

[Time: Three Hours]

[Marks: 80]

Please check whether you have got the right question paper.

- N.B:
1. Question No.1 is compulsory.
 2. Answer any three from the remaining.
 3. Figures to the right indicate marks.

- Q.1. a.** Separate into real part and imaginary of $\cos^{-1}\left(\frac{3i}{4}\right)$ 03
- b.** Show that the matrix A is unitary where $A = \begin{bmatrix} \alpha + i\gamma & \beta + i\delta \\ \beta + i\delta & \alpha + i\gamma \end{bmatrix}$ is unitary if $\alpha^2 + \beta^2 + \gamma^2 + \delta^2 = 1$ 03
- c.** If $z = \tan(y + ax) + (y - ax)^{3/2}$ then show that $\frac{\partial^2 z}{\partial x^2} = a^2 \frac{\partial^2 z}{\partial y^2}$ 03
- d.** If $x = uv$ $y = \frac{u}{v}$ Prove that $Jf^T = 1$ 03
- e.** Find the n^{th} derivative of $\frac{x^3}{(x+1)(x-2)}$ 04
- f.** Using the matrix $A = \begin{bmatrix} -1 & 2 \\ -1 & 1 \end{bmatrix}$ decode the message matrix $C = \begin{bmatrix} 4 & 11 & 12 & -2 \\ -4 & 4 & 9 & -2 \end{bmatrix}$ 04
- Q.2. a.** If $\sin^4 \theta \cos^3 \theta = a \cos \theta + b \cos 3\theta + c \cos 5\theta + d \cos 7\theta$ then find a, b, c, d. 06
- b.** Using Newton Raphson method Solve $3x - \cos x - 1 = 0$ Correct to 3 decimal places. 06
- c.** Find the stationary points of the function $x^3 + 3xy^2 - 3x^2 - 3y^2 + 4$ & also find maximum and minimum values of the function. 08
- Q.3. a.** Show that $x \operatorname{cosec} x = 1 + \frac{x^2}{6} + \frac{7}{360}x^4 + \dots$ 06
- b.** Reduce matrix to PAQ normal form and find 2 non Singular matrices P & Q 06
- $$\begin{bmatrix} 1 & 2 & -1 & 2 \\ 2 & 5 & -2 & 3 \\ 1 & 2 & 1 & 2 \end{bmatrix}$$
- c.** If $y = \cos(m \sin^{-1} x)$ Prove that $(1 - x^2)y_{n+2} - (2n + 1)xy_{n+1} + (m^2 - n^2)y_n = 0$ 08

Q.4. a. State and prove Euler's theorem for three Variables. 06

b. Show that all the roots of $(x+1)^6 + (x-1)^6 = 0$ are given by $-i \cot \frac{(2k+1)\pi}{12}$ where $k=0,1,2,3,4,5$ 06

c. Show that the equations 08

$$-2x + y + z = a$$

$$x - 2y + z = b$$

$$x + y - 2z = c$$

have no solutions unless $a + b + c = 0$ in which case they have infinitely many solutions.

Find these Solutions when $a = 1$ $b = 1$ $c = -2$

Q.5. a. If $z = f(x, y)$ $x = r \cos \theta$ 06

$y = r \sin \theta$ Prove that

$$\left(\frac{\partial z}{\partial x}\right)^2 + \left(\frac{\partial z}{\partial y}\right)^2 = \left(\frac{\partial z}{\partial r}\right)^2 + \frac{1}{r^2} \left(\frac{\partial z}{\partial \theta}\right)^2$$

b. If $\cos hx = \sec \theta$ Prove that 06

i) $x = \log(\sec \theta + \tan \theta)$

ii) $\theta = \frac{\pi}{2} - 2 \tan^{-1}(e^{-x})$

c. Solve by Gauss Jacobi 08

Iteration method

$$5x - y + z = 10$$

$$2x + 4y = 12$$

$$x + y + 5z = -1$$

Q.6. a. Prove that 06

$$\cos^{-1}[\tanh(\log x)] = \pi - 2 \left(x - \frac{x^3}{3} + \frac{x^5}{5} - \dots \right)$$

b. If $y = e^{2x} \sin \frac{x}{2} \cos \frac{x}{2} \sin 3x$ Find y_n 06

c. (i) Evaluate $\lim_{x \rightarrow 0} (\cot x)^{\sin x}$ 04

(ii) Prove that $\log \left[\frac{\sin(x+iy)}{\sin(x-iy)} \right] = 2i \tan^{-1}(\cot x \tan hy)$ 04

