2015-2016
B.TECH. AUTUMN (III SEMESTER) EXAMINATION
(CIVIL ENGINEERING)
MATHEMATICS - III
[AM 211]
Credit: 04

Max Marks: 60
Duration: Three Hours

Note:
(i) Answer all questions.
(ii) Start each part from new page.

1. (a) Find the directional derivative at (1, -2, 1) on sphere \( x^2 + y^2 + z^2 = 6 \) in the direction normal to the surface \( z = 2x^2 + y^2 - 3 \) at the same point.

(b) Show that \( \text{div} (\text{grad} f) = n (n+1) f^{n+2} \).

(c) Show that the vector field given by
\[
\vec{A} - \left(2xy + z^2\right)\hat{i} + \left(2yz + x^2\right)\hat{j} - \left(2xz + y^2\right)\hat{k}
\]
is irrotational. Find scalar function of \( f \) such that \( \vec{A} = \text{grad} f \).

OR

(c') Find the value of \( n \) for which the vector \( r^n \vec{r} \) is solenoidal, where, \( \vec{r} = x\hat{i} + y\hat{j} + z\hat{k} \).

2. (a) Evaluate \( \int \int_{S} \vec{A} \cdot d\vec{s} \), where \( \vec{A} = y\vec{i} + 2xz\vec{j} + xy\vec{k} \) and \( S \) is the surface of sphere \( x^2 + y^2 + z^2 = 1 \) in the first octant.

(b) Use Green's theorem in a plane to evaluate the integral \( \int_{C} \left(2x^2 - y^2\right)dx + \left(x^2 + y^2\right)dy \), where \( C \) is boundary in the xy plane of the area enclosed by X-axis and semi circle \( x^2 + y^2 = 1 \) in the upper half of XY-plane.

OR

(b') Verify Stokes' theorem for the function \( \vec{F} = x^2\hat{i} - xy\hat{j} \) integrated round the square in the plane \( z = 0 \) and bounded by the lines \( x = 0, y = 0, x = a \) and \( y = a \).

3. (a) If \( f(z) \) is an analytic function of \( z \) prove that
\[
\left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}\right) R\ell(z)^2 = 2|f'(z)|^2.
\]

(b) If \( w = z^2 = u + iv \) and \( u - v = (x^2 - y) (x^2 + 4xy + y^2) \), find \( w \) in terms of \( z \).

(c) Use Cauchy's integral formula to evaluate
\[
\int_{C} \frac{3z^2 + z}{z^2 + 1} \, dz,
\]
where \( C \) is circle \( |z| = 2 \).

Contd......2
4. (a) Form the partial differential equation by eliminating the arbitrary function from the relation \( f(xy + z^2, x + y + z) = 0 \)

(b) A tightly stretched violin string of length \( l \) and fixed at both ends is plucked at \( x = \frac{l}{3} \) and assumes initially the shape of a triangle of height \( a \). Find the displacement \( y \) at any distance \( x \) and any time \( t \) after the string is released from rest.

OR

(b') Show that the solution of differential equation \( \frac{\partial u}{\partial t} = k \frac{\partial^2 u}{\partial x^2} \), subject to the conditions:

(i) \( u \) not infinity for \( t \rightarrow \infty \)

(ii) \( \frac{\partial u}{\partial x} = 0 \) for \( x = 0 \) and \( x = l \)

(iii) \( u = \frac{4}{l^2} x - x^2 \) for \( l \rightarrow 0 \) between \( x = 0 \) and \( x = l \) is

\[
\frac{1}{6} k^2 - \frac{\partial^2}{\partial x^2} \sum_{n=1}^{\infty} \frac{1}{n^2} e^{\left(4n^2 \pi^2 \omega^2 / l^2\right)} \cos \frac{2n\pi x}{l}
\]

****
2015-16
B.TECH. (AUTUMN SEMESTER) EXAMINATION
CIVIL ENGINEERING
WATER SUPPLY AND SANITATION
AR 217

Maximum Marks: 60 Credits: 03 Duration: Three Hours

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

Q.No.          Question                                      M.M.
1(a)          Discuss in detail the chemical water quality parameters  [60]
1(b)          With the help of sketches describe the various layout of water distribution piping networks  [60]

OR

1'          Briefly describe the graphical method used for the determination of capacity of overhead tanks. Following table gives the variations in water demand. Using any one of the methods calculate the capacity of storage tank to meet out the variations in water demand if the pumps are operated from 4.0 a.m. to 10.0 a.m. and from 3.0 p.m. to 9.0 p.m.

