(Time: 3 hours)   **Total Marks: 80**

N.B. (1) Question no. 1 is Compulsory
          (2) Solve any three from the remaining.

Q.1) a) Prove that $\left(1 + i\sqrt{3}\right)^8 + \left(1 - i\sqrt{3}\right)^8 = -2^8$ (3)

b) If $A = \frac{1}{3}\begin{pmatrix} 1 & 2 & a \\ 2 & 1 & b \\ 2 & -2 & c \end{pmatrix}$ is orthogonal find a,b,c. (3)

c) $z^3 + xy - y^2 z = 6$ find $\frac{\partial z}{\partial x}$ and $\frac{\partial z}{\partial y}$ where z is an implicit
    function of x and y. (3)

d) If $u = e^x \cos y, v = e^x \sin y$ find $\frac{\partial(u,v)}{\partial(x,y)}$. (3)

e) Find the nth derivative of $y = \frac{x^2+4x+1}{x^3+2x^2-x-2}$ (4)

f) Find a,b if $\lim\limits_{x->0} \frac{a\sinh x + b\sinh x}{x^3} = \frac{5}{3}$ by L'Hospitals Rule. (4)

Q.2) a) Find the roots common to $x^4 + 1 = 0$ and $x^6 - i = 0$ (6)

b) If $y = \sin^{-1}x$ Prove That
    $(1 - x^2)y_{n+2} - (2n + 1)xy_{n+1} - n^2 y_n = 0$ also find $y_9(0)$ (6)

c) Discuss the maxima and minima of
    $f(x,y) = x^3 + 3xy^2 - 15x^2 - 15y^2 + 72x$ (8)
    Hence find maximum and minimum value of $f(x,y)$.

Q.3) a) Find the values of k for which the equations (6)
    $x + y + z = 1, x + 2y + 3z = k, x + 5y + 9z = k^2$ have a solution,
    solve them for these values of k.

b) If $x = \sqrt{vw}, y = \sqrt{wu}, z = \sqrt{uv}$, Prove that (6)
    $x\frac{\partial\phi}{\partial x} + y\frac{\partial\phi}{\partial y} + z\frac{\partial\phi}{\partial z} = u\frac{\partial\phi}{\partial u} + v\frac{\partial\phi}{\partial v} + w\frac{\partial\phi}{\partial w}$
    where ϕ is the function of x,y,z.

c) If $\tan(\alpha + i\beta) = \cos\theta + i\sin\theta$ Prove that (8)
    $\alpha = \left(\frac{n\pi}{2} + \frac{\pi}{4}\right)$ & $\beta = \frac{1}{2}\log\tan\left(\frac{\pi}{4} + \frac{\theta}{2}\right)$.

Q.4) a) If $z = e^{x/y} + \log(x^3 + y^3 - x^2y - xy^2)$, Find the value of (6)
    $x\frac{\partial z}{\partial x} + y\frac{\partial z}{\partial y} + x^2\frac{\partial^2 z}{\partial x^2} + 2xy\frac{\partial^2 z}{\partial x\partial y} + y^2\frac{\partial^2 z}{\partial y^2}$.

b) Using encoding matrix $\begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$ encode and decode the message (6)
    NOW*STUDY

C) Solve the following equations by Gauss Jacobi's Iteration method (8)
    $15x + 2y + z = 18, 2x + 20y - 3z = 19, 3x - 6y + 25z = 22$

Q.5) a) Prove that the general value of $(1 + itan\alpha)^{-i}$ is   (6)
$$e^{2m\pi+\alpha}[cos(logcos\alpha) + isin(logcos\alpha)]$$
   b) State and Prove Eulers Theorem for function of Three Variables.   (6)
   c) Expand $x^5 - x^4 + x^3 - x^2 + x - 1$ in powers of $(x-1)$ and   (8)
      hence find $f\left(\frac{11}{10}\right), f(0.99)$.

Q.6) a) Prove that:
$$sinh^7 x = \frac{1}{64}(sinh7x - 7sinh5x + 21sinh3x - 35sinhx)$$ (6)
   b) Find nonsingular matrices P and Q such that PAQ is in Normal form.

   also find Rank of A, where A= $\begin{bmatrix} 2 & 1 & 4 \\ 3 & 2 & 2 \\ 7 & 4 & 10 \\ 1 & 0 & 6 \end{bmatrix}$.   (6)

   c) Using Newton Raphson Method find an iterative formula for $\sqrt[5]{N}$ where
      N is positive number, Hence find $\sqrt[5]{35}$.   (8)

****

(3 Hours) **Marks :80**

N.B.   1. Question No.1 is compulsory.
2. Answer any three questions from remaining questions.
3. Assume suitable data if required.
4. Figure to the right indicates full marks.
5. Take g= 9.81 m/s².

Q.1   Attempt any four.   **20**
a)   A force of a100 N act at a point P (-2, 3, 5)m has it line of action passing through Q (10,3, 4)m. Calculate the moment of force about origin.
b)   A vertical lift of total mass 750 kg acquires an upward velocity of 3 m/s over a distance of 4m moving with constant acceleration starting from rest. Calculate the tension in cable.
c)   For the mechanism shown express the relation between forces F and P in terms of θ, by principle of virtual work.
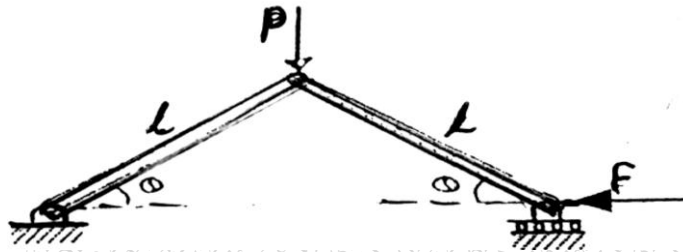
d)   A stone is released from top of the tower during the last second of its motion, it covers 1/4th of the height of the tower. Find the height of the tower.
e)   A roller of weight 500 N has a radius of 120 mm and is pulled over a step at height 60 mm by a horizontal force P. Find magnitude of P to just start the roller over the step.
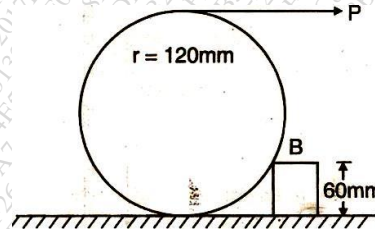
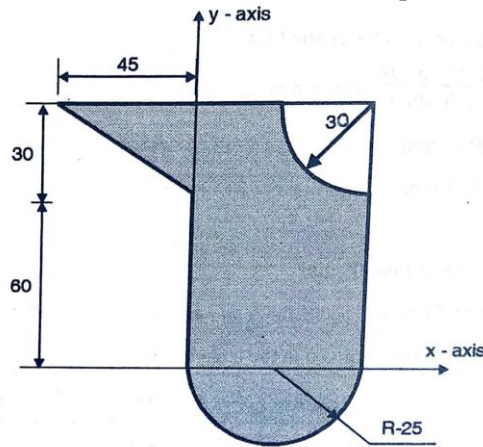f)   Classify types of motion for rigid body with suitable examples.