Q. P. Code: 26572

Time: 2 hours

Marks: 60

- N. B. 1) Question no 1 is compulsory
2) Attempt any three questions from Q.2 to Q.6
3) Assume suitable data wherever required
4) Figures on the right indicates marks

- 1 Attempt any five 15
- 'Crystal act as three dimensional grating for X-rays', explain.
 - Calculate the frequency and wavelength of photon whose energy is 75eV.
 - Draw the energy band diagram of p-n junction diode in forward and reverse bias condition.
 - "Superconductor is a perfect diamagnetic", Explain.
 - What is reverberation time? How is it important? Write the factors affecting reverberation time.
 - A quartz crystal of thickness 1.5mm is vibrating with resonance. Calculate it's fundamental frequency if the Young's modulus of quartz crystal is $7.9 \times 10^{10} \text{N/m}^2$ and density is 2650kg/m^3 .
 - Mobility's of electron and hole in a sample of Ge at room temperature are $0.36 \text{ m}^2/\text{V-sec}$ and $0.17 \text{ m}^2/\text{V-sec}$ respectively. If electron and hole densities are equal and it is $2.5 \times 10^{13}/\text{cm}^3$, calculate its conductivity.
- 2 a With Heisenberg's uncertainty principle prove that electron cannot survive in nucleus. An electron has a speed of 300m/sec. with uncertainty of 0.01%. Find the accuracy in its position. 4
- b Show that Fermi energy level in intrinsic semiconductor is at the Centre of forbidden energy gap. 7
- What is the probability of an electron being thermally excited to the conduction band in Si at 30°C . The band gap energy is 1.12eV.
- 3 a With neat diagram of unit cell, explain the structure of HCP crystal and calculate the no. of ions per unit cell, coordination no. , lattice constant and packing factor of the structure. 8
- b State the Hall effect. Derive the expression for Hall voltage and Hall coefficient with neat diagram. 7

Q. P. Code: 26572

- 4 a What is working principle of Maglev? Explain how it can acquire high speed? 5
 b A hall of dimensions $25 \times 18 \times 12 \text{ m}^3$ has an average absorption coefficient 0.2. Find the reverberation time. If a curtain cloth of area 150 m^2 is suspended at the Centre of hall with coefficient of absorption 0.75, What will be the reverberation time? 5
 c State the piezoelectric effect. With neat circuit diagram explain the principle and working of piezoelectric oscillator. 5
- 5 a With energy band diagram, explain the variation of Fermi energy level with temperature in extrinsic semiconductor. 5
 b Explain with example how to determine crystal structure by Bragg's X-ray spectrometer. 5
 c Obtain one dimensional time dependent Schrodinger equation. 5
- 6 a Define ligancy and critical radius ratio. Calculate critical radius ratio for ligancy 6. 5
 b What is the significance of wave function? Derive the expression for energy Eigen values for free particle in one dimensional potential well. 5
 c What is photovoltaic effect? Explain the principle and working of Solar cell. 5

Q.P. Code :22640

[Time: Two Hours]

[Marks:60]

Please check whether you have got the right question paper.

- N.B:
1. Question.No.1 is compulsory.
 2. Answer any three questions from the remaining five.
 3. All questions carry equal marks.
 4. Atomic weights: Ca= 40, C = 12, O = 16, H =1, Mg =24, S=32, Cl=35.5

Q.1 Attempt **any five** from the following.

15

- a) Distinguish between BOD & COD.
- b) Give the preparation, properties & uses of Kevlar.
- c) Calculate total hardness, in ppm, in given water sample:
 - i) 50ml standard hard water, containing 1mg pure CaCO_3 per ml, consumed 20ml EDTA solution.
 - ii) 50ml water sample consumed 30ml EDTA solution using Erio-Black T indicator.
- d) Define flash point & fire point? Give its significance.
- e) State the number of phases, component for the following equilibrium
 - i) $\text{H}_2\text{O}_{(s)} \rightleftharpoons \text{H}_2\text{O}_{(l)} \rightleftharpoons \text{H}_2\text{O}_{(g)}$
 - ii) Mixture of Rhombic & monoclinic sulphur.
- f) What are plasticizers? Give its uses & examples.
- g) Write a brief note on CNT's.

