

Q.P. Code : 5001

(3 Hours)

[Total Marks : 100]

Q.No.1) is compulsory

ii) Attempt any THREE from remaining

iii) All questions carry equal marks

Q.No.1) a) If  $\log \tan x = y$  then prove that  $\sinh(n+1)y + \sinh(n-1)y = 2 \sinh ny \cdot \operatorname{cosec} 2x$  (3)

b) If  $z = \log(\tan x + \tan y)$  then prove that  $\sin 2x \frac{\partial z}{\partial x} + \sin 2y \frac{\partial z}{\partial y} = 2$  (3)

c) If  $x = r \sin \theta \cos \phi$ ,  $y = r \sin \theta \sin \phi$ ,  $z = r \cos \theta$  then find  $\frac{\partial(r, \theta, \phi)}{\partial(x, y, z)}$  (3)

d) Prove that  $\log \sec x = \frac{x^2}{2} + \frac{x^4}{12} + \frac{x^6}{45} + \dots$  (3)

e) Find the values of  $a, b, c$  and  $A^{-1}$  when  $A = \frac{1}{9} \begin{bmatrix} -8 & 4 & a \\ 1 & 4 & b \\ 4 & 7 & c \end{bmatrix}$  is orthogonal (4)

f) If  $y = \sin \theta + \cos \theta$  then prove that  $y_n = r^n \sqrt{1 + (-1)^n \sin 2\theta}$  where  $\theta = rx$  (4)

Q.No.2) a) If  $z = -1 + i\sqrt{3}$  then prove that  $\left(\frac{z}{2}\right)^n + \left(\frac{\bar{z}}{2}\right)^n = \begin{cases} 2, & \text{if } n \text{ is multiple of } 3 \\ -1, & \text{if } n \text{ is not multiple of } 3 \end{cases}$  (6)

b) If  $A = \begin{bmatrix} 1 & 2 & -2 \\ -1 & 3 & 0 \\ 0 & -2 & 1 \end{bmatrix}$  then find two non-singular matrices  $P$  &  $Q$  such that  $PAQ$  is in normal form also find  $\rho(A)$  and  $A^{-1}$  (6)

c) State and prove Euler's theorem for functions of two independent variable hence prove that

$$\left(x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y}\right) \left(x \frac{\partial v}{\partial x} + y \frac{\partial v}{\partial y}\right) = 0 \text{ if } x = e^u \tan v, y = e^u \sec v \quad (8)$$

Q.No.3) a) Determine the values of  $a$  and  $b$  such that system  $\begin{cases} 3x - 2y + z = b \\ 5x - 8y + 9z = 3 \\ 2x + y + az = -1 \end{cases}$  has i) no solution, ii) a unique solution, iii) infinite number of solutions (6)

b) Discuss the maximum and minimum of  $f(x, y) = x^3 + 3xy^2 - 15(x^2 + y^2) + 72x$  (6)

c) Show that  $\tan^{-1} \left( \frac{x+iy}{x-iy} \right) = \frac{\pi}{4} + \frac{i}{2} \log \left( \frac{x+y}{x-y} \right)$  (8)

[TURN OVER]

Q.No.4) a) If  $u = xyz$ ,  $v = x^2 + y^2 + z^2$ ,  $w = x + y + z$  then prove that  $\frac{\partial x}{\partial u} = \frac{1}{(x-y)(x-z)}$  (6)

b) If  $\sqrt{i}^{\sqrt{i}^{\sqrt{i}^{\dots}}}$   $= \alpha + i\beta$  then prove that i)  $\alpha^2 + \beta^2 = e^{-\frac{\pi\beta}{2}}$  ii)  $\tan\left(\frac{\beta}{\alpha}\right) = \frac{\pi\alpha}{4}$  (6)

c) Apply Crout's method to solve  $\begin{cases} x - y + 2z = 2 \\ 3x + 2y - 3z = 2 \\ 4x - 4y + 2z = 2 \end{cases}$  (8)