Q.2 a)   State the laws of dry friction.   **4**

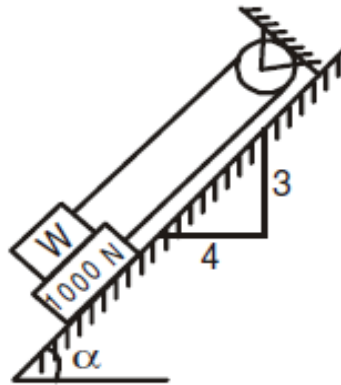b)   Find support reaction of the beam as shown in fig.   **8**
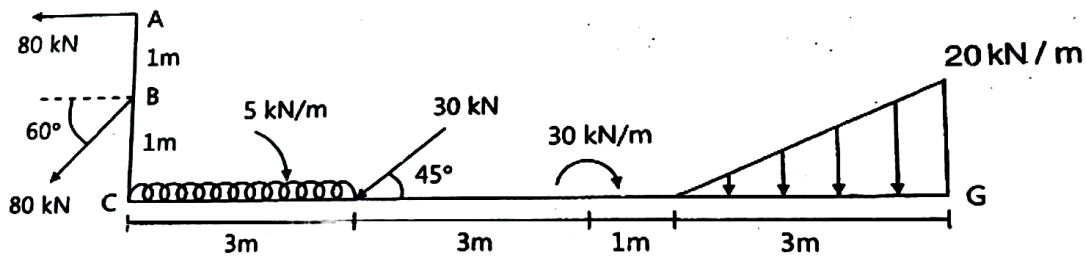

71227   Page **1** of **4**
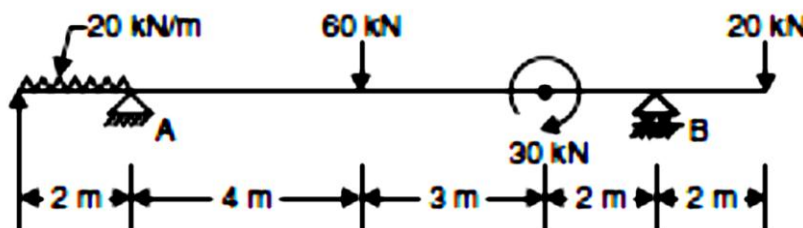
c) Find the coordinates of the centroid of the shaded area with respect to the axes shown in Fig. **8**

Q.3 a) In Fig. The frictionless fixed drum, and coefficient of friction between other surfaces of contact is 0.3. **8**
Determine the minimum weight W to prevent downward motion of the 1000 N body.



b) Determine the resultant of the given force system as shown in fig. **6**

c) An automobile starts from rest and travels on a straight path at 2 m/s² for some time. After which it **6**
deaccelerates at 1 m/s², till its comes to halt. If the distance covered is 300 m, find the maximum
velocity of the automobile and the total time of travel.

71227

2FC8B81F0F26A74E5132017E08DB2FB5

Q.4 a) Two 10^0 wedges of negligible weight are used to just move the block of mass 100 kg. If $\mu = 0.25$ at all   **8**
surfaces of contact. Find the force P that should be applied on the wedge.
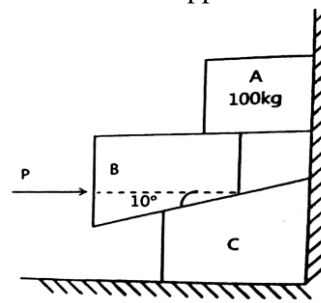
b) State and derive Work Energy principle.   **4**
c) Find the initial velocity and corresponding angle of projection of a projectile such that when projected   **8**
from the ground it just clears a wall 4.5 m high at a horizontal distance of 6 m and finally lands on the
ground at a distance of 35 m beyond the wall.

Q.5 a) Referring to the truss shown in figure, find: **8**
(a) Support Reactions.   .
(c) Forces in members BD, CD and CE by method of sections.
(d) Forces in other members by method of joints.
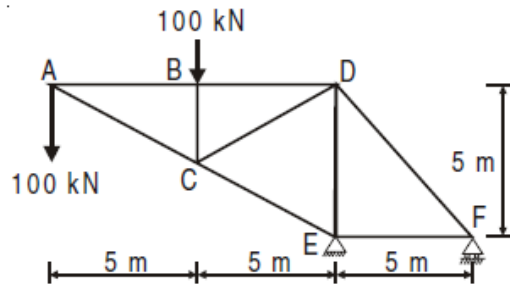
b) Two balls of the masses 10 kg and 20 kg are moving along a straight line towards each other at   **6**
velocities of 4 m/s and 1 m/s respectively. If e=0.6, determine the velocities of the balls just after
collision.
c) For the position shown, the angular velocity of bar AB is 2.8 r/s clockwise if AB is a horizontal.   **6**
Determine the velocities of slider E and point D.

71227   Page **3** of **4**
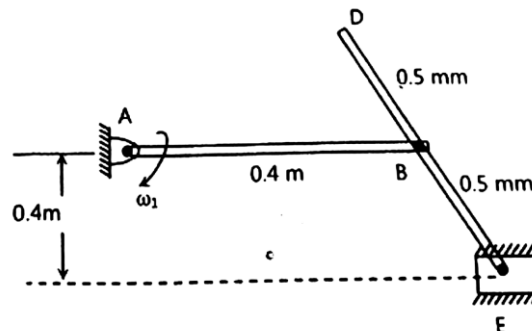
Q.6 a) Three identical spheres P, Q and R each of weight W are arranged on smooth inclined surface are shown in Fig. Determine the minimum angle α, which will prevent the arrangement from collapsing. **8**
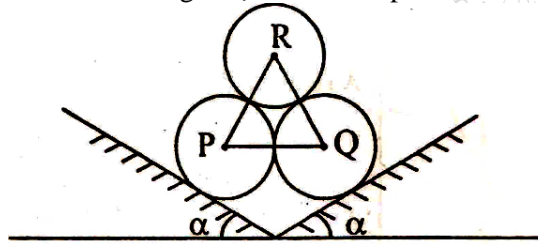
b) The block of amass 0.5 kg moves within the smooth vertical slot. If its start from rest, when the attached spring is in the upstretched position at A. determine constant vertical force F which must be applied to the cord, so that block attains a speed of 2.5 m/s when it reaches B. i.e., $S_B = 0.15$ m, neglect the mass of the cord, pulley and friction between cord and pulley. **6**
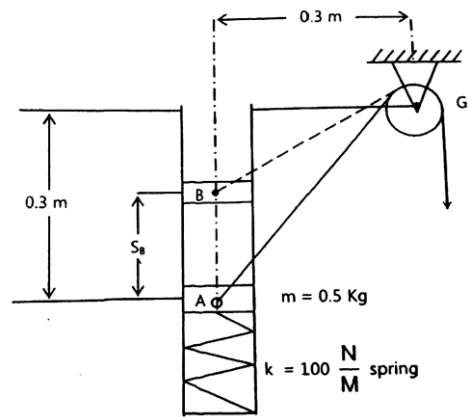
c) A car is moving on a curve of radius 300 m at a speed of 90 kmph. The brakes are suddenly applied, causing speed to decrease at a constant rate of 1.3 m/s². Determine the total acceleration immediately after brakes have been applied. **6**

2FC8B81F0F26A74E5132017E08DB2FB5

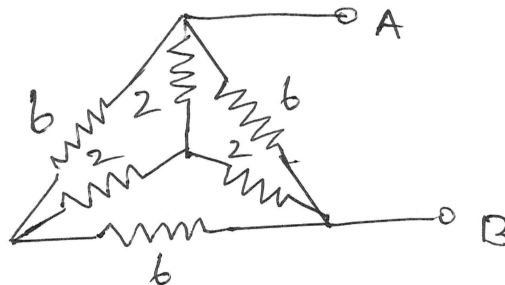**TOTAL MARKS: 80**   **TIME: 3hrs**

NB
1) Question No. 1 is compulsory.
2) Answer any three questions out of remaining five questions.
3) Assumption made should be clearly stated.
4) Answer to questions should be grouped together and written together.