Q.2

- a) Calculate the quantity of lime & soda required for softening of 1,00,000 liters of water containing the following impurities in ppm. The purity of lime is 70% & soda is 85%
 $\text{Ca}(\text{HCO}_3)_2 = 30.2$, $\text{Mg}(\text{HCO}_3)_2 = 20.8$, $\text{CaCl}_2 = 28.1$, $\text{MgCl}_2 = 8.78$,
 $\text{CaSO}_4 = 35$, $\text{MgSO}_4 = 6.7$

06

- b) i) Distinguish between thermoplastic & thermosetting resins.
 ii) What are the functions of lubricants?

03

02

- c) What is Decay of concrete? Discuss its prevention.

04

Q.3

- a) Define fabrication. List the methods used. Discuss extrusion moulding in detail.

06

- b) i) What are the limitations of phase rule?
 ii) Draw a neat, labeled diagram of the Rotary kiln.

03

02

- c) 15,000 liters of hard water was passed through a zeolite softener. The exhausted zeolite required 120 liters of NaCl having strength of 30g/l of NaCl. Calculate the hardness of water.

04

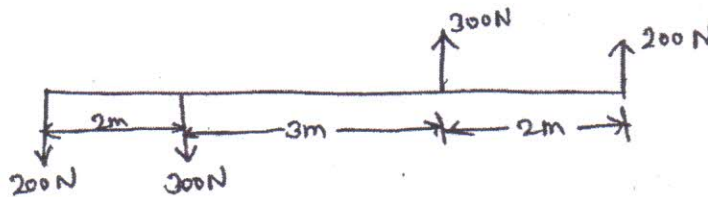
[3 Hours]

[Marks: 80]

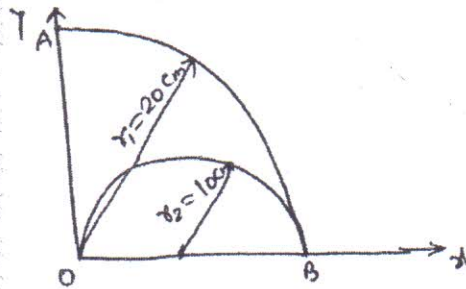
- N.B:
1. Question No. 1 is compulsory.
 2. Attempt any three questions out of remaining five questions.
 3. Assume suitable data if necessary stating them clearly.
 4. Take $g = 9.81 \text{ m/s}^2$.
 5. Draw suitable sketches wherever necessary.

1. Attempt any four :

- (a) State and prove varignon's theorem. 05
- (b) Find the resultant of the force system shown in fig. 05

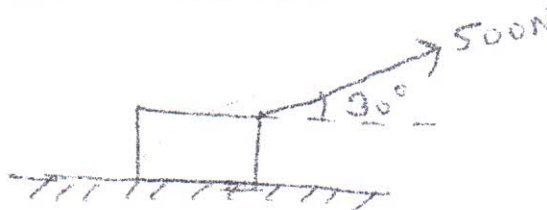


- (c) Find the co-ordinate of the centroid of the area shown in fig. 05



All dimensions are in cm

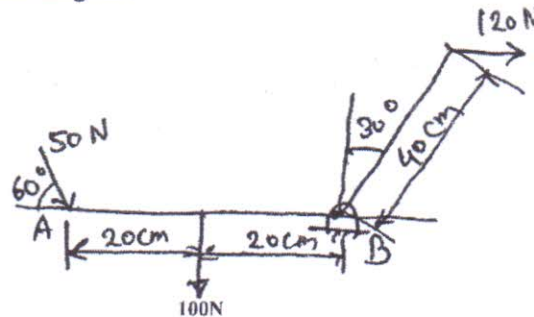
- (d) A force of 500N is acting on a block of 50Kg mass resting on a horizontal surface as shown in fig. Determine the velocity after the block has travelled a distance of 10m. Coeff. of kinetic friction = 0.5. 05