Q.No.5) a) If  $\cos^6\theta + \sin^6\theta = \alpha \cos 4\theta + \beta$  then prove that  $\alpha + \beta = 1$  (6)

b) Find the values of a, b & c such that  $\lim_{x \rightarrow 0} \frac{ae^x - be^{-x} + cx}{x - \sin x} = 4$  (6)

c) If  $x = \cos\left[\log\left(y^{1/m}\right)\right]$  then prove that

$$(1 - x^2)y_{n+2} - (2n + 1)xy_{n+1} - (m^2 + n^2)y_n = 0 \quad (8)$$

Q.No.6) a) Define linear dependence and independence of vectors, Examine for linear dependence of following set of vectors and find the relation between them if dependent

$$X_1 = \begin{bmatrix} 1 \\ -1 \\ 1 \end{bmatrix}, X_2 = \begin{bmatrix} 2 \\ 1 \\ 1 \end{bmatrix}, X_3 = \begin{bmatrix} 3 \\ 0 \\ 2 \end{bmatrix} \quad (6)$$

b) If  $z = f(u, v)$ ,  $u = x^2 - y^2$ ,  $v = 2xy$  then prove that  $\frac{\partial^2 z}{\partial x^2} + \frac{\partial^2 z}{\partial y^2} = 4\sqrt{u^2 + v^2} \left( \frac{\partial^2 z}{\partial u^2} + \frac{\partial^2 z}{\partial v^2} \right)$  (6)

c) Fit a straight line passing through points (0,1), (1,2), (2,3), (3,4.5), (4,6), (5,7.5) (8)

Q.P. Code : 5028

(REVISED COURSE)

(2 Hours)

[Total marks : 60]

**INSTRUCTIONS :** (1) Question No. 1 is compulsory

(2) Attempt any three questions from remaining Question No's 2 to 6

(3) Assume suitable data wherever required.

(4) Figures to the right indicate marks.

**1. Attempt any five.**

(15)

a) Draw the unit cell and Basis of DC structure.

b) Draw the following w.r.t. a cubic unit cell:

$(1 \bar{1} 1)$   $[\bar{1} 1 1]$   $(1 2 3)$

c) Draw a neat labelled Energy band diagram to show the variation of Fermi Level with doping concentration in N-Type semi-conductors.

d) Calculate electronic polarizability of Argon atom. Given relative permittivity is 1.0024 at NTP and the gas contains  $2.7 \times 10^{25}$  atoms per  $m^3$ .

e) What are the properties of soft magnetic materials? Briefly explain one application.

f) Monochromatic high energy x-rays are incident on a crystal. If 1st order reflection is observed at an angle  $3.4^\circ$ , at what angle would 2nd order reflection be expected.

g) A class room has dimensions  $20 \times 15 \times 5 m^3$ . The reverberation time is 3.5 sec. Calculate the total absorption of its surface and average absorption co efficient.

**2. a) Draw the unit cell of HCP. Derive the number of atoms / unit cell, the c/a ratio and the packing fraction. (5 + 3)**

Calculate the ratio of the number of vacancies to the number of atoms when the average energy required to create a vacancy is 0.95 eV at 500 K.

b) Explain Hall effect & its significance. With a neat diagram derive the expression for the Hall voltage & Hall co-efficient. (7)

[TURN OVER]



3. a) Draw the hysteresis loop for a ferromagnetic material. Prove that in a ferromagnetic material, the power loss / unit volume in a hysteresis cycle is equal to the area under the hysteresis loop. (4 + 4)
- A solenoid consisting of 500 turns and carrying 5amp is 0.5m long. Calculate (i) magnetomotive force & (ii) total flux if the area of the cross-section is  $0.0004\text{m}^2$ . (Assume the medium is air)
- b) With a neat labelled diagram explain the principle, construction and working of a piezoelectric oscillator. (7)
4. a) Explain analysis of crystal structure using Bragg's X-ray spectrometer. (5)
- b) An Ultrasonic beam of 1 cm wavelength sent by a ship returns from sea bed after 2 sec. If the salinity of sea water at  $30^\circ\text{C}$  is 29 gm / lit. calculate the depth of sea bed at  $30^\circ\text{C}$  and the frequency of ultrasonic beam. (5)
- c) Explain Critical Configuration & find the Critical radius ratio of an ionic crystal for ligancy 6. (5)
5. a) Explain ionic polarization & derive the expression for ionic polarizability. (5)
- b) In a solid, consider the energy level lying 0.012eV below Fermi level. What is the probability of this level not being occupied by an electron? (5)  
Given  $T = 300\text{ kelvin}$ .  $K_B = 1.38 \times 10^{-23}\text{ J/K}$ .
- c) For an intrinsic semiconductor show that the Fermi level lies in the centre of the forbidden energy gap. (5)
6. a) What is reverberation? Define Reverberation time. Explain its role in acoustics. (5)
- b) Explain the principle, construction & working of a LED. (5)
- c) Describe the types of liquid crystals & their properties. (5)

