Time (3 Hours) **Max. Marks: 80**

Note: (1) Question No. 1 is Compulsory.

(2) Answer any three questions from Q.2 to Q.6.

(3) Figures to the right indicate full marks.

1. (a) Find the eigen values of $A^2 + 2I$ where $A = \begin{bmatrix} 1 & 0 & 0 \\ 2 & -2 & 0 \\ 3 & 5 & 3 \end{bmatrix}$ (5)

(b) Find the Laplace transform of *f(t),* where

$$f(t) = \begin{cases} t^2, 0 < t < 1, \\ 1, \quad t > 1 \end{cases}$$ (5)

(c) Determine the constants a, b, c, d if

$f(z) = x^2 + 2axy + by^2 + i(cx^2 + 2dxy + y^2)$ is analytic. (5)

(d) Obtain half range Sine Series for f(x) $= x^2$, in 0 < x < 3. (5)

2.(a) Find $L^{-1}\left(\frac{4s+12}{(s^2+8s+12)}\right)$ (6)

(b) Find the Laplace transform of $e^{-4t}\int_0^t u \sin 3u \, du$. (6)

(c) Obtain the Fourier expansion for $f(x) = \begin{cases} \pi x & 0 \le x \le 1 \\ \pi(2-x) & 1 \le x \le 2 \end{cases}$ and

hence deduce that

$$\frac{\pi^2}{8} = \frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} + \frac{1}{7^2} + \cdots ..$$ (8)

3(a) Use Cayley- Hamilton theorem to find $2A^4 - 5A^3 - 7A + 6I$ where $A = \begin{bmatrix} 1 & 2 \\ 2 & 2 \end{bmatrix}$. (6)

(b)Determine the solution of one-dimensional heat equation

$\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}$ under the boundary conditions u (0, t) =0, u (*l*, t) =0 and u (x, 0) =x,

(0<x<*l*), *l* being the length of the rod. (6)

(c) Using Convolution theorem find the inverse Laplace transform of $\frac{(s+2)^2}{(s^2+4s+8)^2}$ (8)

4 (a) Find the orthogonal trajectory of the family of curves given by $x^3y - xy^3 = c$ (6)

(b) Prove that $\int_0^\infty e^{-t}\frac{sin^2 t}{t}\,dt = \frac{1}{4}\log 5$. (6)

(c) Using Crank-Nicholson formula, Solve $\frac{\partial^2 u}{\partial x^2} - \frac{\partial u}{\partial t} = 0. u(0,t) = 0, u(4,t) = 0,$

$u(x,0) = \frac{x}{3}(16 - x^2)$. Find u_{ij} for i=0, 1, 2, 3, 4 and j=0, 1, 2 taking $h = 1$. (8)

5 (a) Find inverse Laplace transform of $\log\left(\frac{s^2+a^2}{\sqrt{s+b}}\right)$. (6)

(b) Show that the function $u = \frac{1}{2}\log(x^2 + y^2)$ is harmonic and find its corresponding analytic function and its harmonic conjugate. (6)

(c) Solve $\frac{\partial^2 u}{\partial x^2} - 32\frac{\partial u}{\partial t} = 0$ by Bender-Schmidt method, subject to the conditions, $u(0,t) = 0\,, u(x,0) = 0, u(1,t) =$ t, taking h=0.25, 0<x<1. (8)

6 (a) Using Laplace transform Evaluate

$\int_0^\infty e^{-2t}\left(\int_0^t \frac{e^{-u}\sin u}{u}\,du\right)dt$ (6)

(b) Obtain Fourier series for $f(x) = x\cos x$ in $(-\pi, \pi)$. (6)

(c) Show that the matrix $A = \begin{bmatrix} -9 & 4 & 4 \\ -8 & 3 & 4 \\ -16 & 8 & 7 \end{bmatrix}$ is diagonalisable. Find the diagonal form D and the diagonalising matrix M. (8)

Duration:3 Hours **Marks: 80**

Instructions:

1. **Question No. 1 is Compulsory.**
2. **Answer any three questions from the remaining.**
3. **Each full question carries 20 marks.**
4. **Assume suitable data, if needed and state it clearly.**