Q1   a.   Find R_{AB} 3

b.   Find the Norton's equivalent across AB.   3
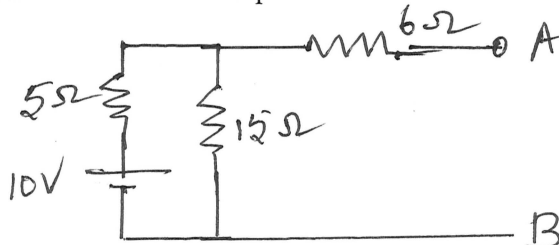
c.   A pure inductor of 0.2 H is connected across single phse 200 V, 50 Hz   3
     supply. Write the instantaneous equation of voltage and current.
d.   Write any four conditions of series resonance.   3
e.   What is the phase line relation in star connected system?   2
f.   Explain the working of a single phase transformer under load   4
g.   Illustrate the working of half wave rectifier.   2

Q2   a.   Using Mesh analysis find current through 2 Ω resistor.   6

b.   The impedances (8+6) Ω and (10-j10)Ω are connected in parallel across   8
     voltage of $230\angle 0$. Determine current in each branch and kVA, kVAR,
     kW and power factor of the whole circuit.

[TURN OVER

   c.   Derive emf equation of a single phase transformer   6

Q3 a.   Calculate the phase and line currents in a balanced delta connected load 8
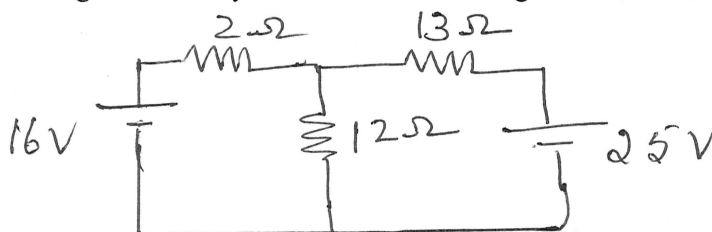   taking 75 kW at a power factor of 0.8 lag from a three phase 440 V
       supply. Also calculate the per phase impedance.

   b.   Illustrate with neat circuit diagram the procedure for conducting open 6
       circuit test and short circuit test.

   c.   Illustrate with neat diagram and explain the input characteristics of an 4
       NPN transistor in CE configuration.

   d.   Draw the circuit diagram and output voltage waveform of a full wave 2
       rectifier with capacitor filter.

Q4 a.   Find current through 8 Ω resistor using source transformation.   7
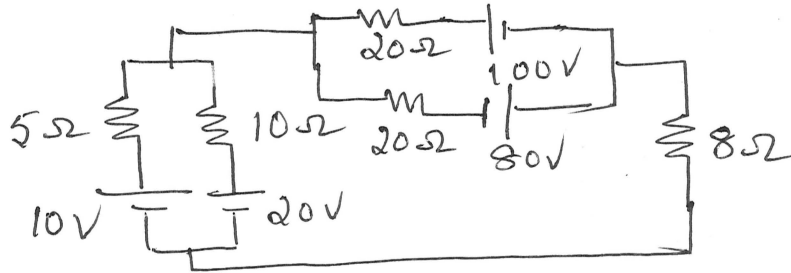
   b.   Three identical coils each having a resistance of 10 Ω and an inductive
       reactance of 10 Ω are connected in star across 400 V three phase supply. 4
       Find the reading on each of the watt meters connected to measure the
       power

   c.   Define the rms value of an ac quantity.   5

   d.   Derive rectification efficiency and ripple factor of a full wave bridge 4
       tapped rectifier.

Q5 a.   Determine the current through 8 Ω resistor in the network using 8
       Thevenin's theorom
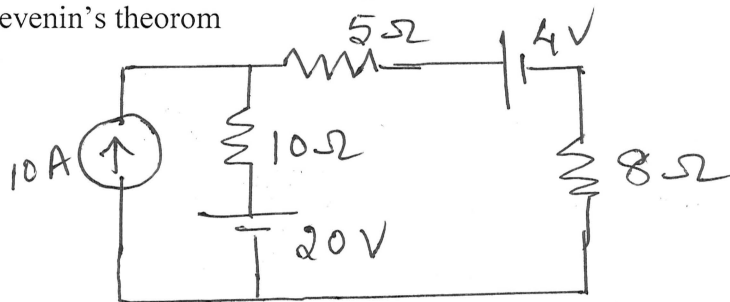
   b.   An rms voltage of $100\angle 0$ is applied to an impedance $Z = 20\angle 30$. Find 4
       the current through the circuit and power factor of the circuit.

   c.   Derive the conditions for maximum efficiency of a single phase 8
       transformer.

Q6 a. Find current through 4 Ω resistor using superposition theorem. 7
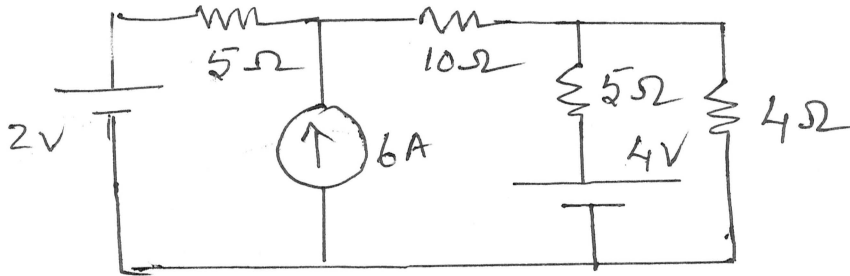
  b. A series R-L-C circuit with R=10 Ω, L=0.014 H and C=10 μF is 7
      connected across 230V variable frequency supply.
      Calculate a) resonance frequency b) current at resonance c) Q-factor d)
      voltage across inductor and capacitor and e) power factor at resonance.

  c. Prove that the power and power factor in a balanced three phase circuit 6
      can be calculated from the reading of two watt meters. Draw relevant
      connections and phasor diagram.

