[Time: 3 Hours] **[Marks:80]**

Please check whether you have got the right question paper.

N.B: 1. Question 1 is compulsory.
2. Attempt any three questions from Q.2 to Q.6.

Q1 (a) Prove $cosh^5 x = \cosh 5x + 5\cosh 3x + 10\cosh x$ **(3)**

(b) If u= log(tanx+ tany) **(3)**
Prove $\sin 2x \frac{\partial u}{\partial x} + \sin 2y \frac{\partial u}{\partial y} = 2$

(c) **(3)**
If $u = \frac{yz}{x}$, $v = \frac{zx}{y}$, $w = \frac{xy}{z}$ Show that $\frac{\partial(u,v,w)}{\partial(x,y,z)} = 4$

(d) Express the following matrix as sum of symmetric and skew symmetric **(3)**
matrix.
$$A= \begin{pmatrix} 2 & 2+i & 3 \\ -2+i & 0 & 4i \\ -i & 3-i & 1-i \end{pmatrix}$$

(e) Show that log(1+ sinx) = $x - \frac{x^2}{2} + \frac{x^3}{6}$ **(4)**

(f) If $y = \frac{x^2}{(x-1)(x-2)}$ Find y_n **(4)**

Q2 (a) Solve the Equation $x^4 - x^3 + x^2 - x + 1 = 0$ **(6)**

(b) Reduce the following Matrix to the Normal form and hence find the **(6)**
rank of the matrix
$$A= \begin{pmatrix} 6 & 1 & 3 & 8 \\ 4 & 2 & 6 & -1 \\ 10 & 3 & 9 & 7 \\ 16 & 4 & 12 & 15 \end{pmatrix}$$

(c) If $u = \frac{x^2 y^2 z^2}{x^2+y^2+z^2} + cos^{-1}\left(\frac{xy+yz}{\sqrt{x^2+y^2+z^2}}\right)$ **(8)**

Find the value of $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} + z\frac{\partial u}{\partial z}$

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Q3 (a)   (a) Investigate for what values of λ and μ the system of equations   **(6)**
         x+2y+3z= 4, x+3y+4z = 5, x+3y+λz =μ.
     have 1) unique solution, 2) Infinite solutions, 3) No solution

(b)   Find the Extreme values of $f(x,y)= xy+ a^3(\frac{1}{x} + \frac{1}{y})$ **(6)**

(c)   Separate into real and imaginary parts of $\tan^{-1}(e^{i\theta})$ **(8)**

Q4 (a)   If $u^2 + xv^2 = x + y, \quad v^2 + yu^2 = x - y$ Find $\frac{\partial u}{\partial x}, \frac{\partial v}{\partial y}$ **(6)**

(b)   If log cos(x+iy)= a+ib Prove $2e^{2a} = $ cosh2y +cos 2x   **(6)**

(c)   **(8)**
     Solve the following Equations by Gauss Seidel method Upto four
     iterations.
         4x-2y-z= 40 , x-6y+2z= -28 , x-2y+12z= -86

Q5 (a)   Using De Moivre's theorem Prove   **(6)**
     $cos^7\theta = \frac{1}{2^6}(\cos 7\theta + 7 \cos 5\theta + 21 \cos 3\theta + 35 \cos \theta)$

(b)   Evaluate $\lim_{x\to 0} \left(\frac{1}{x^2} - cot^2 x\right)$ **(6)**

(c)   If y = $\sin(m \sin^{-1} x)$ Prove that $(1-x^2)y_{n+2} - (2n + 1)xy_{n+1} +$ **(8)**
     $(m^2 - n^2)y_n = 0$
         And hence find $y_3(0)$.

Q6 (a)   (a) Show the following vectors are linearly dependent and find the   **(6)**
     relation between them.
     $[2, -1,3,2] ,[1,3,4,2] ,[3, -5,2,2]$.

