling machine. Name all the parts and explain the principle of operation. **(08 Marks)**

b. Explain the following operations, with simple sketches :
i) Reaming ; ii) Boring ; iii) Counterboring ; iv) Trepanning. **(08 Marks)**

c. Sketch and explain the nomenclature of a twist drill. **(04 Marks)**

PART – B

5 a. Differentiate between :
i) Up – milling and down milling
ii) Simple indexing and compound indexing. **(08 Marks)**

b. 69 teeth of a spur hear are to be cut around the periphery of a cylindrical blank. Recommend a suitable indexing mechanism. **(06 Marks)**

c. With a neat sketch, explain the working of an universal dividing head. **(06 Marks)**

6 a. Explain the centreless grinding process with a neat sketch. Also discuss the advantages and limitations of the same. **(08 Marks)**

b. Write a note on : i) Dressing and truing of grinding wheels ; ii) Wheel balancing. **(08 Marks)**

c. With an example, explain the specifications of a grinding wheel. **(04 Marks)**

7 a. Explain the following, with neat sketches : i) Honing ; ii) Lapping. **(10 Marks)**

b. List the factors which affect the lapping process. Discuss the influence of these parameters on lapping. **(10 Marks)**

8 a. Explain the principle of Laser Beam Machining [LBM], with a neat sketch. **(08 Marks)**

b. With a schematic diagram, explain the ultrasonic machining process [USM]. **(08 Marks)**

c. Discuss the applications and limitations of non – conventional machining processes over conventional machining processes. **(04 Marks)**

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06ME46B

Fourth Semester B.E. Degree Examination, May/June 2010
Fluid Mechanics

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Define the following terms with their units :
   i) Capillarity
   ii) Surface tension
   iii) Mass density
   iv) Pressure intensity
   v) Kinematic viscosity. **(10 Marks)**

   b. Derive the relation for pressure intensity and the surface tensile force, in case of soap bubble. **(04 Marks)**

   c. A steel shaft of 30 mm diameter rotates at 240 rpm, in a bearing of diameter 32 mm. Lubricant oil of viscosity 5 poise is used for lubricant of shaft in the bearing. Determine the torque required at the shaft and power lost in maintaining the lubrication. Length of bearing is 90 mm. **(06 Marks)**

2 a. State and prove Pascal's law. **(04 Marks)**

   b. Show that, for a submerged plane surface, the centre of pressure, lies below the centre of gravity of the submerged surface. **(08 Marks)**

   c. A differential mercury manometer is used for measuring the pressure difference between two pipes A and B. Pipe A is 500 mm above the pipe B and deflection in Hg manometer is 200 mm. Pressure intensity in pipe A is greater than pipe B. Pipes carry oil of specific gravity 0.90. Find the pressure difference between the two pipes. Sp.gr. of mercury = 13.6. **(08 Marks)**

3 a. Explain the importance of metacentre with stability of floating bodies. **(04 Marks)**

   b. A wooden block (barge) 6 mts in length, 4 mts in width and 3 mts deep, floats in fresh water with depth of immersion 1.5 mts. A concrete block is placed centrally on the surface of the wooden block, so that the depth of immersion with concrete is 2.8 mts. Find the volume of the concrete block placed centrally, if the specific gravity of concrete is 2.75. Find also the volume of water displaced. **(08 Marks)**

   c. Differentiate between :
   i) Steady flow and uniform flow ii) Laminar and turbulent flow
   ii) Streamline and streakline iv) Rotational and irrotational flow. **(08 Marks)**

4 a. Show that streamlines and equipotential lines are orthogonal to each other. **(04 Marks)**

   b. Torque developed by a disc of diameter D, rotating at a speed N is dependant on fluid viscosity 'μ' and fluid density 'ρ'. Obtain an expression for torque, $T = \rho N^2 D^5 \phi\left[\frac{\mu}{\rho N D^2}\right]$. **(08 Marks)**

   c. For a two dimensional fluid flow, velocity potential is $\phi = y + x^2 - y^2$. Find the stream function and velocity at a point P (2, 3). Check irrotationality of flow. **(08 Marks)**

PART – B

5 a. Derive Bernoulli's equation and state the assumptions made. Mention the statement of Bernoulli's equation. **(10 Marks)**

b. A pipe gradually tapers from a diameter of 0.4 mts to diameter 0.25 mts at the upper end. The pipe carries oil of specific gravity 0.90 and rate of flow is 45 kg/sec. Elevation difference between two sections is 5.0 metres. If the pressure intensities at the bottom and the upper sections are 225 kN/m^2 and 105 kN/m^2 respectively, find the direction of flow and also loss of head between the two sections. **(10 Marks)**

6 a. Sketch and derive the relation for actual discharge through an orifice meter. **(08 Marks)**

b. A pitot static probe measures the velocity of water flow through a pipe of diameter 7.5 cm. If the mean velocity of water flow is 6.5 m/sec and coefficient of pitot tube is 0.98, find deflection in mercury manometer connected across the pitot – tube. Determine the mass rate of water flow. **(08 Marks)**

c. List the types of losses, with a neat sketch and equations for head losses. **(04 Marks)**

7 a. Derive the relation for the pressure drop in a viscous flow through a circular pipe. **(10 Marks)**

b. Sketch the total energy line and the hydraulic gradient line for a pipeline connecting two reservoirs. **(04 Marks)**

c. A pipeline 50 m long, connects two reservoirs, having water level difference of 10m. Diameter of the pipe is 300 mm. Find rate of water flow, considering all the losses. Coefficient of friction for pipe material is 0.01. **(06 Marks)**

