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10MAT41

Fourth Semester B.E. Degree Examination, Dec.2014/Jan.2015
Engineering Mathematics – IV

Time: 3 hrs. Max. Marks:100

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

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – A

1 a. Employ Taylor's series method to find an approximate solution to find y at x = 0.1 given $\frac{dy}{dx} = x - y^2$, y(0) = 1 by considering upto fourth degree term. **(06 Marks)**

b. Solve the following by Euler's modified method $\frac{dy}{dx} = \log(x+y)$, y(0) = 2 to find y(0.4) by taking h = 0.2. **(07 Marks)**

c. Given $\frac{dy}{dx} = x^2(Hy)$ and y(1) = 1, y(1.1) = 1.233, y(1.2) = 1.548, y(1.3) = 1.979. Evaluate y(1.4) by Adams-Bash forth method. Apply corrector formula twice. **(07 Marks)**

2 a. Solve $\frac{dy}{dx} = 1 + xz$ and $\frac{dz}{dx} = -xy$ for x = 0.3 by applying Runge Kutta method given y(0) = 0 and z(0) = 1. Take h = 0.3. **(06 Marks)**

b. Use Picard's method to obtain the second approximation to the solution of $\frac{d^2y}{dx^2} - x^3\frac{dy}{dx} - x^3y = 0$ given y(0) = 1, y'(0) = 0.5. Also find y(0.1). **(07 Marks)**

c. Apply Milne's method to compute y(0.4) given y'' + xy' + y = 0, y(0) = 1, y'(0) = 0, y(0.1) = 0.995, y'(0.1) = -0.0995, y(0.2) = 0.9802, y'(0.2) = -0.196, y(0.3) = 0.956 and y'(0.3) = -0.2863. **(07 Marks)**

3 a. Derive Cauchy-Riemann equation in Cartesian form. **(06 Marks)**

b. Find an analytic function f(z) whose real part is $\frac{\sin 2x}{\cosh 2y - \cos 2x}$ and hence find its imaginary part. **(07 Marks)**

c. If f(z) is a holomorphic function of z, then show that $\left\{\frac{\partial}{\partial x}|f(z)|\right\}^2 + \left\{\frac{\partial}{\partial y}|f(z)|\right\}^2 = |f'(z)|^2$. **(07 Marks)**

4 a. Discuss the transformation $w = z + \frac{1}{z}$. **(06 Marks)**

b. Find the BLT which maps the points z = 1, i, -1 to w = i, 0, -i. Find image of $|z| < 1$. **(07 Marks)**

c. Evaluate $\int_C \left\{\frac{\sin \pi z^2 + \cos \pi z^2}{(z-1)^2(z-2)}\right\} dz$ where 'C' is circle $|z| = 3$. **(07 Marks)**

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PART – B

5 a. Express $f(x) = x^4 + 3x^3 - x^2 + 5x - 2$ interms of Legendre polynomials. **(06 Marks)**

b. Obtain the solution of $x^2y'' + xy' + (x^2 - x^2)\,y = 0$ interms of $J_n(x)$ and $J_{-n}(x)$. **(07 Marks)**

c. Derive Rodrique's formula $P_n(x) = \frac{1}{2^n \lfloor n} \frac{d}{dx^n}[(x^2-1)^x]$. **(07 Marks)**

6 a. State the axioms of probability. For any two events A and B, prove that, $P(A \cup B) = P(A) + P(B) - P(A \cap B)$. **(06 Marks)**

b. A box 'A' contains 2 white and 4 black balls. Another box 'B' contains 5 white and 7 black balls. A ball is transferred from the box A to the box B. Then a ball is drawn from the box B. Find the probability that it is white. **(07 Marks)**

c. In a certain college 4% of the boys and 1% of girls are taller than 1.8m. Further more 60% of the students are girls. If a student is selected at random and is found to be taller than 1.8m, what is the probability that the student is a girl? **(07 Marks)**

7 a. The probability density of a continuous random variable is given by $p(x) = y_0 e^{-|x|}, -10 < x < \infty$. Find y_0. Also find the mean. **(06 Marks)**

b. Obtain the mean and variance of binomial distribution. **(07 Marks)**

c. In a test on 2000 electric bulbs, it was found that the life of a particular make was normally distributed with an average life of 2040 hours and SD of 60 hours. Estimate the number of bulbs likely to burn for.

i) More than 2150 hours.

ii) Less than 1950 hours.

iii) More than 1920 hours but less than 2160 hours.