(b)   If z=f(x,y) where x = u cosh v ,y = usinh v Prove   **(6)**
     $(\frac{\partial z}{\partial x})^2 - (\frac{\partial z}{\partial y})^2 = (\frac{\partial z}{\partial u})^2 - \frac{1}{u^2}(\frac{\partial z}{\partial v})^2$

(c)   Fit the curve of the form y= ab^x to the following data.   **(8)**

| x	2	3	4	5	6
y	144	172.8	207.4	248.8	298.5

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

N.B.: 1. **Question No. 1** is **compulsory**.
   2. Attempt **any 3** more questions from remaining **five**.
   3. Assume **suitable data** if **necessary**, and **mention** the **same clearly**.
   4. **Figures** to the **right** indicate **full mark**.
   5. Take **g= 9.81m/s^2**.

1. **a**) Forces F_1, F_2, F_3 and F_4 are acting on a particles. Find the force F_4 so as to give the resultant of system of concurrent forces R = 800 N as shown in figure. **[4]**
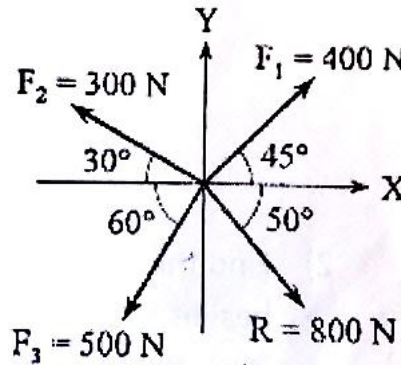
**b**) A light fixture weighing 24 N is hung by a string as shown in figure. Determine the tensions in AC and BC of the string. **[4]**
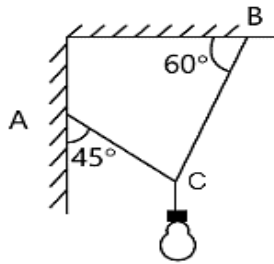
c) State various laws of friction. **[4]**

d) The motion of a particle is defined by the relation **v = 4t^2-3t-1** where v is in m/s and t is in sec. If the displacement $x = -$ 4m at t = 0, determine the displacement and acceleration at t = 3 sec. **[4]**

e) A car travelling at a speed of 60m/s is braked and comes to rest in 10 seconds after the brakes are applied. Find the minimum coefficient of friction between the wheels and the road. **[4]**

2. **a**) Two equal loads of 2500 N are supported by the flexible string ABCD at point B and C. Find the tension in the portion AB, BC and CD of the string. **[8]**
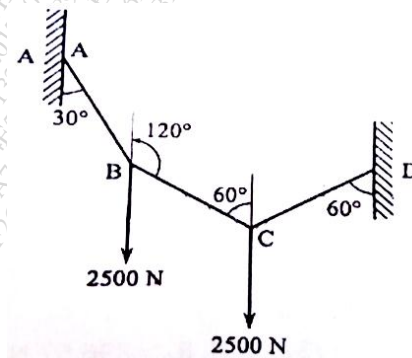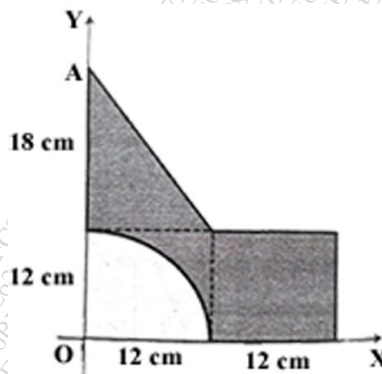

b) Find the resultant of the force system on a body OABC as shown in figure. Also find the

points where the resultant will cut the X and Y axis. [6]
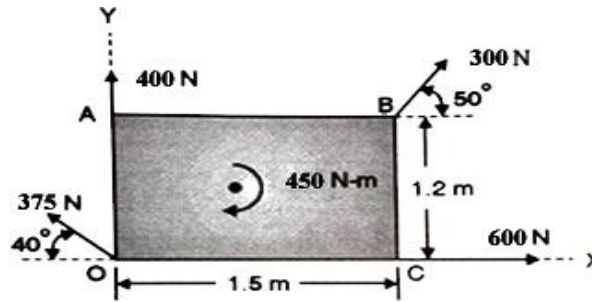
c) If a ball is thrown vertically down with a velocity of 10m/s from a height of 3m. Find the maximum height it can reach after hitting the floor, if the coefficient of restitution is 0.7. [6]