(2 Hours)   **Total Marks: 60**

NB: 1. Question No.1 is compulsory.
    2. Answer any three questions from remaining five.
    3.All questions carry equal marks.
    4. Atomic Weight: H=1,C=12,O=16,Ca=40,Na=23,Mg=24,Si=28,S=32,Cl=35.5,N=14,Al=27,K=39

1.   Solve any five.

(a)   Write the applications of CNT's.   3

(b)   Distinguish between thermoplastic and thermosetting polymer.   3

(c)   Define viscosity and viscosity index.Discuss its significance.   3

(d)   What are conducting polymers?Explain with suitable examples.   3

(e)   Explain Gibb's phase rule.Define the terms involved in it.   3

(f)   Define BOD and COD.   3

(g)   Calculate Temporary and permanent hardness :   3

       $Mg(HCO_3)_2$ = 73.8 mg/l, $Ca(HCO_3)_2$ =162. 8 mg/l, $MgCl_2$ = 95.8 mg/l
              $CaSO_4$ =136 mg/l

2. (a)   1g of $CaCO_3$ was dissolved in 1 litre of distilled water. 50ml of this solution required   6
          45ml of EDTA solution. 50 ml of hard water required 25 ml of EDTA. The same sample
          of water after boiling consumed 15 ml of EDTA. Calculate each type of hardness.

    (b)   i) Write the role of plasticizers and stabilizers in the compounding of polymers.   3
          ii) What are Semi-solid lubricants? Under which conditions they are used.   2

    (c)   What are CNT's? Explain chemical vapour deposition method of preparation of   4
          CNT's.

   3.(a)   What is fabrication of plastic ? Explain transfer moulding process with the help of neat   6
          labelled diagram.

(b) i) Discuss the advantages and limitations of phase rule. 3
ii) What are fullerenes? Write important applications of fullerenes. 2

(c) The hardness of 50,000 litres of water sample was removed by zeolite softener. The 4
softness required 200 litres of NaCl solution containing 50gm/l. NaCl for regeneration.
Calculate the hardness of water sample.

4. (a) Draw the diagram for demineralization process and write suitable reactions involved in 6
the process. What are the advantages and disadvantages of the method.

(b) i) 5 gms of an oil was saponified with 50 ml of 0.5 N alcoholic KOH. After 3

refluxing for 2 hrs,the mixture was titrated by 15 ml of 0.5 N HCl.Find the

saponification value of oil.

ii) What are the advantages of RCC over concrete? 2

(c) Natural rubber requires vulcanization. Give reasons. With appropriate reactions explain 4
how the drawbacks are overcome?

5. (a) Write preparation ,properties and uses of following polymers: 6

i) PMMA ii) Silicone rubber

(b) i) Define Chemical Oxygen Demand (COD). 25 ml of sewage water required 8.3 3
ml of 0.001M $K_2Cr_2O_7$ for its complete oxidation. Calculate COD of this water
sample.
ii) Mention the role of additives used in blended oils. 2

(c) Draw and explain the phase diagram of Pb- Ag system. 4

6. (a) What are lubricants? Define Lubrication. Explain Hydrodynamic lubrication mechanism 6
with neat diagram.

(b) i) What is the Triple Point? At what conditions triple point exists in water system? 3

ii) Write a short note on reverse osmosis. 2

(c) Explain wet process of preparing the Portland cement. 4

(2 Hours) [Total Marks:60]

N.B.: (1) Question. **1** is **compulsory.**
(2) Attempt any **three** questions from the remaining questions N0.**2** to **6.**
(3) **Assume** suitable **data** wherever required.
(4) **Figures** to the **right** indicate **marks.**

1. Attempt any **five** questions from the following- 15
   (a) Calculate atomic packing fraction of HCP unit cell.
   (b) Express de-Broglie wavelength in various forms.
   (c) Draw the energy band diagram for p-n junction diode in forward and reverse bias condition.
   (d) Define: persistent current, critical temperature, critical magnetic field.
   (e) What is reverberation time? Explain its formula.
   (f) With the help of diagram state direct and inverse piezoelectric effect.
   (g) The resistivity of intrinsic material at room temperature is 2×10^{-4} Ohm-cm. If the mobility of electron is 6 m^2/V-sec and mobility of hole is 0.2 m^2/V-sec. Calculate its intrinsic carrier density.

2 (a) Arrive at the statement that electron can not survive inside the nucleus. 8
   An electron has a speed of 300m/s with uncertainty of 0.01% . Find the accuracy in its position.
  (b) A sample of semiconductor is placed in uniform magnetic induction *B* with sample 7
   current *I* and thickness *w* then obtain the expression for (a) Hall voltage and (b) Hall coefficient.

3 (a) With neat diagram of unit cell explain the structure of diamond crystal. 8
  (b) Explain variation of Fermi level with temperature in n-type semiconductor. 7
   What is the probability of an electron being thermally excited to the conduction band
   in Si at 30^0C. The band gap energy is 1.12eV (k=1.38×10^{-23} J/K)

4 (a) Distinguish between Type I and Type II superconductors. 5
  (b) A class room has dimension of (20x15x10) m^3; the reverberation time is 3 sec. 5
   Calculate the total absorption of its surfaces and average coefficient of absorption
  (c) How ultrasonic waves are produced using quartz crystal in an oscillator? 5

5 (a) Show that for an intrinsic semiconductor, the Fermi level lies half way between 5
   conduction and valence band.
  (b) State and explain principle of SQUID and explain its working to determine the strength
   of magnetic field. 5
  (c) The lowest energy of an electron trapped in a one dimensional box is 5
   3.2×10^{-18} J. Calculate the width of the box. Also calculate the next two energies
   in eV the particle can have?

6 (a) Define ligancy and critical radius ratio. Calculate critical radius ratio for ligancy 6. 5
  (b) Obtain one dimensional time dependent Schrodinger equation 5
  (c) Explain photovoltaic effect and write a note on solar cell. 5

****

78352

Time: 2 Hours   **Marks: 60**

N.B.:

(1) Q.1 is compulsory. Attempt any three questions from Q.2 to Q.6.

(2) Draw neat diagrams wherever necessary.

(3) Figures to the right indicate full marks.

Q.1   Attempt **any five** from the following:-   **15M**

a   Define ecosystem. List out any four factors which disturb the energy balance in the
     ecosystem.

b   What is conventional source of energy? Mention any four drawbacks of conventional
     sources of energy.

c   What is photochemical smog? Give any four sources and any four bad effects of
     photochemical smog.

d   State any four sources responsible for water pollution of Ganga river. Mention any
     two ways for elimination of water pollution of Ganga river.

e   State any six functions of central pollution control board.

f   What is soil pollution? State any four side effects of pollution.

g   Mention any three social and economical aspects of sustainable development.

Q.2   Attempt the following:-   **15M**

(a)   What is industrial waste water? Mention any three sources and three bad effects of   5M
       industrial waste water. Mention any two ways for removal of industrial waste water
       pollution.

(b)   Give the principle, construction, working and schematic diagram of steam turbine   6M
       power plant. Mention any two advantages and disadvantages of steam turbine power
       plant.

(c)   What is the importance of environmental education? How does Biomass and energy   4M
       flow are related in ecological pyramid?