8 a. Explain following terms :

i) Lift
ii) Drag
iii) Boundary layer separation
iv) Momentum thickness
v) Displacement thickness. **(10 Marks)**

b. Derive a relation for the velocity of sound in a compressible fluid. **(06 Marks)**

c. Find the velocity of a bullet fired in the air, if the Mach angle is 30°. Temperature of air is 22°C, density of air is 1.2 kg/m^3. Assume $\gamma = 1.4$ and $R = 287$ J/kg K. **(04 Marks)**

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MATDIP401

Fourth Semester B.E. Degree Examination, May/June 2010
Advanced Mathematics – II

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. Find the projection of the line AB on CD where
$A = (1, 2, 3)$, $B = (-1, 0, 2)$, $C = (1, 4, 2)$, $D = (2, 0, -1)$. **(06 Marks)**

b. Find the angle between two lines whose direction cosines are given by $l + 3m + 5n = 0$ and $2mn - 6nl - 5lm = 0$. **(07 Marks)**

c. A line makes angles $\alpha, \beta, \gamma, \delta$ with diagonals of a cube. Prove that
$\cos^2\alpha + \cos^2\beta + \cos^2\gamma + \cos^2\delta = \frac{4}{3}$. **(07 Marks)**

2 a. Find the equation of the plane passing through the points (3, 1, 2) and (3, 4, 4) and perpendicular to $5x + y + 4z = 0$. **(06 Marks)**

b. Show that the points (2, 2, 0), (4, 5, 1), (3, 9, 4) and (0, -1, -1) are coplanar. Find the equation of the plane containing them. **(07 Marks)**

c. Find the equation of a straight line through (7, 2, -3) and perpendicular to each of the lines.
$\frac{x-2}{3} = \frac{y-3}{4} = \frac{z-4}{5}$ and $\frac{x+2}{4} = \frac{y-3}{5} = \frac{z-4}{6}$. **(07 Marks)**

3 a. Show that the position vectors of the vertices of a triangle $\vec{a} = 3\left(\sqrt{3}\,\hat{i} - \hat{j}\right)$, $\vec{b} = 6\hat{j}$ $\vec{c} = 3\left(\sqrt{3}\,\hat{i} + \hat{j}\right)$ form an isosceles triangle. **(06 Marks)**

b. A particle moves along the curve $\vec{r} = 3t^2\hat{i} + (t^3 - 4t)\hat{j} + (3t + 4)\hat{k}$. Find the components of velocity and acceleration at $t = 2$ in the direction $\hat{i} - 2\hat{j} + 2\hat{k}$. **(07 Marks)**

c. Find the angle between the normals to the surfaces $x^2y^2 = z^4$ at (1, 1, 1) and (3, 3, -3). **(07 Marks)**

4 a. Find the directional derivatives of the function $\phi = xyz$ along the direction of the normal to the surface $xy^2 + yz^2 + zx^2 = 3$ at the point (1, 1, 1). **(06 Marks)**

b. Find the div $\vec{F}$ and curl $\vec{F}$ where $\vec{F} = \nabla(x^3 + y^3 + z^3 - 3xyz)$. **(07 Marks)**

c. If $\vec{v} = 2xy\,\hat{i} + 3x^2y\,\hat{j} - 3ayz\,\hat{k}$ is solenoidal at (1, 1, 1), find a. **(07 Marks)**

5 a. Find the unit normal vector to the surface $xy + x + zx = 3$ at (1, 1, 1). **(06 Marks)**

b. Find the constants 'a', 'b', 'c' such that the vector field
$(\text{Sin } y + az)\ \hat{i} + (bx \text{ Cos } y + z)\ \hat{j} + (x + cy)\ \hat{k}$
is irrotational. Also find the scalar field ϕ such that $\vec{F} = \nabla\phi$. **(07 Marks)**

c. Prove that $\nabla^2 (\log r) = \frac{1}{r^2}$ where $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$ and $r = \left|\vec{r}\right|$. **(07 Marks)**

6 a. Find the Laplace transform of Sin 2t Sin 3t. **(05 Marks)**

b. Find $L\left[\frac{(1 - e^t)}{t}\right]$. **(05 Marks)**

c. Find $L\left[e^{-t}(3 \text{ Sinh } 2t - 2 \text{ Cosh } 3t)\right]$. **(05 Marks)**

d. Find the Laplace transform of $f(t) = \begin{cases} t/\lambda & \text{when } 0 < t < \lambda \\ 1 & \text{when } t > \lambda \end{cases}$. **(05 Marks)**

7 a. Evaluate $\int_0^\infty \frac{\text{Sin}t}{t} dt$ using Laplace transform. **(05 Marks)**

b. Find the inverse Laplace transform of $\frac{1}{(s^2 + 3s + 2)(s + 3)}$. **(05 Marks)**

c. Find $L^{-1}\left[\frac{s - 1}{s^2 - 6s + 25}\right]$. **(05 Marks)**

d. Find $L^{-1}\left[\log\left\{\frac{s^2 + 1}{s^2 - s}\right\}\right]$. **(05 Marks)**

8 a. Find $L^{-1}\left[\frac{1}{s^2(s + 5)}\right]$ using convolution theorem. **(10 Marks)**

b. Solve the differential equation $y'' + 2y' + y = 6te^{-t}$ under the condition $y(0) = 0 = y'(0)$ using Laplace transform. **(10 Marks)**

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