\* \* \*

- 13 : (1) Question No.1 is compulsory  
(2) Answer any **three** questions from remaining **five** questions.  
(3) Figure to the right indicate marks  
(4) All questions carry equal marks  
(5) Atomic weight: Ca = 40, H=1, C=12, O=16, Mg=24, Na=23, Cl=35.5, S=32, Al=27.

Attempt any **five** from the following :

15

- (a) Why is hot lime-soda process preferred over cold lime-soda method?  
(b) What are the drawbacks of Natural Rubber.  
(c) List the applications of carbon nanotubes.  
(d) Define flash point and fire point. Give its significance.  
(e) What is Triple point? Explain it with reference to one component water system.  
(f) Distinguish between thermoplastic and thermosetting resins.  
(g) A 5ml sample of waste water was refluxed with 30ml of potassium dichromate solution and after refluxing the excess unreacted dichromate required 23ml of 0.1M FAS solution. A blank of distilled water on refluxing with 30ml of dichromate solution required 36ml of 0.1M FAS solution. Calculate the COD value of the waste water.

- (a) Calculate the quantity of pure lime (70% pure) and soda (85% pure) required for softening of 100,000 litres of water containing the following impurities in ppm.

6

$\text{Ca}(\text{HCO}_3)_2 = 30.2$ ,  $\text{Mg}(\text{HCO}_3)_2 = 20.8$ ,  $\text{CaCl}_2 = 28.1$ ,  $\text{MgCl}_2 = 8.78$ ,  
 $\text{CaSO}_4 = 35$ ,  $\text{MgSO}_4 = 6.7$ ,  $\text{NaCl} = 17.9$ .

- (b) What is the phase Rule? Draw a neat labelled diagram for water system. Using phase rule, find the number of degrees of freedom (F) for the following systems;

5

- (i)  $\text{Ice (s)} \rightleftharpoons \text{water (l)} \rightleftharpoons \text{water vapour (g)}$   
(ii)  $\text{Water} \rightleftharpoons \text{water vapour}$

- (c) Explain the preparation, properties and uses of silica bricks

4

- (a) Define: Lubricant, Lubrication. Discuss the boundary-film Lubrication mechanism.

6

- (b) What is meant by fabrication of plastic? Explain in details the injection moulding method

5

- (c) Discuss the Limitations of phase rule.

4

[TURN OVER



Q.P. Code : 5023

2

Write the preparation, properties and uses of any two of the following :

- (i) Kevlar (ii) PMMA (iii) Buna-S

6

What is activated sludge? Explain the method with a flow-sheet diagram.

5

Find the acid-value of a vegetable oil whose 5ml required 2ml of  $N/100$

4

KOH during titration. (Density of oil = 0.92)

6

Write notes on (Any two)

- (i) Decay of concrete  
(ii) Setting and hardening of cement  
(iii) RCC

5

Explain the functions of the following constituents in the compounding of plastics. Give proper examples. (Any two)

- (i) Fillers (ii) Plasticizers (iii) Lubricants

4

The hardness of 75,000 litres of a water sample was completely removed by a permutit. The exhausted permutit then required 1500L of NaCl containing 117 mg of NaCl per litre for regeneration. Calculate the hardness of water sample.

6

Explain with a neat diagram, the zeolite process of water softening including the following points.

- (i) Principle  
(ii) Softening and regeneration reactions  
(iii) Process  
(iv) advantages

5

What is vulcanization? Explain giving proper reaction. Discuss the improvement in the drawbacks of natural rubber after vulcanization

4

Under what conditions are solid lubricants used? Explain Graphite as a solid lubricant.

QP Code : 5012

(REVISED COURSE)  
(3Hours)

Total Marks : 80

NB.1. Question No. 1 is Compulsory.