Q. 1) Answer any **four** sub-questions.

a) A cantilever beam AB of 2 m length is fixed at left end A & free at right end B. It carries a UDL of 10 kN/m on its entire span. A point load of 10 kN acts at free end in upward direction. Draw shear force & bending moment diagrams. **(05)**

b) What is core or kernel of a section? Locate the core of a hollow circular section having external diameter of 200 mm and thickness of 20 mm. **(05)**

c) Write a note on virtual work principle & Castigliano's theorems. **(05)**

d) What are the assumptions made in theory of pure torsion? **(05)**

e) Derive the relationships between modulus of rigidity, bulk modulus and modulus of elasticity for a material. **(05)**

f) Derive expression for strain energy due to gradually applied axial load to an element. **(05)**

Q. 2) a) A cylindrical shell of internal diameter 1.8 m and 4.2 m length is subjected to an internal fluid pressure of 3.2 MPa. If the hoop stress is limited to 160 MPa, find the shell thickness. Also calculate longitudinal stress, maximum shear stress, changes in length, diameter and volume of the shell. Assume E = 2 x 10^5 MPa & Poisson's ratio = 0.24. **(10)**

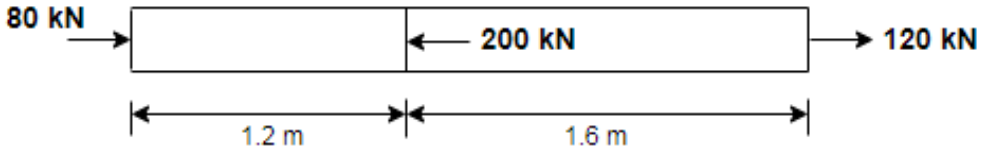
b) A T-beam has a flange (165 mm x 25 mm) and a web (30 mm x 180 mm). The bending stress is limited to 160 MPa. If it is simply supported over a span of 4.5 m, calculate the maximum UDL it can carry safely. **(10)**

Q. 3) a) An I-beam section has top flange of (170 mm x 20 mm), web of (25 mm x 100 mm) & bottom flange of (150 mm x 20 mm). If it is subjected to a shear force of 200 kN, draw shear stress distribution diagram across the C/S. **(10)**

b) A S/S beam ABCD is 12 m long. Left end A is roller supported & right end D is hinged. AB = BC = CD = 4 m. each. Part AB carries a UDL of 10 kN/m. At C, there is an anticlockwise couple of 15 kNm. Draw SFD & BMD. **(10)**

Q. 4) a) A hollow circular shaft has an external diameter of 170 mm. Its internal diameter is 0.8 times the external diameter. Determine the power that can be transmitted if shear stress is limited to 130 MPa & maximum angle of twist is 3.5 degrees for 3.8 m length. Shaft sped is 200 RPM. Maximum torque exceeds average torque by 20%. Take modulus of rigidity as 80 GPa. **(10)**

b) A steel bar has a C/S of (40 mm x 40 mm). Determine change in the length of bar. Young's modulus is 2 x 10^5 MPa. **(05)**



c) A vertical steel bar 25 mm in diameter & 1.8 m long is provided with a collar at the lower end. Determine the maximum weight 'W' that can be dropped through a height of 110 mm over the collar, if maximum permissible tensile stress in steel bar is 155 MPa. Take E = 200 GPa. **(05)**

Q. 5) a) The principal stresses at a point across two perpendicular planes are 135MPa horizontal (Tensile) & 85 MPa vertical (Compressive). Determine the normal stress, tangential stress & resultant stress & its obliquity on a plane at 35 degrees with the major principal plane. **(10)**

b) An overhanging beam ABCD is 10 m long. Left end A is hinged & right end D is free. Part AC is 8 m long. At C, there is a roller support. A point load of 25 kN acts at B, at the centre of part AC. Right overhanging part CD of length 2 m carries a UDL of 5 kN/m on its entire span. Using Macaulay's double integration method, determine slope at C & deflection at B in terms of EI. **(10)**

Q. 6) a) A hollow steel column of 5.5 m length has an outer diameter of 130 mm & thickness of 15 mm. It is fixed at one end & pinned at the other end. Determine Rankine's crippling load. Compare it with the Euler's crippling load. Take E = 2 x 10^5 MPa, crushing stress = 330 MPa & Rankine's constant = (1/7500). **(10)**

b) A short column of 200 mm external diameter & 150 mm internal diameter, when subjected to a load, the stresses are 150 MPa (Compressive) at one end to 25 MPa (Tensile) on the other end. Determine the value of the load & distance of its line of action from the axis of the column. **(10)**