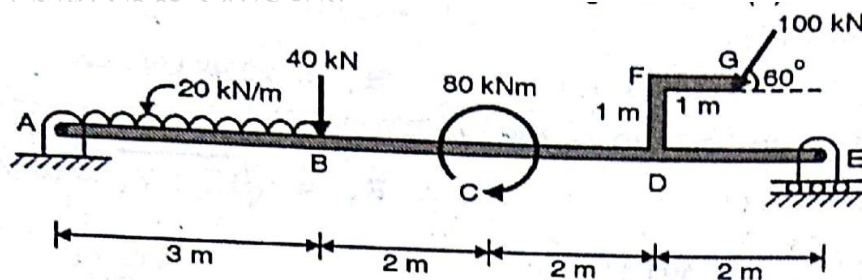**3. a)** Determine the Centroid of the shaded area. [8]

b) The 10kg mass slides from rest at A along the frictionless rod. Determine the speed at B. Stiffness of the spring K = 80 N/m. Unstretched length of spring is 0.3 m. [6]
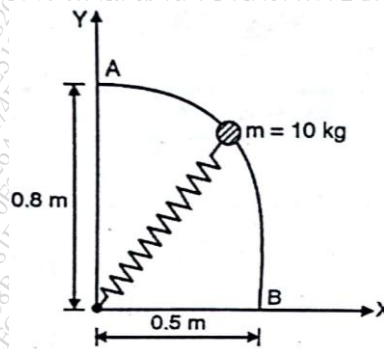
c) A force $F = 80i + 50j - 60k$ passes through a pont A (6,2,6). Compute its moment about origin. [6]
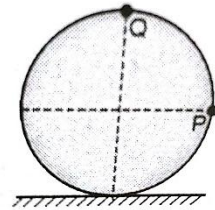
4. a) Find support reactions at A and E for the beam loaded as shown in fig. [8]

b) An aero plane flying horizontally with a velocity of 100m/s releases a packet which lands to the ground after 8 seconds. Find the velocity with which the packet lands. [6]
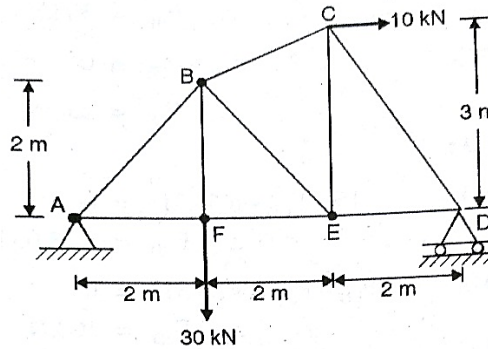
Also find the height from which it was released.

c) A wheel of radius 0.75m rolls without slipping on a horizontal stationary surface to the right. Determine the velocities of the points P and Q when the velocity of centre of the wheel is 25 m/s to the right. **[6]**

5. a) For the truss shown in Fig, determine :
   i) Forces in members AB, BF and EF by method of sections only. **[3]**
   ii) Forces in all other members by method of joints. **[5]**

b) A motorcycle starts from rest and accelerates at $2m/s^2$ till velocity reaches 10m/s. Then it accelerates at $1m/s^2$ till velocity reaches 15m/s and continues at uniform velocity of 15m/s till it covers a total distance of 300m. Find the total time taken to cover this distance. Draw the v-t and x-t graph for this motion. **[6]**

c) In the slider crank mechanism shown in fig, the crank AB of length 10 cm rotates anti-clockwise with an angular velocity of 6 rad/sec. The connecting rod BC is 45 cm in length and the slider at C is constrained to move along a horizontal line. At the instant shown, find the angular velocity of rod BC and velocity of slider at C. **[6]**
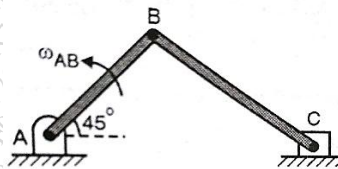
6. a) Determine the force P to cause motion to impend. Take masses of blocks A and B as 8kg and 4kg respectively. Coefficient of static friction between sliding surfaces is 0.2. Assume smooth pulley. The force P and the rope are parallel to the inclined plane. **[8]**
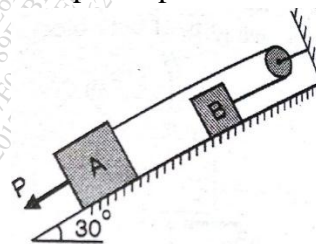
b) Explain conditions for equilibrium for different system of forces in space. **[4]**

c) A car starts from rest and moves along a circular path having a radius of 25m. Its speed increases at a uniform rate of $0.5 \ m/s^2$. Find the time from the start and distance travelled