Given A(1.5) = 0.4332, A(1.83) = 0.4664, A(2) = 0.4772. **(07 Marks)**

8 a. In a city 'A' 20% of a random sample of 900 school boys had a certain slight physical defect. In another city B, 18.5% of a random sample of 1600 school boys had the same defect. Is the difference between the proportions is significant? Why? **(06 Marks)**

b. A manufacturer claimed that atleast 95% of the equipment which he supplied to a factory conformed to specifications. An examination of a sample of 200 pieces of equipment revealed that 18 of them were faulty. Test his claim at a significance level of 1% and 5%. **(07 Marks)**

c. A set of five similar coins is tossed 320 times and the result is

No. of heads	0	1	2	3	4	5
Frequency	6	27	72	112	71	32

Test the hypothesis that the data follow a binomial distribution $\left[\chi^2_{0.05} = 11.07 \text{ for } 5df\right]$. **(07 Marks)**

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10ME42B/AU42B/TL42

Fourth Semester B.E. Degree Examination, Dec.2014/Jan.2015
Mechanical Measurements and Metrology

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting atleast TWO questions from each part.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – A

1 a. Define metrology. What are the objectives of metrology? **(05 Marks)**

b. Explain "Imperial standard yard" and "International prototype meter", with neat sketches. **(10 Marks)**

c. A calibrated meter end bar has an actual length of 1000.0002 mm. It is used in calibration of two bars A and B, each having a basic length of 500 mm. When compared with the meter bar $L_A + L_B$ was found to be shorter by 0.0003 mm. In comparing A and B, it was found that A was 0.0004 mm longer than B. Find the actual length of A and B. **(05 Marks)**

2 a. Differentiate : i) unilateral and bilateral tolerances ii) clearance fit and interference fit. **(06 Marks)**

b. Determine the dimensions of shaft and hole for a fit 30 H_7f_8. The given data are : $i = 0.45\sqrt[3]{D} + 0.001D$ microns. Fundamental deviation for f shaft is $-5.5D^{0.41}$ microns, 30 mm falls in the diameter step of 18 and 30. Tolerance grade for IT_7 and IT_8 are 16i and 25i respectively. Also design plug gauge to check the above hole. Take wear allowance as 10% of the gauge tolerance. **(10 Marks)**

c. Explain : i) Shaft basis system ii) Hole basis system. **(04 Marks)**

3 a. With a neat sketch, explain the construction and working of Johannson Mikrokator comparator. **(08 Marks)**

b. Explain with a neat sketch, the working of Solex pneumatic comparator. What are its advantages? **(08 Marks)**

c. Explain the principle of sine bar. **(04 Marks)**

4 a. With a neat sketch, explain the working principle of an autocollimator. **(06 Marks)**

b. Define "Effective diameter". Explain the 3-wire method of finding the effective diameter of screw threads. **(08 Marks)**

c. Explain with a sketch, how the chordal thickness is measured by using gear tooth vernier caliper. **(06 Marks)**

PART – B

5 a. Define measurement. With a block diagram, explain the generalized measurement system with a suitable example. **(08 Marks)**

b. Define the following terms : i) precision ii) hysteresis iii) sensitivity. **(06 Marks)**

c. Explain the principle of capacitive type electrical transducer. With a sketch explain any one type of capacitive transducer. **(06 Marks)**

6 a. Explain the inherent problems present in mechanical modifying system. **(06 Marks)**

b. With a block diagram, explain the general telemetering system. **(06 Marks)**

c. Explain with neat sketches : i) stylus type oscillograph ii) x – y – plotter. **(08 Marks)**

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7 a. Sketch and explain the analytical balance (equal arm balance). **(08 Marks)**

b. Explain how the torque is measured using prony brake dynamometer. What are its disadvantages? **(06 Marks)**

c. Describe the working principle of pirani gauge with a sketch. **(06 Marks)**

8 a. State the laws of thermocouples. **(04 Marks)**

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

c. Define gauge factor. Explain the wheat stone bridge arrangement for strain measurement. **(08 Marks)**

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10ME/AU43

Fourth Semester B.E. Degree Examination, Dec.2014/Jan.2015
Applied Thermodynamics