Q.3   Attempt the following:-   **15M**

(a)   Explain the case study of Fukushima disaster (March, 2011).   5M

(b)   What is environmental degradation? Mention the causes (any four) and bad effects   5M
       (any four) of depletion of natural water resources.

(c) What is green building? Explain the concepts and give any four objectives of Green building. 5M

Q.4 Attempt the following:- **15M**

(a) Give the schematic diagram of venturi scrubber used for purification of air pollutants. Give the principle, construction, any two advantages and disadvantages of venturi scrubber. 6M

(b) What is indoor air pollution? Mention any four sources and four bad effects of indoor air pollution. 5M

(c) Write a short note on case study on Narmada Bachao Andolan. 4M

Q.5 Attempt the following:- **15M**

(a) Explain the concept of flat plate collector with the help of its principle, construction, working, advantages (any two) and disadvantages (any two). 6M

(b) Define noise pollution. Mention any three sources and three adverse effects of noise pollution. 4M

(c) What do you mean by Solid waste? What are the different sources (any four) responsible for the solid waste? Explain composting in brief. 5M

Q.6 Attempt the following:- **15M**

(a) Give the neat and labeled diagram for photovoltaic cell. Give the principle, construction, working, advantages (any two) and disadvantages (any two) involved in photovoltaic cell. 6M

(b) What is e-pollution? State any four sources and any four bad effects of e-pollution. What are the preliminary actions to be taken to avoid e-pollution? 5M

(c) What is acid rain? Give the reactions taking place in the environment during acid rain. Give any two bad effects of acid rain. 4M

****

(3 Hours) [Total Marks : 80

Note:

1) Question No.1 is compulsory

2) Attempt any three out of remaining five questions

3) Figures to the right indicate full marks

Q1.

a) If $\sin(\theta + i\varphi) = tan\alpha + iseca$, then show that $\cos 2\theta \cdot cosh2\varphi = 3$ **[5]**

b) If $u = \log(tanx + tany)$, then show that $sin2x\frac{\partial u}{\partial x} + sin2y\frac{\partial u}{\partial y} = 2$ **[5]**

c) Express the matrix A $= \begin{bmatrix} 0 & 5 & -3 \\ 1 & 1 & 1 \\ 4 & 5 & 9 \end{bmatrix}$ as the sum of a symmetric and skew symmetric matrix.

[5]

d) Expand $\sqrt{1 + sinx}$ in ascending powers of x upto x^4 term. **[5]**

Q2.

a) Find non-singular matrices P and Q such that PAQ is in normal form where, **[6]**

A$= \begin{bmatrix} 4 & 3 & 1 & 6 \\ 2 & 4 & 2 & 2 \\ 12 & 14 & 5 & 16 \end{bmatrix}$. Also find the rank of A.

b) If $z = f(x, y)$ and $x = u \, coshv, \; y = u \, sinhv$; prove that **[6]**

$$\left(\frac{\partial z}{\partial x}\right)^2 - \left(\frac{\partial z}{\partial y}\right)^2 = \left(\frac{\partial z}{\partial u}\right)^2 - \frac{1}{u^2}\left(\frac{\partial z}{\partial v}\right)^2$$

c) Prove that $Log\left[\frac{(a-b)+i(a+b)}{(a+b)+i(a-b)}\right] = i(2n\pi + tan^{-1}\frac{2ab}{a^2-b^2})$. Hence evaluate $Log\left(\frac{1+5i}{5+i}\right)$

[6]

77691 **Page 1 of 3**

Q3.

a) If α *and* β are the roots of the equation $z^2 sin^2\theta - z \, sin \, 2\theta + 1 = 0$, then prove that

$\alpha^n + \beta^n = 2\cos n\theta \, cosec^n\theta$ and $\alpha^n\beta^n = cosec^{2n}\theta$ **[6]**

b) Solve the following equations by Gauss–Seidal Method ; **[6]**

$15x + 2y + z = 18$, $2x + 20y - 3z = 19$, $3x - 6y + 25z = 22$,

Take three iterations.

c) Prove that if z is a homogeneous function of two variables x and y of degree n, then

$x^2 \frac{\partial^2 z}{\partial x^2} + 2xy \frac{\partial^2 z}{\partial x \partial y} + y^2 \frac{\partial^2 z}{\partial y^2} = n(n-1)z$. Hence find the value of $x^2 \frac{\partial^2 z}{\partial x^2} + 2xy \frac{\partial^2 z}{\partial x \partial y} + y^2 \frac{\partial^2 z}{\partial y^2}$

at $x = 1, y = 1$ when $z = x^6 \, tan^{-1}\left(\frac{x^2+y^2}{x^2+xy}\right) + \frac{x^4+y^4}{x^2y^2}$ **[8]**

Q4.

a) If $\tan(\alpha + i\beta) = \cos\theta + i\sin\theta$ then prove that $\alpha = \frac{n\pi}{2} + \frac{\pi}{4}, \beta = \frac{1}{2} \, \log\left(\frac{\pi}{4} + \frac{\theta}{2}\right)$ **[6]**

b) Expand $x^5 + x^3 - x^2 + x - 1$ in powers of $(x-1)$ and hence find the value of **[6]**

1) $f\left(\frac{9}{10}\right)$

2) $f(1.01)$

c) For what values of λ and μ , the equations, **[8]**

$x + y + z = 6$; $x + 2y + 3z = 10$; $x + 2y + \lambda z = \mu$

1) have a unique solution

2) have infinite solution

Find the solution in each case for a possible value of μ and λ.

Q5.

a) Find the nth derivative of $y = \dfrac{1}{x^2 + a^2}$ [6]

b) Discuss the maxima and minima of $x^3 + xy^2 - 12x^2 - 2y^2 + 21x + 16$ [6]

c) Prove that if A and B are two unitary matrices then AB is also unitary. Verify the result when

$A = \dfrac{1}{\sqrt{3}}\begin{bmatrix} 1 & 1+i \\ 1-i & -1 \end{bmatrix}$ and $B = \begin{bmatrix} \dfrac{1+i}{2} & \dfrac{-1+i}{2} \\ \dfrac{1+i}{2} & \dfrac{1-i}{2} \end{bmatrix}$ [8]

Q6.

a) If $x = \cosh\left(\dfrac{1}{m}\log y\right)$, prove that [6]

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

b) Find a root of the equation $xe^x = \cos x$ using the Regular Falsi Method correct to three decimal places. [6]

c) 1) Expand $sin^4\theta \, cos^2\theta$ in a series of multiples of θ. [4]

2) If one root of $x^4 - 6x^3 + 18x^2 - 24x + 16 = 0$ is (1+i); find the other roots. [4]

92659A00AD7B035B581DE244EB28FFF1

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.

Q.1   Attempt any five questions from the following   [15]

(a) Draw (0 0 2), ($\bar{1}$ 0 0), (0 1 1)

(b) Explain any three properties of matter waves.

(c) Differentiate between Direct and Indirect band gap semiconductor.

(d) Explain any three conditions for Sustained Interference.

(e) A source is emitting 150W of red light of wavelength of 600nm. How many photons
per second are emerging from the source?

(f) Explain the Meissner effect with application.