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when its resultant acceleration becomes 1.5 m/s^2. **[4]**

d) Blocks $P_1 = 4N$ and $P_2 = 8N$ are connected by inextensible string. Find acceleration of the blocks. The coefficient of kinetic friction is 0.15, pulley is frictionless. **[4]**


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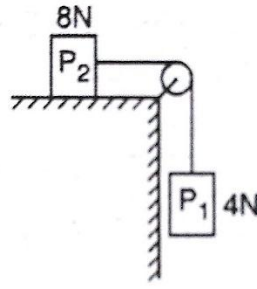
N. B.   1) Question No. **1** is **compulsory**.
        2) Answer any **3** questions from the remaining **5** questions.
        3) Assume suitable data wherever necessary.

Q1   Solve the following   20
            (a) Using source transformation, find I in the circuit shown.
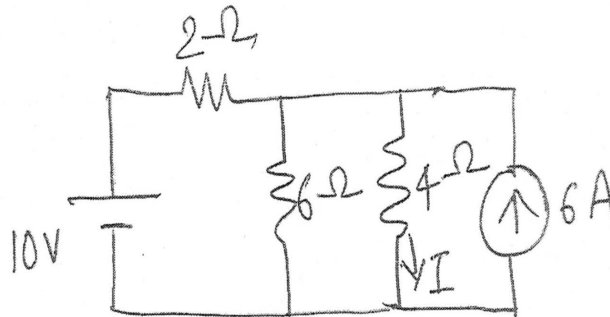

        (b) Derive emf   equation for single phase transformer.
        (c) Show that the sum of three phase emf's is zero in a three phase ac circuit.
        (d) Compare series and parallel resonant circuit.

Q2   (a)Coil A takes 2A at power factor of 0.8 lagging with an applied voltage of   10
            10 V, second coil B takes 2 A with power factor of 0.7 lagging with applied
        voltage of 5V. What voltage will be required to produce a total current of
        2 A with coil A and B in series. Find power factor in this case.

        (b) Draw no load phasor diagram of transformer and explain it.   6

        (c) Explain working principle of DC motor and DC generator.   4

Q3   (a) Using Thevenin's Theorem, obtain the power drawn by 20Ω resistor in the   10
            network shown below.
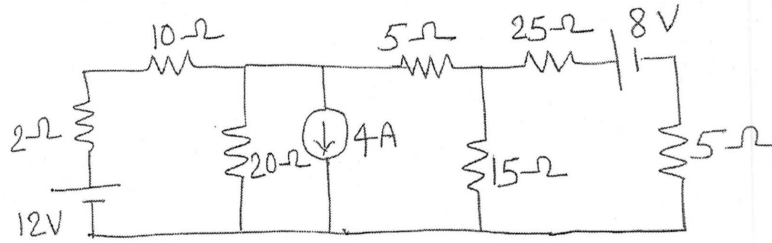
(b) In a balanced three phase circuit, the power is measured by two wattmeters, the ratio of wattmeter reading is 2:1. Determine the power factor of the system.

4

(c) Find the RMS value of the waveform.

6
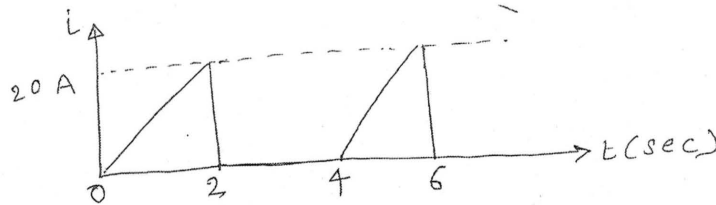
Q4 (a) A parallel circuit consists of 2.5µF capacitor and a coil whose resistance and inductance are 15 Ω and 260 mH respectively. Determine resonant frequency,Q factor of the circuit at resonance and dynamic impedance of the circuit.