<table>
<thead>
<tr>
<th>Time (hours)</th>
<th>Water demand (10^3 L.)</th>
<th>Time (hours)</th>
<th>Water demand (10^3 L.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midnight to 1.0 a.m.</td>
<td>15</td>
<td>12.0 - 13.0</td>
<td>95</td>
</tr>
<tr>
<td>1.0 - 2.0</td>
<td>15</td>
<td>13.0 - 14.0</td>
<td>110</td>
</tr>
<tr>
<td>2.0 - 3.0</td>
<td>20</td>
<td>14.0 - 15.0</td>
<td>105</td>
</tr>
<tr>
<td>3.0 - 4.0</td>
<td>40</td>
<td>15.0 - 16.0</td>
<td>100</td>
</tr>
<tr>
<td>4.0 - 5.0</td>
<td>60</td>
<td>16.0 - 17.0</td>
<td>110</td>
</tr>
<tr>
<td>5.0 - 6.0</td>
<td>80</td>
<td>17.0 - 18.0</td>
<td>100</td>
</tr>
<tr>
<td>6.0 - 7.0</td>
<td>90</td>
<td>18.0 - 19.0</td>
<td>90</td>
</tr>
<tr>
<td>7.0 - 8.0</td>
<td>100</td>
<td>19.0 - 20.0</td>
<td>100</td>
</tr>
<tr>
<td>8.0 - 9.0</td>
<td>130</td>
<td>20.0 - 21.0</td>
<td>110</td>
</tr>
<tr>
<td>9.0 - 10.0</td>
<td>110</td>
<td>21.0 - 22.0</td>
<td>80</td>
</tr>
<tr>
<td>10.0 - 11.0</td>
<td>100</td>
<td>22.0 - 23.0</td>
<td>60</td>
</tr>
<tr>
<td>11.0 - 12.0</td>
<td>90</td>
<td>23.0 Midnight</td>
<td>40</td>
</tr>
</tbody>
</table>

Contd.....2.
2 (a) Draw the water treatment flowsheets for surface and subsurface sources of water supplies. [02]

2 (b) Derive the equations used for the determination of terminal settling velocities. Find the terminal settling velocity of a particle of diameter 0.4 mm and specific gravity 2.65 settling in water. Assume dynamic viscosity of water as $1.002 \times 10^{-3} \text{ N} \cdot \text{s/m}^2$. [06]

2 (c) Draw breakpoint chlorination curve and explain its significance in water treatment. [04]

3 (a) Differentiate between separate and combined sewerage system. [64]

3 (b) What is the objective of secondary treatment in wastewater treatment? Briefly describe the different systems used for secondary treatment. [06]

3 (c) Differentiate between velocity and displacement types of water meters. [02]

OR

3'(a) Briefly explain the precautions to be taken while using wastewater for irrigation purpose. [04]

3'(b) What are the different types of sanitary appliances used these days? Give the specifications of each. [08]

4 (a) Briefly explain wastewater collection systems. [04]

4 (a) With the help of neat sketches describe the various building plumbing systems. [08]

5(a) Design a septic tank for 50 users assuming wastewater contribution per person as 50 l/d and period of cleaning as two years. [04]

5 (b) Explain the functioning of a Bell type of Cistern. [04]

5 (c) Briefly describe the different types of sewers and drainage pipes (based on materials). [04]
2015
B. TECH. (AUTUMN SEMESTER) EXAMINATION
CIVIL ENGINEERING
CIVIL ENGINEERING MATERIALS
CE-212

Maximum Marks: 60
Credits: 04
Duration: Three Hours

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

Q.No. Question
1(a) What is the significance of heat of hydration? How is it determined in the laboratory?
1(b) Discuss classification of aggregate based on their geological origin and size.