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(3) Hours **Total Marks : 80**

N.B. 1. Question No. 1 is compulsory
2. Attempt any Three questions out of remaining Five questions.
3. Draw neat labeled diagrams wherever necessary.
4. All the parts of a question should be grouped together.
5. Figures to the right indicate marks

Q.1a	Answer the following-	**05**
(i)	Give characteristic properties and use of the following minerals- Hematite Orthoclase Gypsum Quartz Talc	
Q.1b	Define the following terms-	**05**
(i)	GSI	
(ii)	Lining in tunnel	
(iii)	Fissure Eruption	
(iv)	Mohorovicic discontinuity	
(v)	Solifluction	
Q.1c	Explain with the help of labeled diagram	**10**
(i)	Artesian aquifer	
(ii)	Dip and strike of geological structures	
(iii)	Parts of gravity dam	
(iv)	Laws of Stratigraphy	
(v)	Columnar joints	
Q.2(a)	Describe erosional and depositional landforms created by running water	**10**
(b)	What is plate Tectonic Theory? With the help of diagram Explain types of plate boundary with associated features.	**10**
Q.3(a)	Describe classification and texture of Igneous rocks with neat sketch.	**10**
(b)	What is fault? Explain types of faults with diagram and correlate it with types of plate boundary.	**10**
Q.4(a)	A coal bearing horizon is exposed on horizontal ground. It dips 45° eastward and the width of the outcrop is 280m. Determine its True Thickness and vertical thickness.	**06**
(b)	What is unconformity? Elaborate types of unconformity and its significance at construction site.	**05**
(c)	What should be the precautionary measures while doing construction in seismic prone areas?	**05**
(d)	Describe the products of volcanic eruption	**04**

Q.5(a) What is an aquifer? Describe cone of depression (exhaustion) in an aquifer and its significance in purification of ground water. **10**

(b) Define RQD and Core Recovery, Calculate RQD and Core Recovery from the given data and comment on the suitability of rocks for foundation purpose. Total run 2.5m. **10**

Sample No.	**Length of the core in cms**	**Nature of the lower end of the core sample**		**Sample No.**	**Length of the core in cms**	**Nature of the lower end of the core sample**
a	30	N		i	34	N
b	10	N		j	6	M
c	25	N		k	2	N
d	06	M		l	24	N
e	02	M		m	4	M
f	01	N		n	06	N
g	29	N		o	04	M
h	21	M		p	05	N

Q.6 (a) Classify the rock according to Geomechanics (RMR) classification for a Rock having UCS of 200Mpa and RQD of 70% with average spacing of discontinuity of 1000mm which is slightly rough in nature and highly weathered. The Strike is perpendicular to the tunnel axis and drive with dip is 25°. Also 8 lit/min groundwater inflows the tunnel length per 10m. Calculate the RMR value of the rock and state the condition of rock for tunnel construction. **10**
(**Note:** Table containing RMR Classification parameters should be provided to solve Question).

(b) What are the forces acting on a dam? Explain influence of lithology and geological structure for the success of a dam? **10**

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Duration: 3 Hours **Marks: 80**

Note: (1)Q. No. 1 is compulsory.

(2)Attempt any 3 from the remaining.

1. It is proposed to develop a Hospital as a (G+1) RCC framed structure with the following requirements: (Floor-Floor Height = 3.9 m)

i) Entrance lobby with inquiry counter [min. 3 m wide]
ii) Consulting rooms [4 nos.] (15 m^2 each)
iii) Pharmacy (30 m^2)
iv) Pathology lab (50 m^2)
v) Radiology lab (50 m^2)
vi) Emergency ward (50 m^2)
vii) Female & children's ward (100 m^2)
viii) Male ward (100 m^2)
ix) Hospital management's office (30 m^2)
x) Hospital staff room (40 m^2)
xi) Operation theatre (50 m^2)
xii) ICU (50 m^2)
xiii) Canteen (50 m^2)

Provide sanitary units, staircases, openings, passages etc. as per bye-laws.

a) Draw Developed plan of Ground Floor (with walls). **15**

b) Draw Single Line plan of First floor. **05**

2. a) Draw the Front Elevation of the structure designed in Q.1. **10**

b) Draw the Sectional Elevation of structure designed in Q.1. **10**

3. **a)** Draw the foundation plan &Section of a footing, structure designed in Q.No.1. **10**

b) Plan a Residential Bungalow (Ground Floor Structure) as RCC Framed Structure with the following: **10**

(i) Living-cum-Dining = 24 Sq.m
(ii) Master's Bed Room (with A.T) = 22 Sq.m
(iii) Dining = 14 Sq.m.
(iv) Bed Room = 15 Sq.m
(v) Guest Room = 16 Sq.m.