2. Answer any Three more questions out of the remaining Five questions.

3. Assume any suitable data wherever required but justify the same.

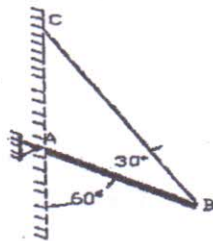
4. Figures to the right indicate full mark

5. Take  $g = 9.81 \text{ m/s}^2$

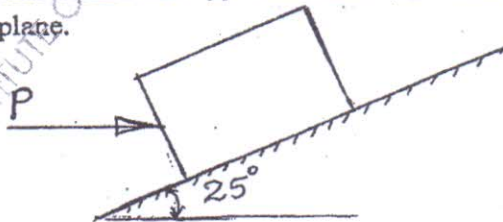
Q1a) Three concurrent forces  $P=150\text{N}$ ,  $Q=250\text{N}$  and  $S=300\text{N}$  are acting at  $120^\circ$  with each other.

Determine their resultant force magnitude and direction with respect to  $P$ . What is their equilibrant? [4]

b) A prismatic bar  $AB$  of length  $6\text{m}$  and weight  $3\text{ kN}$  is hinged to a wall and supported by a cable  $BC$ . Find hinge reaction and tension in cable  $BC$ . [4]



c) A block of weight  $800\text{N}$  is acted upon by a horizontal force  $P$  as shown in figure. If the coefficient of friction between the block and incline are  $\mu_s = 0.35$  and  $\mu_k = 0.25$ , determine the value of  $P$  for impending motion up the plane. [4]



d) A hot air balloon starts rising vertically up from the ground with an acceleration of  $0.2 \text{ m/s}^2$ . 12 seconds later the man sitting inside the balloon releases a stone. Find the time taken by the stone to hit the ground. [4]

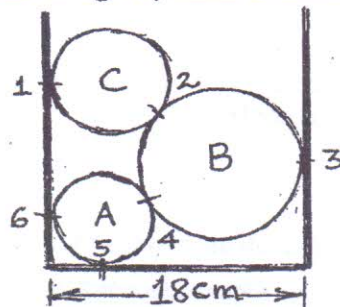
e) A small block rests on a turn table,  $0.5\text{m}$  away from its centre. The turn table, starting from rest, is rotated in such a way that the block undergoes a constant tangential acceleration. Determine the angular velocity of the turn table at the instant when the block starts slipping.  $\mu = 0.4$  [4]



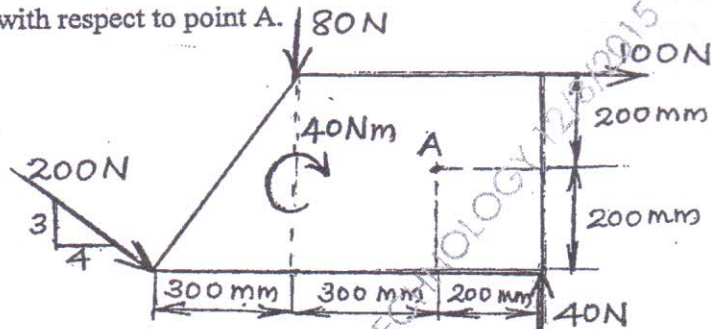
Q2a) Three right circular cylinders A, B, C are piled up in a rectangular channel as shown in figure. Determine the reactions at point 6 between the cylinder A and vertical wall of the channel. [8]

(Cylinder A: radius=4cm, mass= 15kg

Cylinder B: radius=6cm, mass=40kg. Cylinder C: radius=5cm, mass=20kg.)