OR

1' Write notes on the following:
   (i) L.S. Sand
   (ii) Rapid hardening and low heat Portland cement
   (iii) Soundness test on cement
   (iv) Bulkling of fine aggregate

2(a) Define workability and also explain the factors affecting it.
2(b) How the modulus of rupture of concrete is determined? Explain.
2(c) Explain w/c ratio and curing of concrete
3 (a) Describe the classifications of bricks.
3 (b) Describe the tests performed to check the quality of bricks.
4 (a) Discuss the various defects in timber with neat diagram.
4 (b) What are the various tests on timber? Describe in detail the tests performed to determine moisture content and specific gravity of timber.

OR

4' (a) What do you understand by preservation of timber? Describe the methods of preservation of timber.
4' (b) Write short notes on the following
   (i) Plywood
   (ii) Block Board
   (iii) Fiber Board

5 (a) What is the use of glass in building construction? Describe the functions of constituents of glass.
5 (b) Define plastic. Describe the functions of constituents of plastic.
2015-16
B.TECH. (AUTUMN SEMESTER) EXAMINATION
CIVIL ENGINEERING
FLUID MECHANICS (CE-213)

Maximum Marks: 60
Credits: 04
Duration: Three Hours

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

<table>
<thead>
<tr>
<th>Q. No.</th>
<th>Question</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a)</td>
<td>Explain Newtonian and non-Newtonian fluids giving few examples of each.</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>A steel plate with square base area weighing 320 N slides with a constant speed of 1.0 m/s on an inclined plane surface (4H.3V). The gap between the plate and the surface is 2 mm and is filled with a lubricating oil (dynamic viscosity = 3 poise). Find the size of the plate.</td>
<td></td>
</tr>
<tr>
<td>1(b)</td>
<td>Explain local and convective accelerations. For a curved stream line show that the total tangential acceleration is given ( a_t = \frac{\partial v}{\partial r} + v \frac{\partial a}{\partial r} ).</td>
<td>10</td>
</tr>
<tr>
<td>1(c)</td>
<td>If ( u = 2xy ) and ( v = xy^2 ), check whether the flow is potential.</td>
<td>07</td>
</tr>
</tbody>
</table>

OR

| Q1'(a) | Differentiate between circulation and vorticity.                         |       |
|        | If velocity distribution in a given flow field is defined as \( V = x^2y + 2xyz + 2tk \) |       |
|        | Find (i) Acceleration along \( x \)-direction at \( P(1,1,1) \) and \( t = 1 \) unit | 03    |
|        | (ii) Rotation component along \( y \)-direction at \( Q(1,2,1) \) and \( t = 2 \) units |       |
|        | (iii) Vorticity along \( z \)-direction at \( R(1,2,3) \) and \( t = 3 \) units |       |
| 1'(b)  | What is a flow net? What are its utilities?                             | 07    |
|        | If velocity potential is defined as \( \phi = -x^2 - y^2 - \frac{z^2}{2} \), determine stream function \( \phi \). |       |
| 2(a)   | Classify manometers. For the manometer arrangement shown in Fig. 1 there is flow of water from \( A \) towards \( B \). If, the manometer reading \( h = 5 \) cm, calculate the pressure difference \( (p_A - p_B) \). | 04    |
| 2(b)   | A flash board is held in place by two stops as shown in Fig. 2. Determine the distance \( \rho \) between them so that the flash board will tumble when water reaches to 3m depth. | 13    |
| 2(c)   | Determine the magnitude and lines of action of horizontal and vertical components of force acting on radial gate shown in Fig. 3. The gate has 2.5 m radius and 3 m length into the paper. | 13    |