7

(b) A balanced delta connected load has impedance of (14.151-j200) Ω in each branch. Determine branch current, line current, total power taken if balanced three phase 400V, 50 Hz supply is used. How much power is absorbed in each branch of delta?

6

(c) Find the equivalent resistance between A&B.

7

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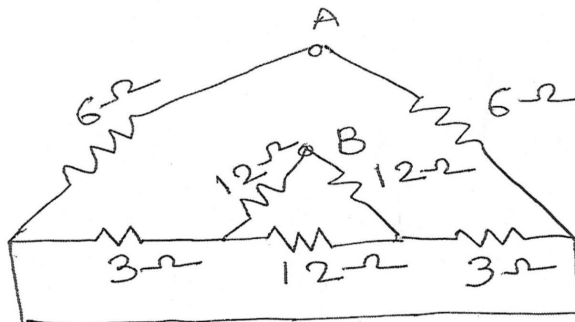
Q5   (a) Find the current through 6Ω resistance using Nodal analysis.   7
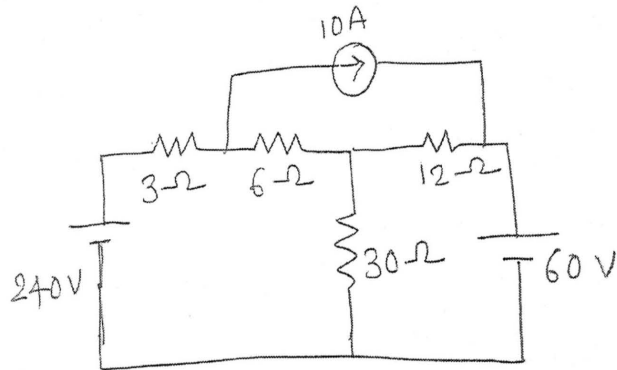
(b) Find I_1 & I_2.   7
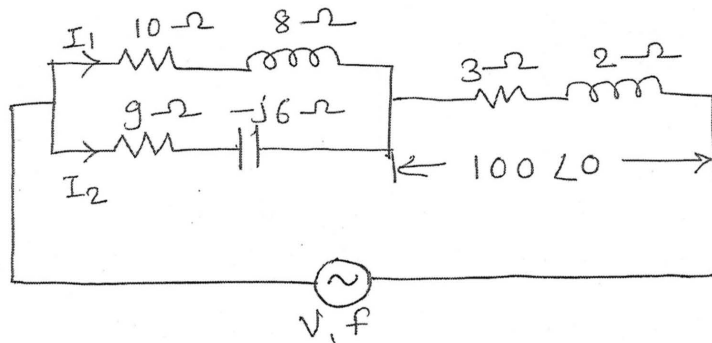
(c) A single phase 440/220V, 10 KVA, 50 Hz transformer has resistance of   0.2Ω   6
    and reactance of 0.6 Ω on high voltage side. The corresponding values of low
    voltage side are 0.04 Ω and 0.014 Ω. Calculate the regulation on full load for 0.8
    lagging power factor.

Q6   (a) Determine the relationship between phase and line voltage and current for star   6
    connected balanced load across a three phase balanced system.

(b) By mesh analysis, find V.   8
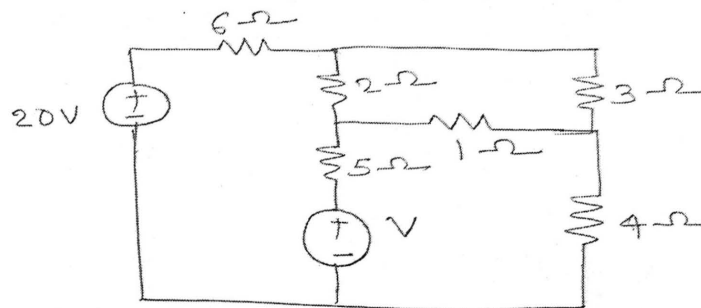
c) If v= 100 sin3t, determine branch current I_1 & I_2 with their phase angle and total   6
current supplied by the source and its phase angle.

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(2 Hours)   (Total 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 remaining **five** questions.

3) **Figures** to the **right** indicate **full marks**.