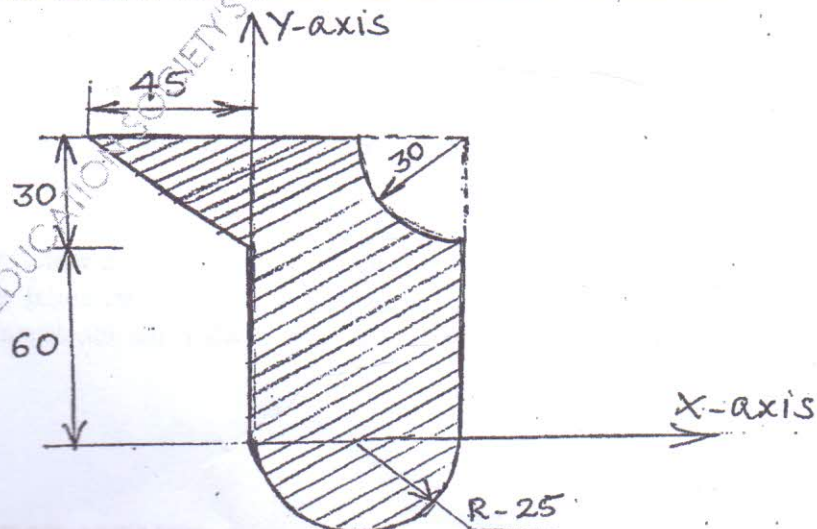


b) Four forces and a couple are acting on a plate as shown in figure. Determine the resultant force and locate it with respect to point A. [6]



c) Two balls with masses 20kg and 30kg are moving towards each other with velocities 10m/s and 5m/s respectively. If after impact the ball having mass 30kg reverses its direction of motion and moves with velocity 6m/s, then determine the coefficient of restitution between the two balls. [6]

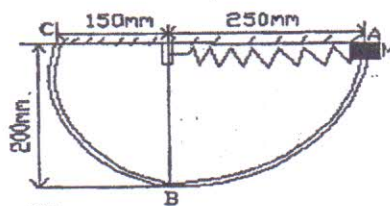
Q3.a) Determine the Centroid of the shaded area. All dimensions are in mm. [8]



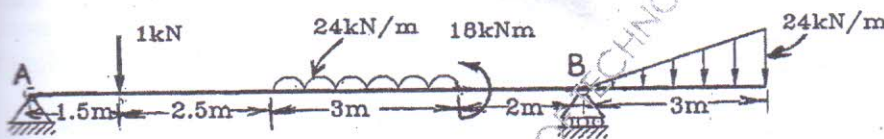


b) Force 5kN is acting along AB where A(0,0,-1)m and B(5,-2,-4)m. Another force 8kN is acting along BC where C(3,3,4)m. Find resultant of two forces and find moment of resultant force about a point D(0,3,-2) m. [6]

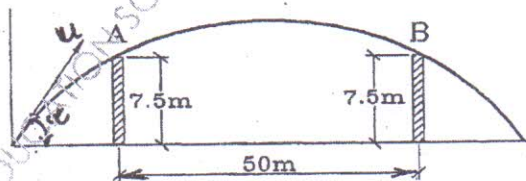
c) A 2kg collar M is attached to a spring and slides without friction in a vertical plane along the curved rod ABC as shown in figure. The spring has an un-deformed length of 100mm and its stiffness  $k=800\text{N/m}$ . If the collar is released from rest at A, determine its velocity i) as it passes through B. ii) as it reaches C. [6]



Q4.a) Find support reactions at A and B for the beam loaded as shown in figure. A is hinged and B is roller. [8]

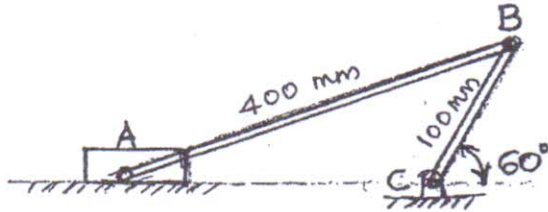


b) An object is projected so that it just clears two obstacles each of 7.5 m height, which are situated 50 m from each other. If the time of passing between the obstacles is 2.5 s, calculate the complete range of projection and the initial velocity of the projectile. [6]



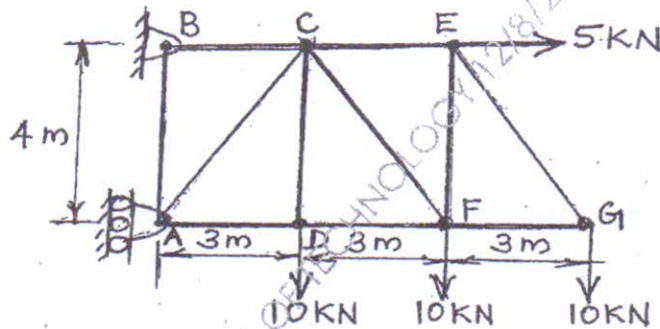
- c) The crank BC of a slider crank mechanism is rotating at constant speed of 30 rpm clockwise. Determine the velocity of the piston A at the given instant. [6]