Could... 2.
<table>
<thead>
<tr>
<th>Question</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2(a)</td>
<td>List the various forces that temporarily cause heeling of floating bodies.</td>
</tr>
<tr>
<td>2(b)</td>
<td>A cylindrical buoy 2m in diameter and 1.5m in height weighing 12kN floats with its axis vertical in water ( \rho = 1020 \text{kg/m}^3 ). Centre of gravity of buoy is 0.65 m above the bottom. If a cylindrical load of 2kN is placed on its top symmetrically, find the maximum height of centre of gravity of this load above the bottom if the buoy is to remain in just stable equilibrium.</td>
</tr>
<tr>
<td>2(c)</td>
<td>An open cylindrical tank of diameter 2R and height H is completely filled with water with its axis vertical and is rotated about its axis at an angular velocity ( \omega ). Determine ( \omega ) such that the central portion of bottom of diameter R is exposed to atmosphere.</td>
</tr>
<tr>
<td>Q3(a)</td>
<td>List out all assumptions of Bernoulli's theorem. What is the value of energy correction factor for laminar and turbulent flows in closed conduits? Water is flowing through a siphon as shown in Fig. 4. Find the flow rate in the siphon. What is the pressure at point B? If minimum pressure allowable in the siphon is 70 kN/m² vacuum, what should be the maximum elevation of B above A.?</td>
</tr>
<tr>
<td>Q3(b)</td>
<td>What is momentum correction factor? What are its values for laminar and turbulent flows for pipes? For a two dimensional water jet deflected as shown in Fig. 5, determine the components of hydrodynamic force on the block.</td>
</tr>
<tr>
<td>Q3(c)</td>
<td>Write torque equation. For a frictionless shaft in the rotating sprinkler as shown in Fig. 6, equal discharge flows through each nozzle (relative velocities = 10 m/s), find the speed of rotation in rpm.</td>
</tr>
<tr>
<td>Q4(a)</td>
<td>Classify mouthpieces. Why an external cylindrical mouthpiece discharges more than an orifice having same diameter and working under same head?</td>
</tr>
<tr>
<td>Q4(b)</td>
<td>A tank in the form of hemisphere having radius 2m is completely filled with water. It is to be emptied using an orifice of diameter 5cm fitted at its bottom. Determine the time of emptying if ( C_o ) is 0.62.</td>
</tr>
<tr>
<td>Q4(e)</td>
<td>A 3.5m wide channel is to be provided with a contracted sharp crested weir of 1.2m height running free. If a maximum of 4 m³/s water discharge is to be passed over the weir with upstream depth not exceeding 2.25m, what should be the length of the weir? Also consider velocity of approach.</td>
</tr>
</tbody>
</table>
2015-2016
B. TECH. AUTUMN (III SEMESTER) EXAMINATION
(CIVIL ENGINEERING)
ENGINEERING GEOLOGY
(CE – 215)

MAXIMUM MARKS: 60
Credits: 04
Duration: Three Hours

Note: Answer all questions.

1. Give detailed classification of rocks. Discuss important structural, textural features and uses of two rocks each from the three major rock groups. (12)

2. What do you understand by exogenous processes? What are the different agencies which carry out these works? Enumerate civil engineering aspect of this process. (12)

OR

2’ Discuss the classification and role of joints in engineering classification of rock mass. (12)

3. Define different types of aquifers. How water is distributed under the ground, explain with the help of a diagram. (12)

4. Give a brief account of earthquakes. Enumerate associated hazards. What are the methods and measures to mitigate the problems of earthquakes? (12)

OR

4’ Give a classification scheme for tunnels. Discuss important geomorphological and geological factors taken into consideration during designing and construction of the tunnels. (12)

5. Write short notes on any two of the followings:
   a. Physico-mechanical properties of rocks in construction industry (06)
   b. Rock Quality Designation (06)
   c. Terzaghi’s Rock Load Theory (06)
   d. Unconformity (06)
2015-16
B.TECH. EXAMINATION
CIVIL
Structural Mechanics CE 216
B. Tech. II (Civil) (Graduating Course)

Maximum Marks: 60
Credits: 04
Duration: Three Hours

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

Q. No.

1(a) A masonry dam of trapezoidal section with 2m width at top and 7.5m wide at bottom, with water face vertical is 10 m high and filled with 9m depth of water, keeping 1m free board. Calculate extreme stresses at base of the dam. Assume unit weight of masonry and water as 21 kN/m³ and 10 kN/m³ respectively. [06]

1(b) A cylindrical shell 3 m long, closed at the ends, has an internal diameter of 1 m and a wall thickness of 20 mm. Calculate the circumferential and longitudinal stresses induced and also change in the dimensions of the shell if it is subjected to an internal pressure of 1.5 MN/m². Take: Young's modulus = 200 GN/m² and Poisson's ratio = 0.3 [06]

OR

1' Calculate force in members AB, BE, FE and BF of the cantilever frame shown in Fig. 1.