(g) Explain Magneto Resistance with application.

Q.2   (a) Show that Non- Existence of electron in the Nucleus, Find the uncertainty in the
position of electron . The speed of an electron is measured to be 4.0×10^3 m/s
to an accuracy of 0.002% .   [8]

(b) Define the Fermi energy level , Show that in intrinsic semiconductor Fermi level is at
the centre of Forbidden energy gap. Draw the position of Fermi level in intrinsic,
P-type and N-type semiconductor.   [7]

Q.3   (a) Explain with diagram Bragg's X Ray Spectrometer . Calculate the interplaner
spacing between the family of planes (1 1 1) in crystal of lattice constant $3A^0$.   [8]

(b) Prove that the Diameter of the nth dark ring in Newton's ring setup is directly
proportional to the square root of the ring number . In Newton's Rings reflected
light of wavelength 5×10^{-5} cm. The diameter of the 10th dark ring is 0.5 cm.
Calculate radius of curvature R.   [7]

Q.4 (a) Derive one dimensional time independent Schrodinger Equation. [5]

(b) Differentiate between Type I superconductor and Type II superconductor. [5]

(c) Find Resistance of an intrinsic Ge rod of dimensions (1cm long ,
1mm wide and 1mm thick) at 300K . For Ge $n_i = 2.5 \times 10^{19}/m^3$, $\mu_n = 0.39 m^2/v\text{-}s$,
$\mu_p = 0.19 m^2/v\text{-}s$ [5]

Q.5 (a) Derive the condition for maxima and minima due to interference of light reflected
from thin film of uniform thickness. [5]

(b) Explain Hall Effect . Derive the equation for Hall Voltage. [5]

(c) Calculate the lowest three energy states of an electron confined in potential
well of width $10A^0$. [5]

Q.6 (a) Explain multiferroics and its different types. [5]

(b) A soap film 4×10^{-5} cm thick is viewed at angle of 35^0 to normal. Calculate
Wavelength of light in the visible spectrum which will be absent from the
Reflected light ($\mu = 1.33$) [5]

(c) The Coefficient (Rh) of semiconductor is 3.22×10^{-4} m^3c^{-1} . Its resistivity
is 9×10^{-3} Ω m . Calculate the mobility and concentration of carriers. [5]

****

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

N.B.:   (1) Question **No. 1** is compulsory.

       (2) Attempt any **THREE** questions from the remaining **FIVE** questions.

       (3) Assume suitable data if necessary and mention the same clearly.

       (4) Take g=9.81 m/s^2

Q.1   Answer any **FIVE** questions

    a.   The top end of a pole is connected by three cables having tension 500 N, 1500   [4]
        N and a guy wire 'AB' as shown in figure below. Determine tension in cable
        'AB' if the resultant of the concurrent force is vertical.
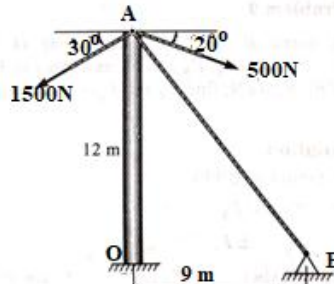
    b.   Locate the centroid of the shaded area obtained by cutting a semicircle of   [4]
        diameter 20 mm from the quadrant of a circle of radius 20 mm as shown in
        Figure below.
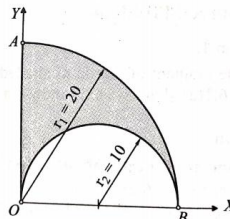
    c.   A body weighing 1000 N is lying on a horizontal plane. Determine the   [4]
        necessary force to move the body along the plane if the force is applied at an
        angle of 45 degrees to the horizontal with a coefficient of friction 0.24

    d.   The motion of a particle is defined by the relation x= t^3- 3t^2+2 t+5 where x is   [4]
        the position expressed in meters and time in seconds. Determine (i) velocity
        and acceleration after 5 seconds (ii) maximum or minimum velocity and
        corresponding displacement.

    e.   A steel ball of mass 8 kg is dropped onto a spring of stiffness 600 N/m and   [4]
        attains a maximum velocity of 2.5 m/s. Find (i) the height from it is dropped
        and (ii) the maximum deflection of spring.

    f.   A ladder AB of length l=4.8 m rests on a horizontal floor at A and leans against   [4]
        a vertical wall at B. If the lower end A is pulled away from the wall with a
        constant velocity 3 m/s, what is the angular velocity of the ladder at the instant
        when A is 2.4 m from the wall.

Q.2   a.   Find the resultant of the force system acting on the plate as shown in Fig, where   [8]
        does this resultant act with respect to point A?
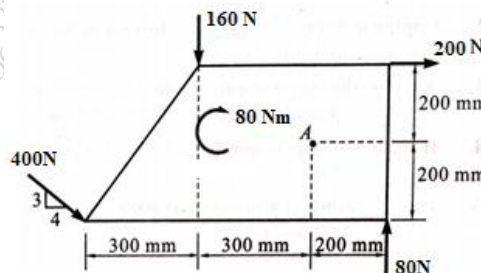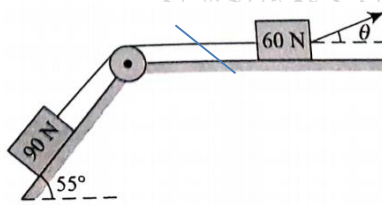

TURN OVER

b. Find the centroid of the shaded area with reference to X and Y Axes. [6]
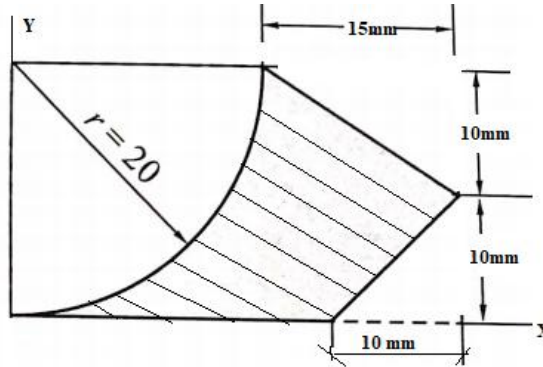

c. Two bodies A and B weighing 90N and 60N respectively placed on an inclined [6]
plane are connected by the string which is parallel to the plane as shown in Fig.
Find the inclination of the minimum force P for the motion to impend in the
direction of "P". Take μ=0.2 for the surface of contact.