Time: 3 hrs. Max. Marks:100

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

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – A

1 a. Define:
i) Enthalpy of formation.
ii) Enthalpy of combustion.
iii) Stoichiometric air.
iv) Excess air and
v) Adiabatic flame temperature. **(10 Marks)**

b. The products of combustion of an unknown hydro carbon C_xH_y have the following composition as measured by an orsat apparatus: CO_2 = 8.0%, CO = 0.9%, O_2 = 8.8%, N_2 = 82.3%.
Determine:
i) The composition of the fuel.
ii) The air/fuel ratio and
iii) The percent excess air used. **(10 Marks)**

2 a. With the help of P-V and T-S diagrams, derive an expression for the air standard efficiency of diesel cycle. **(10 Marks)**

b. An ideal diesel cycle running at 2000rpm, has a compression ratio of 20 and uses air as the working fluid. The state of air at the beginning of the compression process is 95kPa and 20°C. If the maximum temperature in the cycle is not to exceed 2200K, Determine: i) Thermal efficiency; ii) Mean effective pressure; iii) Net work output per unit mass of air; iv) Specific air consumption in kg/s and Take density air = 1.225 kg/m^3. **(10 Marks)**

3 a. Explain briefly Morse test. **(06 Marks)**

b. Explain the heat balance sheet. **(04 Marks)**

c. A 4 cylinder gasoline engine operates on a 4 stroke cycle. The base of each cylinder is 70mm and the stroke is 90mm. Clearance volume per cylinder is 70CC. At a speed of 3500 rpm, the fuel consumption is 20 kg/hr and torque developed is 150N-m. Calorific value of fuel is 42000 kJ/kg. IP of the engine is 72 kW. Calculate BP, BMEP, brake thermal efficiency, relative efficiency and ISFC. **(10 Marks)**

4 a. With the help of a schematic diagram and T-S diagram, explain the working of a regenerative vapour power cycle and derive an expression for the overall efficiency. **(08 Marks)**

b. An ideal Rankine cycle with reheat is designed to operate according to the following specification:
Steam at boiler outlet 150bar and 550°C.
Reheat at 40 bar to 550°C.
Condensor pressure -0.100 bar.
Using the Molier chart find:
i) Quality at turbine exit; ii) Cycle efficiency and iii) Steam rate. **(12 Marks)**

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PART – B

5 a. Derive an expression for the minimum work input to a two stage compressor with perfect inter cooling between the stages. Also derive an expression for the ideal intermediate pressure for the same. **(10 Marks)**

b. A two stage air compressor with complete intercooling delivers air to the mains at a pressure of 30bar. Suction conditions are 1 bar and 15°C. If both cylinders have same stroke find ratio of cylinder diameter for maximum efficiency. **(10 Marks)**

6 a. Derive an expression for the optimum pressure ratio for the maximum network output in a brayton cycle. **(06 Marks)**

b. With the help of a schematic layout, explain the working of turbo prop jet engine. **(04 Marks)**

c. A gas turbine plant has temperature limit 1000°C and 10°C Compression and expansion process are isentropics. Determine:

i) Pressure ratio which will give the maximum net workout put.
ii) Maximum net specific work output.
iii) Thermal efficiency of maximum work out put.
iv) Carnot efficiency within the cycle temperature limits take $\gamma = 1.4$, CP = 1.005 kJ/kg K. **(10 Marks)**

7 a. With a neat sketch, explain the working of vapour absorption refrigeration system. **(06 Marks)**

b. Explain the effect of superheating and subcooling on the vapour compression cycle with the help of T-S and P-H diagrams. **(04 Marks)**

c. A R-12 vapour compression refrigeration plant is to develop 5 tonnes of refrigeration. The condensor and evaporator temperatures are to be +40°C and -10°C respectively. Determine: i) The flow rate of refrigerant in kg/s; ii) The volume flow rate handled by the compressor; iii) The compressor discharge temperature; iv) The pressure ratio; v) The heat rejected to the condenser in kW; vi) The flash gas percentage after throttling; vii) COP and viii)The power required to drive the compressor. **(10 Marks)**