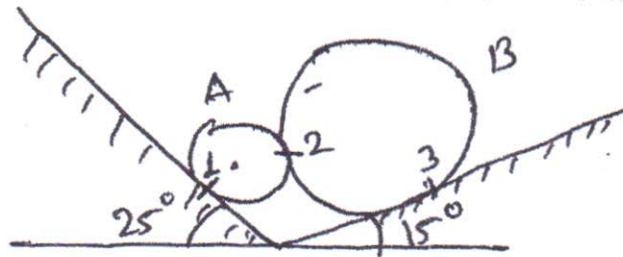
- (e) The position vector of a particle which moves in the X-Y plane is given by $\vec{r} = (3t^3 - 4t^2)\mathbf{i} + (0.5t^4)\mathbf{j} \text{ m}$. Calculate velocity and acceleration at $t = 1 \text{ sec}$. 05

[TURN OVER]

2. (a) Find the resultant of the force acting on the bell crank level shown. Also locate its position write hinge B. 08



- (b) Determine the reaction at points of contact 1, 2 and 3. Assume smooth surfaces. 05

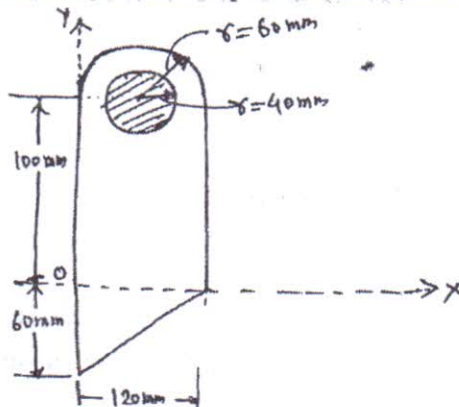


$$W_A = 1 \text{ kg}, \quad r_A = 1 \text{ cm}$$

$$W_B = 4 \text{ kg}, \quad r_B = 4 \text{ cm}.$$

- (c) Two balls having 20Kg and 30Kg masses are moving towards each other with velocities of 10m/s and 5m/s respectively as shown in fig. If after impact the ball having 30Kg mass is moving with 6m/s velocity to the right then determine the coefficient of restitution between the two balls. 06

3. (a) Determine the centroid of the plane lamina shaded portion is removed. 08

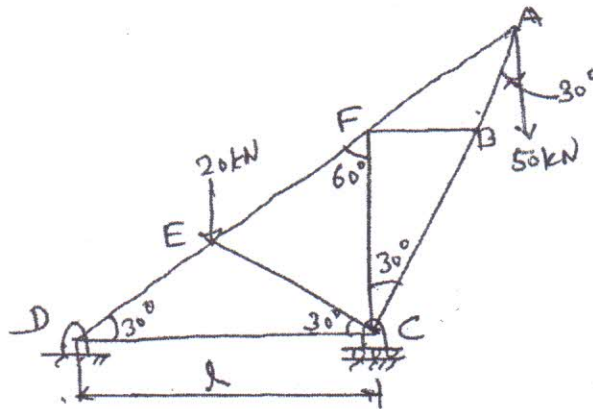


- (b) Explain conditions for equilibrium for forces in spaces. 06

[TURN OVER

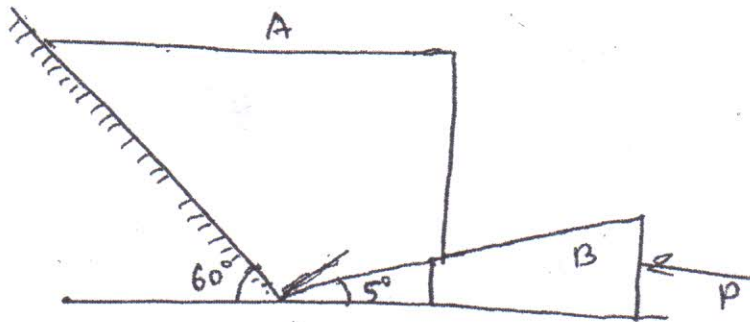
5. (a) Referring to the truss shown in fig. Find
- Reaction at D and C
 - Zero Force members
 - Forces in members FE & DC by method of section.
 - Forces in other members by method of joints.