Q.3 a. A horizontal force of 5KN is acting on the wedgw as shown in the figure. The [8]
coefficient of friction at all rubbing surfaces is 0.25. Find the load "W" which
can be held in position. The weight of block "B" may be neglected.
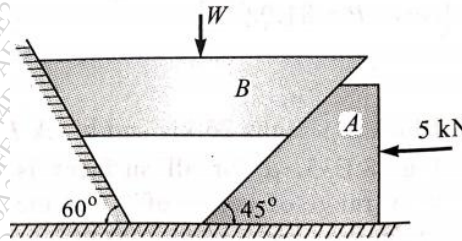
b. A road roller of radius 36cm and weight 6000N, which is of cylindrical [6]
shape, is pulled by a force F, acting at an angle of 45^0 as shown in the figure
below. It has to cross an obstacle of height 6cm. Calculate the force "F"
required to just cross over the obstacle.
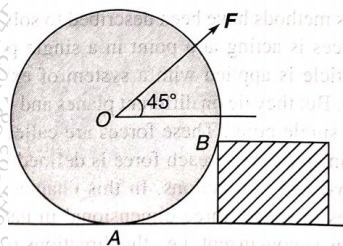
c. At the instant t=0, a locomotive start to move with uniformly accelerated speed [6]
along a circular curve of radius r=600 m and acquires, at the end of the first 60
seconds of motion, a speed equal to 24kmph. Find the tangential and normal
acceleration at the instant t=30 s.

Q.4 a. A particle is thrown with an initial velocity of 10 m/s at a 45^0 angle with [8]
horizontal. If another particle is thrown from the same position at an angle
60^0 with the horizontal, find the velocity of the latter for the following situation:
(i) Both have the same range.
(ii) Both have the same time of flight.

TURN OVER

b. The motion of a particle is represented by the velocity-time diagram as shown [6] in the graph shown below. Draw acceleration-time and displacement – time graphs.
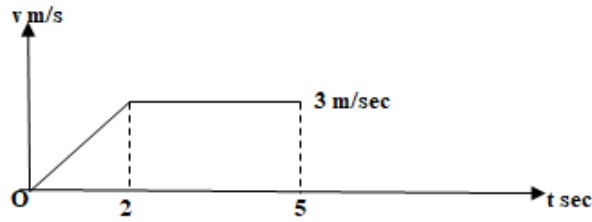

c. In the reciprocating engine mechanism shown in Fig. the crank OA of length [6] 200mm rotates at 100rad/sec. determine the angular velocity of the connecting rod AB and the velocity of the piston at B.
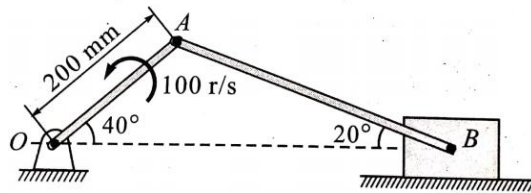

Q.5 a. Find the support reaction at A and force P if reaction at B is 60 kN for the [8] beam loaded as shown in Figure below.
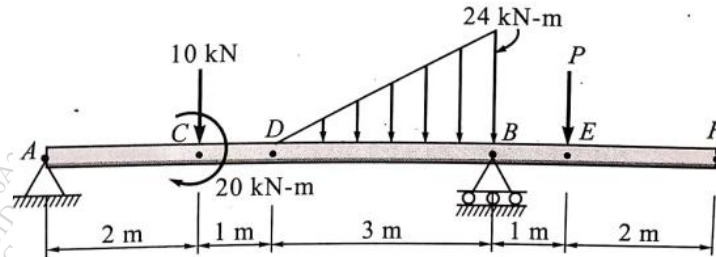
b. A 1200Kg car has a light bumper supported horizontally by two springs of [6] stiffness 15kN/m. Determine the initial speed of impact with the fixed wall that causes 0.2 m compression. Neglect friction.
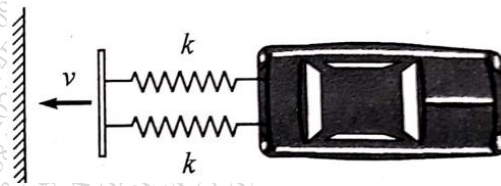
c. Determine the resultant force of the force system shown in figure where [6] $F_1=150N$, $F_2 = 120$ N, $F_3 = 200$ N and $F_4 = 220$ N.


TURN OVER

D6358A02F4D091DC1D6A2FF44DAEE28F
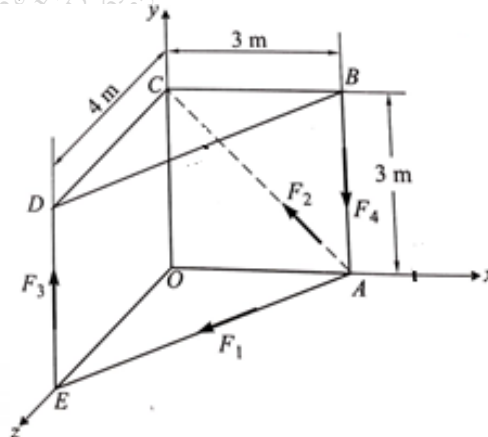
Q.6 a. Two bodies A and B are connected by a thread and move along a rough [8] horizontal plane ($\mu=0.3$) under the action of 400 N force applied to the body as shown in Fig.12. Determine the acceleration of the two bodies and the tension in the thread using D'Alembert's principle.

b. Train A starts with a uniform acceleration of 0.5 m/s^2 and attains a speed of 90 [6] km/hr which subsequently remains constant. One minute after it starts, another train B starts on a parallel track with a uniform acceleration of 0.9 m/s^2 and attains a speed of 120 km/hr. How much time does train B take to overtake train A.

c. The magnitude and direction of the velocities of two identical spheres having [6] frictionless surfaces are shown in Figure below. Assuming coefficient of restitution as 0.90, determine the magnitude and direction of the velocity of each sphere after the impact. Also find the loss in Kinetic energy.

D6358A02F4D091DC1D6A2FF44DAEE28F
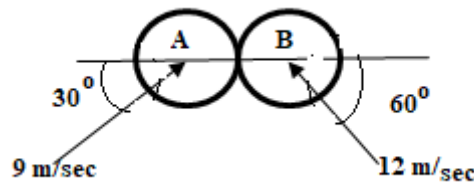
3hrs   **80marks**
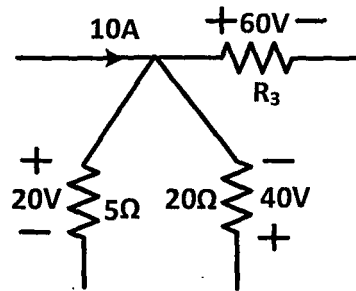
N. B:(1) Question No.1 is compulsory.

    (2) Answer any THREE from the remaining five questions.

    (3) Assume suitable data if required and state the assumption.

Q1.   **Answer any five.**
    (i) Find value of R_3 in the figure given below by applying Kirchhoff's laws.   4

   (ii) Briefly describe the operation of any one type of stepper motor.   4

    (iii) Two pure circuits elements in a series connection have the following current 4
and applied voltage: v(t) = 150 sin (500t+10°) V, i(t) = 13.42 sin (500t-53.4°) A.
Find the supply frequency (in Hz) and the value of circuit elements.

    (iv) A three-phase, three-wire, 100V system supplies a balanced delta-connected 4
load with per phase impedance of 20∟45° ohms. Determine the line current drawn
and active power taken by the load.

    (v) Draw the phasor diagram of a single phase non ideal transformer feeding a 4
resistive load.

    vi) Single phase induction motor is not self-starting. State True or False and Justify 4
your answer.