8 a. Distinguish between:

i) Specific humidity and relative humidity.
ii) Dry bulb temperature and wet bulb temperature.
iii) Summer air conditioning and winter air conditioning. **(09 Marks)**

b. Atmospheric air at 1.0132 bar has a dbt of 32°C and a wbt of 26°C. Compute:

i) The partial pressure of water vapour.
ii) The specific humidity.
iii) The dew point temperature.
iv) The relative humidity.
v) The degree of saturation.
vi) The density of air in the mixture.
vii) The density of vapour in the mixture and
viii) The enthalpy of the mixture. **(11 Marks)**

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10ME/AU44

Fourth Semester B.E. Degree Examination, Dec.2014/Jan.2015
Kinematics of Machines

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. What do you mean by rigid link? Explain types of links with examples. **(06 Marks)**

b. Explain the following inversions with neat sketch:
   i) Double rocker mechanism.
   ii) Crank and slotted lever type quick return motion mechanism. **(10 Marks)**

c. Define degrees of freedom and state the relation for the same for planar mechanisms having only turning and sliding pairs. **(04 Marks)**

2 a. Sketch Peausellies mechanism and prove that it can trace a straight line. **(10 Marks)**

b. Explain pawl and ratchet wheel mechanism with neat sketch. **(05 Marks)**

c. With neat sketch, explain the conditions for correct steering for Ackermann-mechanism. **(05 Marks)**

3 a. What is Coriolis component of acceleration? Derive the expression for the same. **(08 Marks)**

b. A quick return motion mechanism is shown in Fig.Q.3(b). Link 2 rotates with constant speed of 21 rad/sec. in CW direction. Determine the angular acceleration of link 3. Take OA = 150mm, OC = 350mm, CB = 250mm. **(12 Marks)**

4 a. State and prove Kennedy's theorem. **(05 Marks)**

b. Locate all I-centers for the mechanism shown in Fig.Q.4(b). Find the velocity of the slider by I-center method W_2 = 20 r/s CCW. Take OA = 180mm, AB = 360mm, BC = 250mm and BD = 540mm. **(15 Marks)**

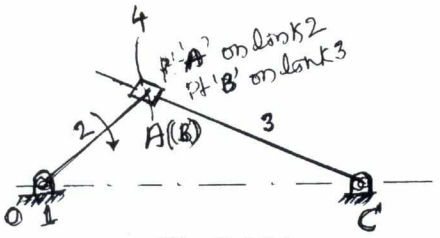

Fig.Q.3(b)

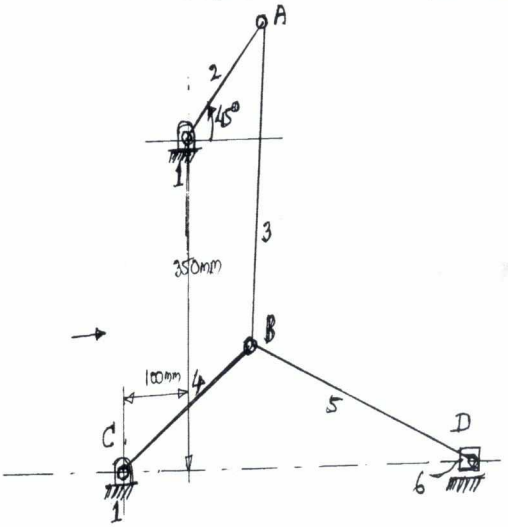

Fig.Q.4(b)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
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PART – B

5 a. Using complex algebra derive the expressions for velocity and acceleration of the piston for an in-line slider crank mechanism. **(10 Marks)**

b. For an in-line slider crank mechanism of crank length of 50mm, crank angle of 30° and connecting rod of length of 150mm. Determine the velocity and acceleration of the slider using complex algebra-method. Take the constant speed of crank as 2100rpm in CW direction. **(10 Marks)**

6 a. What is interference? Derive the relation for the minimum number of teeth for a pair of involute profile of teeth to avoid interference. **(10 Marks)**

b. The two spur gears of 19 and 47 teeth respectively are in mesh. The module is 6.5mm and pressure angle is 20°. Determine the number of pairs in contact and the angle turned by the larger wheel when one pair of teeth in contact. **(10 Marks)**

7 a. Explain reverted type gear train with sketch. **(05 Marks)**

b. An epicyclic gear train is shown in Fig.Q.7(b) Annular gear A is keyed to the driving shaft and has 30 teeth. Compound wheel C and D of 20 and 22 teeth respectively are free to rotate on the pin fixed to the arm P which is rigidly connected to the driven shaft. Internal gear B which has 32 teeth is fixed. If the driving shaft runs at 100rpm in CW. Find the speed of the driven shaft. What is the direction of rotation of the driven shaft with reference to the driving shaft? **(15 Marks)**