[12]

Contd.....2.
2. The principal stresses at point in a wall are given as follows.

\[ \sigma_{xx} = -30 \text{ N/mm}^2, \quad \sigma_{yy} = +20 \text{ N/mm}^2 \text{ and } \tau_{xy} = 7 \text{ N/mm}^2. \]

Calculate stresses on a plane perpendicular to which is inclined to axis by 30° in clockwise direction. Also locate the principal planes and planes maximum shear and calculate principal stresses.

3(a) A steel girder of 6 m length acting as a beam carries a uniformly distributed load \( w \) N/m run through its entire length. If \( l = 30 \times 10^6 \text{ m}^3 \) and depth 270 \( \text{mm} \), calculate:

(i) The magnitude of \( w \) so that the maximum stress developed in the beam section does not exceed 72 \( \text{MN/m}^2 \).

(ii) The slope at the support and deflection at the mid-span under this load.

3(b) A cantilever of span \( 'L' \) is subjected to a uniformly varying load of intensity zero at the free end and \( 'w' \) at the fixed end. Find slope and deflection at the free end of the cantilever using the method of double integration. Take flexural rigidity \( EI \) as uniform throughout.

OR

3' A horizontal beam rests on two supports at the same level and carries a uniformly distributed load on its entire span as shown in Fig. 2. Find the ratio of \( L_1 \) to \( L_2 \) if the deflection at the mid-span is equal to that at each end.

![Fig. 2](image)

4. Using Castigliano’s theorem, determine slope at support \( A \) and deflection at \( C \) for a simply supported beam as shown in Fig. 3. Assume \( E = 2 \times 10^4 \text{ N/mm}^2, I = 1 \times 10^6 \text{ mm}^4 \) and \( v = 0.3 \).
5(a) A cast iron hollow cylindrical column 4m in length when hinged at both the ends, has a critical buckling load of $P \text{ kN}$. When the column is fixed at both the ends, its critical load rises to $(P + 35000) \text{ kN}$. If the ratio of external diameter to internal diameter is 1.50 and $E = 1.0 \times 10^5 \text{ N/mm}^2$, determine the external diameter of the column.

5(b) Determine the ratio of the buckling strengths of a solid steel column to that of a hollow column of the same material and having the same cross-sectional area. The internal diameter of the hollow column is $\frac{3}{4}$ of its external diameter. Both the columns are of the same length and are fixed at both ends.

OR

5' A slender column is built-in at one end and an eccentric load is applied at the free end. Working from the first principles, find the expression for the maximum length of column such that the deflection of the free end does not exceed the eccentricity of loading.
2015-16
B.TECH. (AUTUMN SEMESTER) EXAMINATION
CIVIL ENGINEERING
SURVEYING-I
CE 218

Maximum Marks: 60
Credits: 04
Duration: Three Hours

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

Q. No.  
1 (a) What are the principles of surveying? Explain.  [04]
1 (b) A 20 m chain was found to be 15 cm too long after chaining a distance of 1600 m. It was found to be 30 cm too long after chaining a distance of 3000 m. Determine the correct distance if the chain was correct before the commencement of the work.  [08]

OR

1' (a) What do you mean by reciprocal ranging? Explain.  [04]
1' (b) To continue a survey line AB past an obstacle, a line BC 100 metres long was set out perpendicular to AB, and from C angles BCD and BCE were set out at 60° and 45° respectively. Determine the lengths which must be chained off along CD and DE in order that ED may be in line AB produced. Also determine the obstructed length BH.  [08]

2 (a) Briefly describe the process of orientation of plane table by back sighting method.  [04]
2 (b) The following bearings were observed in running a closed traverse with a compass.  [08]

<table>
<thead>
<tr>
<th>Line</th>
<th>Observed Bearings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Front bearing</td>
</tr>
<tr>
<td>AB</td>
<td>76° 05'</td>
</tr>
<tr>
<td>BC</td>
<td>114° 20'</td>
</tr>
<tr>
<td>CD</td>
<td>165° 35'</td>
</tr>
<tr>
<td>DE</td>
<td>224° 50'</td>
</tr>
<tr>
<td>FA</td>
<td>304° 50'</td>
</tr>
</tbody>
</table>

At what station (s) do you suspect local attractions? Determine the correct magnetic bearings. If the magnetic declination was 5° 10' W, what are the true bearings?