$$AB = 400 \text{ mm} \quad BC = 100 \text{ mm}$$

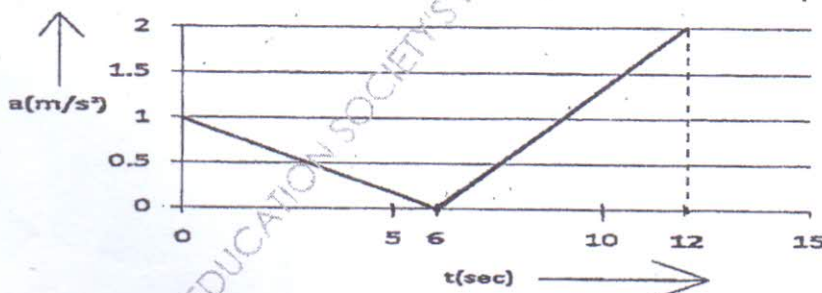


- Q5a) For the truss shown in figure, determine,

- Support Reactions [2]
- Forces in members CE and CF by method of sections only. [2]
- Forces in any other four members by method of joints [4]



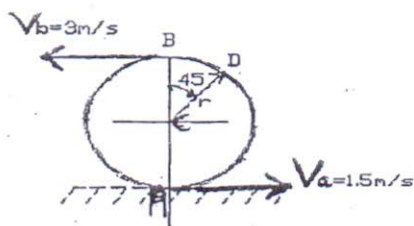
- b) A particle moves in a straight line with acceleration-time diagram shown in figure. Construct velocity-time diagram for the motion assuming that the motion starts with initial velocity of 5 m/s from the starting point. Also determine its displacement at  $t = 12$  seconds. [6]



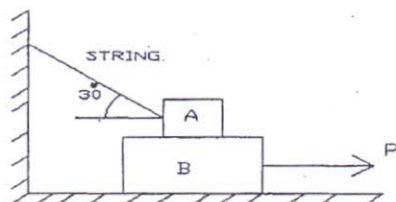


kwise.

c) Due to slipping, points A and B on the rim of the disk have the velocities  $V_a = 1.5 \text{ m/s}$  to the right and  $V_b = 3 \text{ m/s}$  to the left as shown in figure. Determine the velocities of the centre point C and point D on the rim at this instant. Take radius of disk  $0.24 \text{ m}$ . [6]



Q6a) Find force requires to pull block B as shown. Coefficient of friction between A and B is  $0.3$  and between B and floor is  $0.25$ . Mass of  $A = 40 \text{ kg}$  and  $B = 60 \text{ kg}$ . [8]

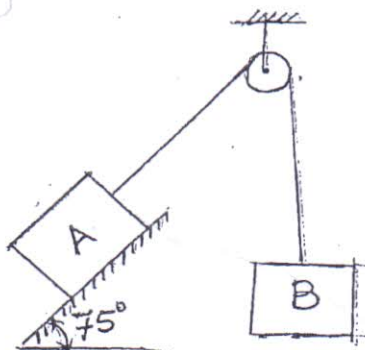


b) A force acts at the origin in a direction defined by the angles  $\theta_y = 65^\circ$  and  $\theta_z = 40^\circ$ . Knowing that the x-component of the force is  $750 \text{ N}$ , determine i) the other components ii) magnitude of the force iii) the value of  $\theta_x$ . [4]

construct  
of  $5 \text{ m/s}$   
[6]

c) A particle travels on a circular path, whose distance travelled is defined by  $S = (0.5t^3 + 3t) \text{ m}$ . If the total acceleration is  $10 \text{ m/s}^2$ , at  $t = 2 \text{ sec}$ , find its radius of curvature. [4]

d) Block A and B of mass  $6 \text{ kg}$  and  $12 \text{ kg}$  respectively are connected by a string passing over a smooth pulley. Neglect mass of pulley. If coefficient of kinetic friction between the block A and the inclined surface is  $0.2$ , determine the acceleration of block A and block B. [4]