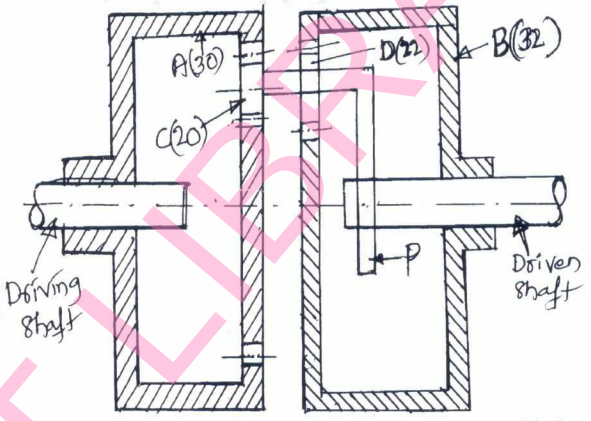

Fig.Q.7(b)

8 Draw the cam profile for the following data for a roller follower:

Offset	= 10mm towards right of cam center
Roller radius	= 10mm
Minimum radius of the cam	= 20mm
Maximum displacement of the follower	= 24mm
Outstroke angle	= 90° of cam rotation with UARM, acceleration being half of the retardation
Dwell at the elevated position	= 30° of cam rotation
Return stroke	= 90° of cam rotation with modified uniform velocity

After the return stroke cam dwells for the remaining period. Determine the maximum velocity and acceleration during outstroke only. Speed of cam is 600rpm in CW. **(20 Marks)**

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10ME/AU45

Fourth Semester B.E. Degree Examination, Dec.2014/Jan. 2015
Manufacturing Process – II

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting atleast TWO questions from each part.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
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PART – A

1 a. What are the assumptions made in Earnst – Merchant theory? **(02 Marks)**

b. Show that, $\phi = \frac{\pi}{4} - \frac{\beta}{2} + \frac{\alpha}{2}$, using Earnst – Merchant theory. **(08 Marks)**

c. In turning a steel rod by a given cutting tool at a given machining condition under a given environment, the tool life decreases from 80 min to 20 min due to increase in cutting velocity from 60 m/min to 120 m/min. At what cutting velocity, the tool life of that tool under the same condition and environment will be 40 minutes? **(06 Marks)**

d. Explain with sketches, flank wear and crater wear. **(04 Marks)**

2 a. Discuss about high – speed steels (HSS) and cemented carbide tool materials as regard to its composition, manufacturing and applications. **(12 Marks)**

b. What are the factors affecting temperature in metal cutting? Explain. **(06 Marks)**

c. List any four desirable properties of cutting tool material. **(02 Marks)**

3 a. With a neat sketch, explain crank and slotted link mechanism in a shaper. **(06 Marks)**

b. With a neat sketch, explain the parts of a turret lathe. **(08 Marks)**

c. Explain thread cutting operation in a lathe. **(06 Marks)**

4 a. Show the twist drill elements and drill angles using twist drill nomenclature. **(06 Marks)**

b. Explain straight cut and contouring NC systems. **(06 Marks)**

c. Discuss about preparatory functions and miscellaneous functions in a manual part programming. **(08 Marks)**

PART – B

5 a. What is indexing? Mention different methods of indexing. Briefly explain compound indexing method. **(08 Marks)**

b. Index 24 divisions on a work-piece using simple indexing. **(06 Marks)**

c. Explain any three milling operations. **(06 Marks)**

6 a. Explain any three grinding wheel characteristics / parameters. **(06 Marks)**

b. Briefly explain any five bonding processes. **(05 Marks)**

c. Sketch and explain surface grinding machine. **(05 Marks)**

d. Explain truing and dressing of grinding wheels. **(04 Marks)**

7 a. What is the principle of broaching? **(02 Marks)**

b. What are the advantages and limitations of broaching? **(04 Marks)**

c. Explain with neat sketches, lapping and super finishing processes. **(10 Marks)**

c. Explain any two broaching operations. **(04 Marks)**

8 a. What is the need of non – traditional machining (NTM)? **(04 Marks)**

b. Explain with neat sketches :

i) Electron beam machining

ii) Laser beam machining. **(16 Marks)**

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10ME/AU46B

Fourth Semester B.E. Degree Examination, Dec.2014/Jan.2015

Fluid Mechanics

Time: 3 hrs. Max. Marks:100

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

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
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PART – A