08



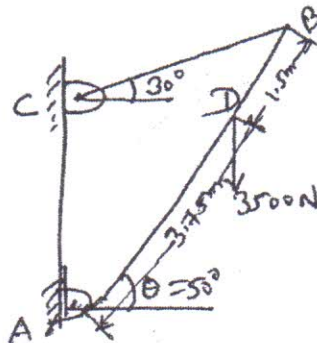
- (b) Determine the force P required to move the block A of 5000N weight up the inclined plane, coefficient of friction between all contact surfaces is 0.25. Neglect the weight of the wedge and the wedge angle is 15 degrees.

06



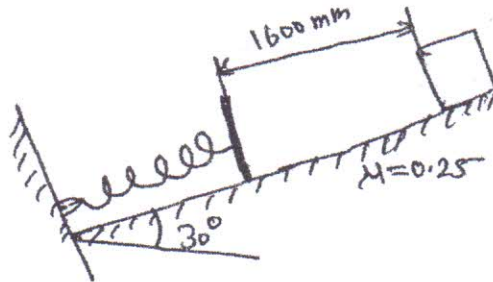
- (c) Determine the tension in a cable BC shown in fig by virtual work method.

06

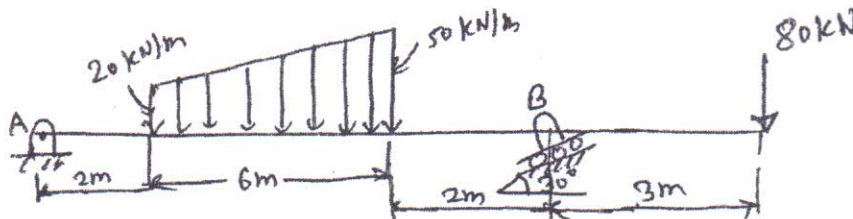


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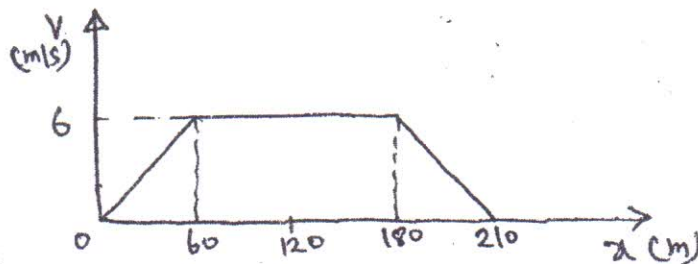
- (c) A 30N block is released from rest. It slides down a rough incline having coefficient of friction 0.25. Determine the maximum compression of the spring. 06



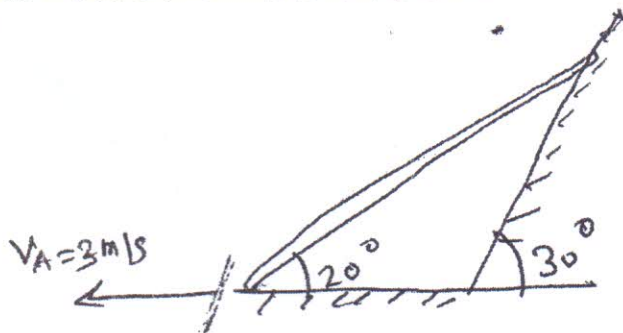
4. (a) Find the support reaction at A and B for the beam loaded as shown in fig. 08



- (b) The V-X graph of a rectilinear moving particle is shown. Find acceleration of the particle at 20m, 80m and 200m. 06



- (c) A bar AB 2m long slides down the plane as shown. The end A slides on the horizontal floor with a velocity of 3m/s. Determine the angular velocity of the rod AB and the velocity of end B for the position shown. 06



[TURN OVER]