4) **Atomic weight :**

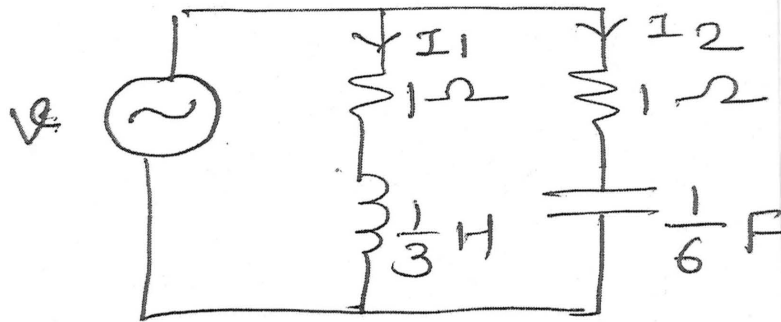Ca = 40, Mg = 24, H = 1, C = 12, O = 16, Cl = 35.5, S = 32, N = 14.

1. Attempt **any five** from the following :   (15)

   a) Give the preparation, properties and uses of PMMA.

   b) Why COD is greater than BOD?

   c) Define Viscosity Index and give its significance in lubrication.

   d) Find out degree of freedom for the following equation :

      i) $CaCO_{3(S)} \rightleftarrows CaO_{(S)} + CO_{2(g)}$

      ii) $NH_4Cl_{(S)} \rightleftarrows NH_{3(g)} + HCl_{(g)}$

   e) Write a note on concrete.

   f) Define fabrication. Draw labelled diagram for injection moulding.

   g) Calculate temporary and permanent hardness of water sample containing following impurities; $CaSO_4 = 13.6ppm$, $MgCl_2 = 9.5ppm$, $MgSO_4 = 6.0ppm$, $CaCl_2 = 11.1ppm$.

2. a) A water sample on analysis gave the following data :   (06)

     $MgSO_4 = 8.4ppm$, $Mg(HCO_3)_2 = 173.4$, $CO_2 = 300ppm$, $MgCl_2 = 95ppm$, $Mg(NO_3)_2 = 26.9ppm$. Calculate the lime (80% pure) and soda (85% pure) requirement in Kg for softening of 30,000 liters of water.

   b) What is reduced phase rule? Explain two-component lead- silver system with neat and labeled phase diagram.   (05)

   c) Write a short note on laser method used in manufacturing of CNT.   (04)

3. a) Define Lubricant. Explain thin film lubrication in detail.   (06)

   b) What is vulcanization? How it help to remove drawback of natural rubber?   (05)

   c) Define triple point. Explain with example.   (04)

4. a) Explain the role of each constituent in compounding of plastics. **(06)**

b) Explain following : **(05)**

    i) Chlorine treatment method for municipal water

    ii) Reverse osmosis.

c) 20 ml of lubricating oil required 2.5 ml of 0.1N KOH for titration. Calculate acid **(04)** value of a lubricating oil. (Density of oil = 0.81 gm/ml). From acid value state whether the oil is useful for lubrication or not.

5. a) Define Portland cement. Name the raw materials and give composition of **(06)** Portland cement.

b) Write a note on conducting polymer. **(05)**

c) An zeolite softener was completely exhausted and was regenerated by passing **(04)** 8 liters of NaCl solution having strength 150g/L. If hardness of water is 170 ppm, then calculate total volume that can be softened by zeolite softener.

6. a) What is Activated sludge process? Explain activated sludge process in detail. **(06)**

b) Give preparation and uses of Kevlar and Urea formaldehyde resin. **(05)**

c) Explain following properties of lubricant with their significance **(any two)** : **(04)**

    i) Oiliness

    ii) Saponification Value

    iii) Cloud point and Pour point.

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Time: 2 Hours **Marks: 60**

N:B 1. Question **No.1** is compulsory.
2. Attempt any **Three** questions from the remaining questions Nos.2 to 6.
3. Assume suitable data wherever required.
4. Figures to the right indicate marks.