1 a. Define the following properties of fluid:
i) Density ii) Specific volume iii) Specific gravity
iv) Kinematic viscosity v) Capillarity **(05 Marks)**

b. The pressure outside the droplet of water of diameter 0.04 mm is 10.32 N/cm^2 (atmospheric pressure). Calculate the pressure within the droplet if surface tension is given as 0.0725 N/m of water. **(05 Marks)**

c. Calculate the capillary effect in mm in a glass tube of 4 mm diameter, when immersed in Hg. The temperature of liquid is 20°C and surface tension of Hg at 20°C in contact with air is 0.51 N/m. Angle of contact is 130° (specific gravity of Hg is 13.6). **(05 Marks)**

d. Determine the specific gravity of a fluid having viscosity 0.05 poise and kinematic viscosity 0.035 stokes. **(05 Marks)**

2 a. State and prove Pascal's law. **(05 Marks)**

b. The right limb of a simple U tube manometer containing Hg is open to the atmosphere while the left limb is connected to a pipe in which a fluid of specific gravity 0.9 is flowing. The centre of pipe is 12 cm below the level of Hg in the right limb. Find the pressure of fluid in the pipe if the difference of Hg level in two limbs is 20 cm. **(05 Marks)**

c. A caisson for closing the entrance to a dry dock is of trapezoidal form 16 m wide at the top and 10 m wide at bottom and 6 m deep. Find the total pressure and centre of pressure on the caisson, if the water on the outside is just level with the tap and dock is empty. **(10 Marks)**

3 a. Define: i) Buoyancy, ii) Centre of buoyancy, iii) Path line,
iv) Laminar flow, v) Turbulent flow. **(05 Marks)**

b. A body of dimensions 1.5m × 1.0m × 2m weighs 1962 N in water. Find its weight in air. What will be its specific gravity? **(05 Marks)**

c. A 25 cm diameter pipe carrier oil of specific gravity 0.9 at a velocity of 3 m/s. At another section the diameter is 20 cm. Find the velocity at this section and mass rate of flow of oil. **(10 Marks)**

4 a. What is Euler's equation of motion? How will you obtain Bernoulli's equation from it? **(10 Marks)**

b. The water is flowing through a taper pipe of length 100 m having diameters 600 mm at the upper end and 300 mm at the lower end, at the rate of 50 ℓt/s. The pipe has a slope of 1 in 30. Find the pressure at the lower end if the pressure at the higher level is 19.62 N/cm^2. **(10 Marks)**

PART – B

5 a. Sketch and derive the relation for actual discharge through an orifice meter. **(10 Marks)**

b. State Buckingham's π theorem. The efficiency η of a fan depends on density ρ, dynamic viscosity μ of the fluid, angular velocity ω, diameter D, discharge Q. Express η in terms of dimensionless parameters. **(10 Marks)**

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

b. Find the head lost due to friction in a pipe of diameter 300 mm and length 50 m through which water is flowing at a velocity of 3 m/s using: (i) Darcy's formula, (ii) Chezy's formula for which C = 60. **(10 Marks)**

7 a. Define Reynolds number. What is its significance? **(04 Marks)**

b. Derive Hagen Poisoulle's equation for viscous flow through a circular pipe. **(10 Marks)**

c. An oil of viscosity 10 poise flows between two parallel fixed plates which are kept at a distance of 50 mm apart. Find the rate of flow of oil between the plates if the drop of pressure in a length of 1.2 m be 0.3 N/cm^3. The width of plates is 200 mm. **(06 Marks)**

8 a. Explain terms: i) Lift; ii) Drag; iii) Displacement thickness; iv) Momentum thickness. **(08 Marks)**

b. Define the terms subsonic flow and supersonic flow. **(04 Marks)**

c. A flat plate 1.5m × 1.5m moves at 50 km/hr in stationery 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. **(08 Marks)**

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MATDIP401

Fourth Semester B.E. Degree Examination, Dec.2014/Jan.2015
Advanced Mathematics – II