3 (a) Briefly explain the purpose of profile levelling and cross sectioning.  [04]
3 (b) The following is the page of a field book. Fill in the missing readings and calculate the R. L. of all the points. Apply usual checks.  [08]

Contd.....2.
<table>
<thead>
<tr>
<th>Station</th>
<th>BS (m)</th>
<th>IS (m)</th>
<th>FS (m)</th>
<th>Rise (m)</th>
<th>Fall (m)</th>
<th>R. L. (m)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.150</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>450.00</td>
<td>BM 1</td>
</tr>
<tr>
<td>2</td>
<td>1.645</td>
<td></td>
<td></td>
<td></td>
<td>0.500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>2.345</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>?</td>
<td>1.965</td>
<td>?</td>
<td></td>
<td>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>2.050</td>
<td>1.825</td>
<td></td>
<td></td>
<td>0.400</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td>?</td>
<td></td>
<td>?</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1.690</td>
<td></td>
<td>0.120</td>
<td></td>
<td></td>
<td>451.500</td>
<td>BM 2</td>
</tr>
<tr>
<td>8</td>
<td>2.863</td>
<td>2.100</td>
<td></td>
<td></td>
<td>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td>?</td>
<td></td>
<td>?</td>
<td>452.500</td>
<td>BM 3</td>
</tr>
</tbody>
</table>

4 (a) Differentiate between loose and fast needle methods of theodolite traversing. [04]

4 (b) A closed traverse was conducted round an obstacle and the following observations were made. Work out the missing quantities. [08]

<table>
<thead>
<tr>
<th>Line</th>
<th>Length (m)</th>
<th>Azimuth</th>
</tr>
</thead>
<tbody>
<tr>
<td>AB</td>
<td>500</td>
<td>98° 30'</td>
</tr>
<tr>
<td>BC</td>
<td>620</td>
<td>30° 20'</td>
</tr>
<tr>
<td>CD</td>
<td>408</td>
<td>298° 30'</td>
</tr>
<tr>
<td>DE</td>
<td></td>
<td>230° 00'</td>
</tr>
<tr>
<td>EA</td>
<td></td>
<td>150° 10'</td>
</tr>
</tbody>
</table>

OR

4' (a) Define tacheometry? Explain the methods employed in tacheometric survey. [04]

4' (b) Determine the gradient of a line AB, with the following observations made with a tacheometer. [08]

<table>
<thead>
<tr>
<th>Instrument station</th>
<th>Staff station</th>
<th>Horizontal angle</th>
<th>Vertical angle</th>
<th>Staff reading (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>A</td>
<td>0° 0' 00&quot;</td>
<td>10° 05' 20&quot;</td>
<td>2.385</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>40° 10' 30&quot;</td>
<td>0° 0' 00&quot;</td>
<td>3.100</td>
</tr>
</tbody>
</table>

Take constants of tacheometer as 100 and 0.

5 (a) Explain trapezoidal rule for the measurement of area by offsets from a base line. [02]

5 (b) A series of perpendicular offset were taken from a chain line to curved boundary. [10]

<table>
<thead>
<tr>
<th>Chainage (m)</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offset (m)</td>
<td>2.20</td>
<td>2.60</td>
<td>0.85</td>
<td>1.24</td>
<td>2.05</td>
<td>1.65</td>
<td>1.00</td>
<td>0.84</td>
</tr>
</tbody>
</table>

Determine the area between chain line and curved boundary by trapezoidal and Simpson's rule.
2015-16
B.TECH (AUTUMN SEMESTER) EXAMINATION
MECHANICAL ENGINEERING
APPLIED THERMODYNAMICS
ME221.

Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.
Use of property tables is allowed.