Q2.   **(A)** Find the current through 5Ω (I_x) using Superposition theorem **without using** 10
source transformation.
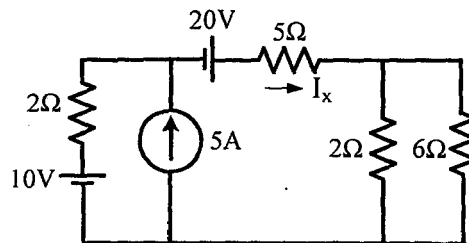
   **(B)** State and prove Maximum Power Transfer theorem.   05

(C) Plot the variation of current, impedance, resistance, inductive reactance and capacitive reactance when supply frequency is varied in R-L-C series circuit.   05

Q3. **(A)** The Open Circuit (OC) and Short Circuit (SC) tests on a 5 KVA, 200/400 V, 50 Hz, single phase transformer gave the following results.   10
OC: 200 V, 1 A, 100 W (lv side), **SC:** 15 V, 10 A, 85 W (hv side). Draw the equivalent circuit referred to primary and put all values.

(B) Derive the EMF equation of a dc motor.   05

**(C)** Find the Root Mean Square (RMS) value of the following waveform.   05
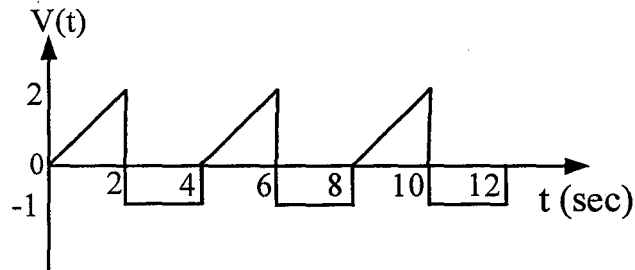
Q4. **(A)** With neat circuit diagram and phasor diagram, prove that by two watt meter method active power and reactive power of a three phase load can be measured.   10

(B) A sinusoidal voltage $v(t)=200\sin\omega t$ is applied to a series R-L-C circuit with $R = 20\,\Omega$, $L=100$ mH, and $C=10\,\mu F$. Find (i) the resonant frequency, (ii) RMS value of current at resonance (iii) Quality factor of the circuit, (iv) voltage across the inductor at resonant frequency and (v) phasor diagram at resonance.   10

**Q5.** **(A)** Derive the transformation formula to convert a delta network of resistors to an equivalent star network and star network of resistors to an equivalent delta network.   10

(B) In the parallel circuit, voltmeter across 3 Ω resistor reads 45 V. What is the indication on the ammeter? Also find the input power factor.

  10

4B678D8F74E0DDBA0CE90F29C2D6A93A
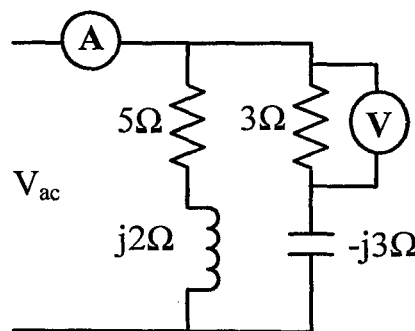
Q6. **(A)** Find current through 5Ω from A to B using Thevenin's theorem.   10
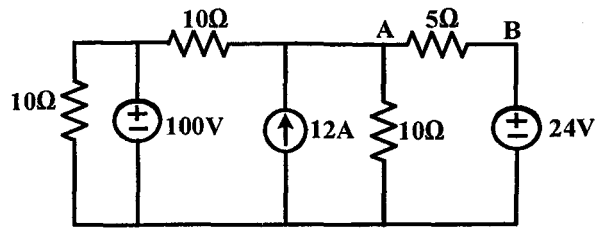
(B) A 20 KVA Transformer has iron loss of 450W and full load copper loss of   05
900W. Assume power factor of load as 0.8 lagging. Find full load and half load
efficiency of the transformer.

(C) Briefly explain the principle of operation of three phase Induction motor. What   05
are the types of three phase Induction motor?

4B678D8F74E0DDBA0CE90F29C2D6A93A

Time: 2 Hrs   Marks: 60

NB:
1) **Question No.1 is Compulsory**
2) Attempt any **Three questions** from the remaining **Five questions**
3) Figures to the right indicate full marks
4) Atomic weight: Ca = 40, Mg = 24, N = 14, Cl = 35.5, C = 12, H = 1, O = 16, Na = 23.

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

a) What are the characteristics of aromatic compounds?

b) What happens when temporary hard water is boiled? Explain giving examples

c) Distinguish between thermoplastic and thermosetting resins.

d) Give difference between bonding and antibonding orbitals.

e) What is the temporary and permanent hardness of water sample having the following impurities in ppm: $Ca(HCO_3)_2= 32.4$, $CaSO_4= 13.5$, $Mg(HCO_3)_2= 29.2$.

f) Discuss the reduced phase rule.

g) What is a real gas?

Q2)   a) Explain the application of phase rule to one component system   **(6)** with an appropriate graph, areas and the triple point.

b) What is compounding of plastics? Discuss the below mentioned constituents with appropriate examples: **(5)**

    i)   Fillers   ii) Pasticizers

c) Write notes on: **(4)**

    i) BOD   ii) COD

Q3)   a) Draw the Molecular Orbital diagram of Be_2. Give its electronic configuration .Explain why it does not exist .   **(6)**

b) (1) Identify the most important intermolecular interaction in each of the following: (i) CCl_4 (ii) HF   **(2)**
    (2) Explain the correction for volume term in the ideal gas equation. **(3)**

79617   **Page 1 of 2**

c) A polymer consists of 9 polymer chains as given below: **(4)**
   No. of polymer(N1) :   1   3   2   1   2
   Mol. Wt. of each polymer: 200 100 300 500 400
   Calculate the number – average molecular weight of the polymer

Q4) a) Discuss the following with examples: **(6)**
   i) Phase   ii) Components   iii) degree of freedom

b) Give the KeKule structure for benzene. Discuss the problems with **(5)**
   the structure. (any **two**)

C) Write notes on: supercritical fluids and critical temperature **(4)**

Q5) a) Give the preparation, properties and uses of: **(6)**
   i) Kevlar   ii) PMMA

b) What are atomic orbitals? Explain the s-orbitals and p-orbitals. **(5)**

c) 1gm of $CaCO_3$ was dissolved in 1 litre of distilled water. 50ml of **(4)**
   solution required 45ml EDTA for titration. 50ml of hard water
   required 25 ml of EDTA for titration. The water sample after boiling
   and filtering consumed 15ml of EDTA for titration. Calculate the total and
   permanent hardness of the sample.

Q6) Explain the ion-exchange method for softening of water giving the
   following details: **(6)**
   Diagram, process and Reactions

b) Calculate the number of phases in the **(1)**
   following examples:
   i) Rhombic Sulphur $\longrightarrow$ Monoclinic sulphur

   ii) An alloy of tin and lead contains 73% tin. Find the mass of eutectic **(4)**
      in 1kg of solid alloy, if the eutectic contains 64% of tin.

C) i) Give the Molecular Orbital diagram of nitric oxide (NO) molecule. **(2)**
   ii) Discuss: Glass transition temperature **(2)**