Q.1 Attempt **Any Five**
a) Define the following terms 1) Space lattice 2) Unit cell 3) lattice point **03**
b) Distinguish between insulators, conductors and semi-conductors in terms of their energy bands. **03**
c) What are liquid crystals? List the various types of liquid crystals. **03**
d) What are polar and non-polar dielectrics? **03**
e) Define relative permeability and susceptibility. Write the relation between them. **03**
f) A classroom has dimensions $20x15x5$ m^3, the reverberation time is 3.5sec.Calculate the total absorption of its surfaces and the average absorption coefficient. **03**
g) What are ultrasonic waves? State the direct piezoelectric effect. **03**

Q.2 a) Show that Fermi level in intrinsic semiconductor lies at the centre of the forbidden band. $E_F=E_C +E_V/2$ **08**
b) Draw the following: (i) $(2\ 3\ \bar{1})$ (ii) $[2\ 0\ 1]$ (iii) $(\bar{1}\ \bar{2}\ \bar{1})$ Calculate the packing efficiency for Body centered cubic cell? **07**

Q.3 a) Explain various stages of hysteresis and give the significance of hysteresis **08**
b) Deduce the Braggs law for the diffraction of X- rays in crystals. **07**

Q.4 a) For a cubic structure in a crystal, derive an expression for interplanar spacing between the planes with miller indices (hkl) **05**
b) What is potential barrier? How is it formed in a p-n junction? **05**
c) Derive Clausius –Masotti relation for non-polar dielectrics. **05**

Q.5 a) Copper has F.C.C. structure and the atomic radius is 1.28 Å. Calculate its density. (At wt = 63.54, N_A = 6.023 X 10^{23}) **05**
b) A copper strip 2cm wide and 1mm thick is placed in a magnetic field with B=1.5 Wb/m^2.If current of 200 A is set up in the strip, calculate Hall voltage that appears across the trip. Given R_H =6 x 10^{-7} m^3/C. **05**
c) Explain in detail the conditions necessary for good acoustical design of an auditorium **05**

Q.6 a) What are real crystals? Differentiate between Frenkel and Schottky defect **05**

b) Define the terms:i) mobility ii) conductivity. Find the resistivity of intrinsic germanium at 300K.Given the density of carriers as 2.5 x 10^{19} /m^3,μ_e =0.39 m^2/V-sec and μ_h = 0.19m^2 /V-sec. **05**
c) Find the natural frequency of vibration of quartz plate of thickness 1.8mm.Given Young's modulus for quartz is 8 x 10^{10} N/m^2, Density of quartz is 2650 kg/m^3. **05**

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Q.P. Code : 75825

[2 Hours] [Total Marks: 60]

Please check whether you have got the right question paper.

N.B: 1. **Question no. 1 is compulsory.**
2. **Answer any three from remaining Q.2 to Q.6.**
3. **Draw neat labelled diagrams where applicable.**
4. **Figures to the right indicate full marks.**

Q1. Attempt any five questions from the following:- [15]
(a) Explain the concept of 'food web'
(b) Briefly explain the importance of environmental education for sustainable development.
(c) Explain the role of MoE&F (ministry of environment and forest) towards conservation of environment.
(d) Draw a labeled diagram of wind turbine and explain only its working principles.
(e) Explain the term 'Carbon credit'
(f) What is photochemical smog and what are its effects.
(g) What are the causes and effects of noise pollution?

Q2. (a) What are the economic and environmental aspects of sustainable development? [5]
(b) What is global warming? How does it affects us adversely? [5]
(c) Draw a rough schematic of photovoltaic cell and explain its role in energy generation. [5]

Q3. (a) Draw a neat diagram of bag house filter and explain its working. [5]
(b) Briefly explain important features of environmental clearance and authorization mechanism. [5]
(c) How disaster management is important in the event of earthquake. [5]

Q4. (a) What are the causes and impact of depletion of natural forest resources? [5]
(b) Write a note on environmental protection act. [5]
(c) Explain how hydropower is generated with suitable diagram. [5]

Q5. (a) What is the relevance of appropriate technology for sustainable development? [5]
(b) Differentiate between: conventional and non-conventional energy sources. [5]
(c) Write a brief note on: E- pollution. [5]

Q6. (a) What are the global environmental problems due to population? [5]
(b) Explain briefly how composting is carried out. [5]
(c) Explain how technology is useful for better human health and environment. [5]

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