Q.No. Answer

1(a) Derive third Tds equation

\[ Tds = C_v \left( \frac{\partial T}{\partial p} \right)_v dp + C_p \left( \frac{\partial T}{\partial v} \right)_p dv \]

1(b) For a Van der Waal's gas, show that \( \beta = \frac{RV}{(v-b)} \left[ \frac{RT^2}{2a(v-b)^2} \right] \)

OR

1'(a) Determine the sublimation pressure of water vapour at -60\(^\circ\)C using data available in the steam tables.

1'(b) Carbon dioxide enters an adiabatic nozzle at 8 MPa and 450 K with a low velocity and leaves at 2 MPa and 350 K. Using the generalized enthalpy departure chart, determine the exit velocity of CO\(_2\). Take \( T_e = 304 \) K, \( P_e = 7.38 \) MPa

2(a) At steady state, 100 m\(^3\)/min of dry air at 32\(^\circ\)C and 1 bar is mixed adiabatically with a stream of oxygen (O\(_2\)) at 127 \(^\circ\)C and 1 bar to form a mixed stream at 47\(^\circ\)C and 1 bar. Kinetic and potential energy effects can be ignored. Determine (a) the mass flow rates of the dry air and oxygen, in kg/min, (b) the mole fractions of the dry air and oxygen in the existing mixture, and (c) the time rate of entropy production, in kJ/K, min.

2(b) A stream consisting of 142 m\(^3\)/min of moist air at a temperature of 5\(^\circ\)C and a humidity ratio of 0.002 kg (vapour)/kg (dry air) is mixed adiabatically with a second stream consisting of 425 m\(^3\)/min of moist air at 24\(^\circ\)C and 50% RH. The pressure is constant throughout at 1 bar. Using the psychrometric chart,
determine (a) the humidity ratio and (b) the temperature of the exiting mixed stream, in °C.

OR

2(a) Moist air enters an air conditioning unit at P=105 kPa, T=30°C, φ=80%. At the exit the moist air is at P=100 kPa, T=15°C, φ=93%. The condensate exits in separate stream at T=15°C. Calculate the heat transfer per kilogram of dry air, assuming that changes in kinetic energy are negligible. Also derive the relation used.

2(b) Water leaving the condenser of a power plant at 38°C enters a cooling tower with a mass flow rate of 4.5 x 10⁷ kg/h. A stream of cooled water is returned to the condenser from a cooling tower with a temperature of 20°C and the same flow rate. Make up water is added in a separate stream at 20°C. Atmospheric air enters the cooling tower at 25°C and 35% relative humidity. Moist air exits the tower at 35°C and 90% relative humidity. Determine the mass flow rates of the dry air and the makeup water, in kg/h.

3(a) Write short notes on any one of the following.
(i) Domestic refrigerators (ii) Refrigerants

3(b) A vapour compression system has a cooling load of 2 kW, operating between 50°C and -15°C, using R-22 as refrigerant. The refrigerant is dry saturated at the inlet of compressor and saturated liquid at the exit of condenser. Show p-h diagram of the system and calculate by using tables (a) mass flow rate of refrigerant (b) heating load (c) power required to drive the compressor, (d) COPc (e) COPh.

4(a) Derive expression for thermal efficiency and mean effective pressure of air standard Otto cycle.

4(b) An air engine works on the ideal Diesel cycle. The overall compression ratio is 18 and the constant pressure energy addition ceases at 10% of the stroke. Intake conditions are 1 bar and 20°C. The engine uses 10 m³ of air per hour. Determine (a) the maximum temperature and pressure in the cycle, (b) thermal efficiency of the engine, and (c) the indicated power of the engine.

5(a) Define the volumetric efficiency of a compressor. On what factors does it depend?

5(b) With neat sketch explain the working of a centrifugal compressor.

5(c) A 4-cylinder single stage air compressor has a bore of 200 mm and a stroke of 300 mm and runs at 400 rpm. At a working pressure of 620 kPa (g) it delivers 5.1 m³ of air per minute at 270 °C. Calculate (a) mass flow rate, (b) free air delivery, (c) effective swept volume, (d) volumetric efficiency. Take free air conditions at inlet as 101.3 kPa, 21°C.