Time: 3 hrs. Max. Marks:100

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

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
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1 a. If l, m, n are the direction cosines of a line then prove that $l^2 + m^2 + n^2 = 1$ **(06 Marks)**

b. Find angle between any two diagonals of a cube. **(07 Marks)**

c. Find angle between two lines whose direction cosines satisfy the equations, $l + m + n = 0$ and $2l + 2m - mn = 0$. **(07 Marks)**

2 a. With the usual notations derive the equation of the plane in the form $lx + my + nz = 0$. **(06 Marks)**

b. Find the equation of the plane through (1, 2, -1) and perpendicular to the planes $x + y - 2z = 5$ and $3x - y + 4z = 12$. **(07 Marks)**

c. Find the shortest distance between the lines,

$$\frac{x-6}{3} = \frac{y-7}{-1} = \frac{z-4}{1} \text{ and}$$

$$\frac{x}{-3} = \frac{y+9}{2} = \frac{z-2}{4}$$

(07 Marks)

3 a. Prove that $\vec{a} \times (\vec{b} \times \vec{c}) = \vec{b}(\vec{c} \cdot \vec{a}) - \vec{c}(\vec{a} \cdot \vec{b})$. **(06 Marks)**

b. Find the sine of angle between the vectors $\vec{a} = 2\hat{i} - 2\hat{j} + \hat{k}$ and $\vec{b} = \hat{i} - 2\hat{j} + 2\hat{k}$. **(07 Marks)**

c. Show that the vectors $\vec{a} = \hat{i} - 2\hat{j} + 3\hat{k}$, $\vec{b} = 2\hat{i} + \hat{j} + \hat{k}$ and $\vec{c} = 3\hat{i} + 4\hat{j} - \hat{k}$ are coplanar. **(07 Marks)**

4 a. Find the unit normal vector to the space curve $\vec{r} = 4\sin t\,\hat{i} + 4\cos t\,\hat{j} + 3t\,\hat{k}$. **(06 Marks)**

b. A particle moves along the curve $\vec{r} = \cos 2t\,\hat{i} + \sin 2t\,\hat{j} + t\,\hat{k}$. Find the velocity and acceleration at $t = \frac{\pi}{8}$ along $\sqrt{2}\,\hat{i} + \sqrt{2}\,\hat{j} + \hat{k}$. **(07 Marks)**

c. Find angle between the surfaces $x^2 + y^2 + z^2 = 9$ and $x = z^2 + y^2 - 3$ at (2, -1, 2) **(07 Marks)**

5 a. Find the directional derivative of x^2yz^3 at (1, 1, 1) in the direction of $\hat{i} + \hat{j} + 2\hat{k}$. **(06 Marks)**

b. If $\vec{F} = (x + y + 1)\hat{i} + \hat{j} - (x + y)\hat{k}$ then show that $\vec{F} \cdot \text{curl}\,\vec{F} = 0$ **(07 Marks)**

c. Show that the vector $\vec{F} = (3x^2 - 2yz)\hat{i} + (3y^2 - 2zx)\hat{j} + (3z^2 - 2xy)\hat{k}$ is irrotational. **(07 Marks)**

6 a. Prove that $L[\sin at] = \frac{a}{s^2 + a^2}$. **(05 Marks)**

b. Find $L[\sin t \sin 2t \sin 3t]$. **(05 Marks)**

c. Find $L[te^{-t} \sin 2t]$. **(05 Marks)**

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

7 a. If $L[f(t)] = \int_0^\infty e^{-st} f(t)dt$ then prove that $L[f''(t)] = s^2 L[f(t)] - sf(0) - f'(0)$. **(05 Marks)**

b. Find $L^{-1}\left[\frac{s+2}{s^2 - 4s + 13}\right]$. **(05 Marks)**

c. Find $L^{-1}\left[\frac{s+1}{(s-2)^3}\right]$. **(05 Marks)**

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

8 a. Using Laplace transform solve $y'' - 2y' + y = e^{2t}$ with $y(0) = 0$, $y'(0) = 1$. **(10 Marks)**

b. Using Laplace transform solve the simultaneous equation,

$$\frac{dx}{dt} + y = \sin t$$

$$\frac{dy}{dt} + x = \cos t$$

given that x(0)=1, y(0) = 0 **(10 Marks)**

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