Provide Toilets, Passages etc. as per By-laws.
Assume Floor-Floor Height = 3.0 m.

Draw Ground Floor Single Line PLAN

4. Draw the **One-Point Perspective** of a clubhouse of size (12 x 8) m and height 3.6 m. It has a pitched roof of height 2.4 m. **20**

Provide adequate door(s), windows (with chajja) and entrance steps. Assume suitable station point, height of observer etc. and clearly mention all assumptions. used (if any). **Draw Plan, Front Views & Perspective properly.**

5. a) Explain sun-path diagram& Wind-Rose diagram **5**

b) Enlist the principles of Architectural planning & explain properly **5**

c) Write detailed notes on Computer aided drawing (CAD), with all features. **5**

d) Enlist the types of Shallow foundations & explain combined footing in detail. **5**

6. a) Explain the Principles of Town Planning. **5**

b) Write notes on Master Plan & Regional Plan **5**

c) Explain Redevelopment of buildings, with proper procedure **5**

d) Write notes on Green Buildings Concept & Built Environment **5**

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(3Hours) **Max Marks=80**

Note 1. Question 1 is compulsory
2. Attempt any 4 out of six questions
3. Assume any suitable data where ever required

Q.1 Attempt any **four**

a. Define co-efficient of contraction, co-efficient of velocity, co-efficient of discharge. **05**

b. A projectile is travelling in air having pressure and temperature as 10.1043 N/cm^2 and -10^{o}C at a speed of 1500 km/hour. Find Mach number and the Mach angle. Take k=1.4 and R= 287 J/kg^{o}K **05**

c. Explain types of fluid flow. **05**

d. Define following terms: **05**
a) Bulk modulus
b) Surface tension
c) Specific weight
d) Specific gravity
e) Mass density

e. Short note : condition of stability of floating and submerged bodies **05**

Q.2 **a.** What is meta centre? Derive an expression for the meta-centric height of a floating body by analytical method. **10**

b. What is viscosity? A plate 0.025 mm distant from a fixed plate, moves at 60 cm/s and requires a force of 2 N per unit area i.e., 2 N/m^2 to maintain this speed. Determine the fluid viscosity between the plates. **10**

Q.3 **a.** Water flows over a rectangular weir 1 m wide at a depth of 150 mm and afterwards passes through a triangular right-angled weir. Taking Cd for the rectangular and triangular weir as 0.62 and 0.59 respectively, find the depth over the triangular weir. **10**

b. An orifice meter with orifice diameter 10 cm is inserted in a pipe of 20 cm diameter. The pressure gauge fitted upstream and downstream of the orifice meter gives reading of 19.62 N/cm2 and 9.81 N/cm2 respectively. Co-efficient of discharge for the orifice meter is given as 0.60. Find the discharge of water through pipe. **10**

Q.4 **a.** State and prove Pascal's law. **10**

b. A rectangular plane surface 2 m wide and 3 m deep lies in water in such a way that its plane makes an angle of 30o with the free surface of water. Determine the total pressure and position of centre of pressure when the upper edge is 1.5 m below the free water surface. **10**

Q.5 **a.** The velocity components in a two-dimensional flow field for an incompressible fluid are as follow: $u = y^3 + 6x - 3x^2y$ and $v = 3xy^2 - 6y - x^3$. Obtain expression for stream function Ψ. **10**

b. Find the mach number when an aeroplane is flying at 1100 km/hour through still air having a pressure of 7 N/cm2 and temperature -5o C. wind velocity may be taken as zero. Take R= 287.14 J/kg K. Calculate the pressure, temperature, and density of air at stagnation point on the nose of the plane. Take k = 1.4. **10**

Q.6 **a.** A horizontal venturimeter with inlet and throat diameters 30 cm and 15 cm respectively is used to measure the flow rate of water. The reading of differential manometer connected to the inlet and the throat is 20 cm of mercury. Determine the rate of flow. Take Cd = 0.98. **10**

b. What is Euler's equation of motion? Derive Bernoulli's equation from Euler's equation. state the assumption made and limitation of Bernoulli's equation. **10**

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