VER

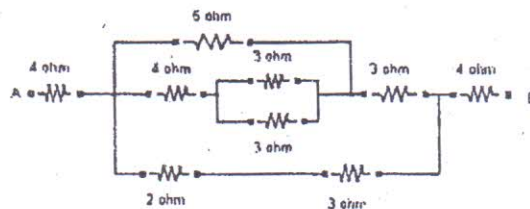
QP Code : 5014

(3 Hours)

[ Total Marks :80

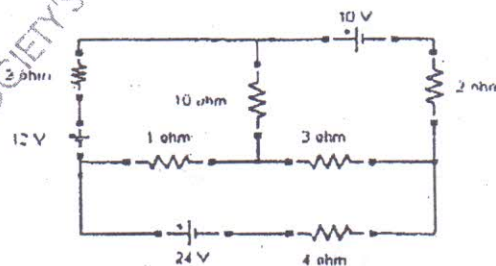
- N.B. : (1) Question no. 1 is compulsory.  
(2) Attempt any three questions out of remaining questions.  
(3) Assume suitable data if necessary.

1. (a) Find equivalent resistance across terminals A & B of network shown



- (b) State and explain maximum power transfer theorem. 3  
(c) Find the rms value of current flowing through a  $314 \mu F$  capacitor when connected to 230V, 50 Hz, 1- $\Phi$  AC Supply. 3  
(d) A series R-L-C circuit is supplied with  $v(t) = 10\sin(1000t)$  Volts. If the maximum peak voltage across capacitor is 400 Volts, find the quality factor of the circuit. 3  
(e) Draw and explain the power triangle for a 3- $\Phi$  lagging load. 2  
(f) A 80 kVA, 3200/400 V, 1- $\Phi$ , 50 Hz transformer has 111 turns on secondary winding calculate (i) Number of turns on primary winding ii) Secondary full load current (iii) Cross sectional area of the core if the maximum flux density is 1.2 tesla. 4  
(g) Justify that full wave rectifier is more efficient than half wave rectifier. 2

2. (a) By mesh analysis find the current through 4 ohm resistor for the given circuit shown below



- (b) When a resistor and a choke coil in series are connected to a 240V supply, a current of 3A flows, lagging  $37^\circ$  behind the supply voltage, while voltage across the coil is 171V. Find resistance of resistor, resistance and reactance of coil. 8  
(c) Draw and explain the phasor diagram for practical transformer connected to lagging power factor load. 6

[ TURN OVER



(2 Hours)

[Total Marks : 60]

- B :** (1) Question No. 1 is compulsory.  
(2) Attempt any **three** questions from Question Nos. 2 to 6.  
(3) Draw **neat labelled diagrams** wherever necessary.  
(4) **Figures to right** indicate **full marks**.

Attempt any **five** of the following :—

- (a) How environmental education is essential for sustainable development ? 15
- (b) What are the stationary and mobile sources of air pollution ?
- (c) What are the functions and powers of Central Pollution Control Board (CPCB) ?
- (d) Explain the term : 'Carbon Credit'.
- (e) What are the conventional sources of energy ? and  
What are their advantages and limitations ?
- (f) What is ecological pyramid ? How energy flows across pyramid ?
- (g) What are the reasons of Ozone layer depletion ? What are its effects ?

- (a) Explain economic and environmental aspects of sustainable development. 5
- (b) Draw a neat diagram and explain working of bag house filter. 5
- (c) Draw a neat diagram and explain working of photovoltaic cell. 5

- (a) Outline important features of environmental clearance and authorization mechanism. 5
- (b) Discuss how the techniques of disaster management are implemented at the time of Tsunami ? 5
- (c) Write briefly about Minamata disease in Japan. 5

- (a) What are the global environmental problems pertaining to sanitation and land ? 5
- (b) Describe briefly the important features of environmental protection act. 5
- (c) Draw a neat labelled diagram and explain how is it possible to obtain electricity from geothermal energy. 5

- (a) Explain why resource utilization as per carrying capacity of earth is important for sustainable development. 5

- (b) What are the causes and effects of acid-rain ? 5
- (c) What is Hydel energy ? How hydropower generation is carried out ? 5

- (a) What are the reasons for depleting nature of our mineral resources ? 5

- (b) Explain how industrial waste water treatment is carried out ? 5

- (c) What is Indoor Air Pollution ? 5

List indoor air pollutants and explain their effects on human health.