6. (a) A 500N Crate kept on the top of a 15° sloping surface is pushed down the plane with an initial velocity of 20 m/s. If $\mu_s = 0.5$ and $\mu_k = 0.4$, Determine the distance travelled by the block and the time it will take as it comes to rest. 05
- (b) Derive the equation of the path of a projectile and hence show that the path traced by a projectile is a parabolic curve. 05
- (c) A particle is moving in X-Y plane and its position is defined by $\vec{r} = \left(\frac{3}{2}t^2\right)\vec{i} + \left(\frac{2}{3}t^3\right)\vec{j}$. 05
Find ratio of curvature when $t = 2$ sec.
- (d) A force of 100N acts at a point P(-2, 3, 5) m has its line of action passing through Q (10, 3, 4) m. Calculate moment of this force about origin (0,0,0). 05

1

(3 Hours)

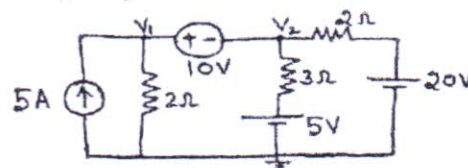
Q.P. Code : 25675

[Total Marks : 80

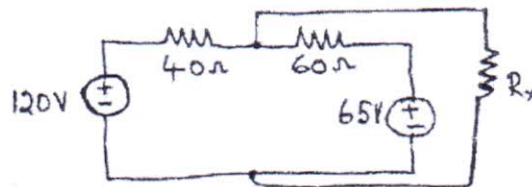
- N.B. :** (1) Question No.1 is compulsory.
 (2) Solve **any three** from remaining questions.
 (3) Assume suitable **data** if necessary.
 (4) **Figures** to the right indicate **full marks**.

1. Answer any Five :

- (a) A voltage $v(t)=282.85 \sin 100\pi t$ is applied to a coil, having resistance of 20Ω in series with inductance of 31.83mH . Find 04
 (i) RMS value of voltage;
 (ii) RMS value of current;
 (iii) power dissipated in the coil and
 (iv) power factor of the coil.
 (b) Derive the relation between line voltage and phase voltage in star connected three phase system. 04
 (c) Find the node voltage V_2 by nodal analysis. 04



- (d) A single phase transformer has a turn ratio (N_1/N_2) of 2:1 and is connected to a resistive load. Find the value of primary current (both magnitude and angle with reference to flux), if the magnetizing current is 1A and the secondary current is 4A. Neglect core losses and leakage reactance. Draw the corresponding phasor diagram. 04
 (e) Find the Norton's equivalent of the given circuit across R_x . 04



- (f) A coil having a resistance of 20Ω , and an inductance of 0.1H is connected in series with a $50\mu\text{F}$ capacitor. An alternating voltage of 250V is applied to the circuit. At what value of frequency will the current in the circuit be maximum? What is the value of this current? Also find the voltage across the inductor and quality factor. 04

TURN OVER

3 sem-I
(choice based)

Time : 2 hours

Max marks : 60

- N.B.:** i) Question No 1 is compulsory
ii) Attempt any 3 from Q.2 to Q.6
iii) Figures to the right indicate marks.

Q1. Attempt any Five

[15]

- Explain depleting nature of forests: causes, effects and prevention.
- Explain the concept of socio-economic aspects of sustainable development.
- What is meant by 'greenhouse effect' ?
- Write a short note : Environmental Clearance mechanism .
- What are limitations of conventional energy sources ?
- Write a short note on 'water crisis'.
- Explain the concept of 'carbon credit'.

Q2.

- Write a detailed account of 'Chipko movement'. [5]
- What are '3R control measures'? [5]
- Define 'noise pollution'. Which are its sources? What are its health effects? [5]

Q3.

- Explain principle, construction and working of electrostatic precipitator. [5]
- Discuss the case study of cloudburst and landslide at Kedarnath. [5]
- How electricity is generated from wind energy? [5]

Q4

- Discuss the case study of 'London smog'. [5]
- Write in details : Food chain and food web. [5]
- Write a note on : Green buildings – Concept and objectives. [5]

Q5.

- What is land pollution ? Discuss solid waste management. [5]
- Which are renewable energy resources ? Write about their importance. [5]
- Write on : Functions and powers of Central pollution control board. [5]

Q6.

- a) What is nuclear pollution ? Discuss Fukushima disaster. [5]
- b) What is an ecosystem ? Discuss the classification of ecosystems with examples. [5]
- c) Draw a schematic diagram of photovoltaic cell. Explain its principle and working. [5]
-