**EXAM** KGCE KARJAT, RAIGAD

Q.P. Code : 803104

( 3 Hours ) [Total Marks : 80]

N.B : (1) Question No.1 is compulsory.
(2) Answer any three questions from remaining.
(3) Assume suitable data if necessary.

1. (a) If $\cos\alpha\cosh\beta = \dfrac{x}{2}, \sin\alpha\sinh\beta = \dfrac{y}{2}$, Prove that 03

$$\sec(\alpha - i\beta) + \sec(\alpha + i\beta) = \frac{4x}{x^2 + y^2}$$

(b) If $z = \log(e^x + e^y)$, show that $rt - s^2 = 0$, where 03

$$r = \frac{\partial^2 z}{\partial x^2}, t = \frac{\partial^2 z}{\partial y^2}, s = \frac{\partial^2 z}{\partial x \partial y}$$

(c) If $x = uv, y = \dfrac{u+v}{u-v}$. Find $\dfrac{\partial(u,v)}{\partial(x,y)}$. 03

(d) If $y = 2^x \sin^2 x \cos x$ find $y_n$ 03

(e) Express the matrix 04

$$A = \begin{bmatrix} 1 & 0 & 5 & 3 \\ -2 & 1 & 6 & 1 \\ 3 & 2 & 7 & 1 \\ 4 & -4 & 2 & 0 \end{bmatrix}$$ as the sum of symmetric and skew-

symmetric matrices.

(f) Evaluate $\displaystyle\lim_{x \to 0} \frac{e^{2x} - (1+x)^2}{x\log(1+x)}$ 04

2. (a) Show that the roots of $x^5 = 1$ can be written as $1, \alpha, \alpha^2, \alpha^3, \alpha^4$. Hence 06
show that $(1-\alpha)(1-\alpha^2)(1-\alpha^3)(1-\alpha^4) = 5$

(b) Reduce the following matrix to its normal form and hence find its rank. 06

$$A = \begin{bmatrix} 3 & -2 & 0 & 1 \\ 0 & 2 & 2 & 7 \\ 1 & -2 & -3 & 2 \\ 0 & 1 & 2 & 1 \end{bmatrix}$$

(c) Solve the following system of equations by Gauss-Seidel Iterative Method 08
upto four iterations.

$4x - 2y - z = 40$

$x - 6y + 2z = -28$

$x - 2y + 12z = -86$

**TURN OVER**

3. (a) Investigate for what values of '$\lambda$' and '$\mu$' the system of equations     06

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

has (i) no solution

   (ii) a unique solution

   (iii) an infinite no. of solutions.

(b) If $u = x^2 + y^2 + z^2$, where $x = e^t, y = e^t \sin t, z = e^t \cos t$     06

Prove that $\dfrac{du}{dt} = 4e^{2t}$

(c) i) Show that $\sin(e^x - 1) = x + \dfrac{x^2}{2} - \dfrac{5x^4}{24} + \ldots\ldots$     04

ii) Expand $2x^3 + 7x^2 + x - 6$ in powers of $x - 2$     04

4. (a) If $x = u + v + w, y = uv + vw + uw, z = uvw$ and $\phi$ is a function of $x, y$ and $z$.  06
Prove that

$$x\frac{\partial \phi}{\partial x} + 2y\frac{\partial \phi}{\partial y} + 3z\frac{\partial \phi}{\partial z} = u\frac{\partial \phi}{\partial u} + v\frac{\partial \phi}{\partial v} + w\frac{\partial \phi}{\partial w}$$

(b) If $\tan(\theta + i\phi) = \tan\alpha + i\sec\alpha$,     06

Prove that i) $e^{2\phi} = \cot\dfrac{\alpha}{2}$    ii) $2\theta = n\pi + \dfrac{\pi}{2} + \alpha$

(c) Find the root of the equation $x^4 + x^3 - 7x^2 - x + 5 = 0$ which lies     08
between 2 and 2.1 correct to three places of decimals using Regula Falsi
Method.

5. (a) If $y = \left(x + \sqrt{x^2 - 1}\right)^m$, Prove That     06

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

(b) Using the encoding matrix $\begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$, encode and decode the message     06

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(c) i) Considering only principal values separate into real and imaginary parts     04
$i^{\log(1+i)}$

ii) Show that $i\log\left(\dfrac{x-i}{x+i}\right) = \pi - 2\tan^{-1}x$     04

**TURN OVER**

6. (a)  Using De Moivre's theorem prove that

$$\cos^6\theta - \sin^6\theta = \frac{1}{16}\left(\cos 6\theta + 15\cos 2\theta\right)$$
06

(b)

If $u = \sin^{-1}\left(\dfrac{x^{\frac{1}{3}} + y^{\frac{1}{3}}}{x^{\frac{1}{2}} - y^{\frac{1}{2}}}\right)^{\frac{1}{2}}$, Prove that
06

$$x^2 \frac{\partial^2 u}{\partial x^2} + 2xy \frac{\partial^2 u}{\partial x \partial y} + y^2 \frac{\partial^2 u}{\partial y^2} = \frac{\tan u}{144}\left(\tan^2 u + 13\right)$$

(c)  Discuss the maxima and minima of $f(x,y) = x^3 y^2 (1 - x - y)$
08

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Q.P. Code : 803400

(2 Hours) | Total Marks : 60

N.B. : (1) Question **No.1** is **Compulsory**.
    (2) Attempt any **3** questions from remaining.
    (3) Figures to the right indicate full marks.
    (4) Atomic weight  H=1 , C=12, N=14, O=16, Na=23, Mg=24, S=32, Cl=35.5,Ca =40

1. Answer **any five** from the following :      15
    (a) What is the role of polymers in medicine and surgery ? Explain with the help of any three examples.
    (b) Distinguish between alkaline and non alkaline hardness.
    (c) State the limitations of phase rule.
    (d) What are carbon nanotubes ? Explain different types of carbon nanotubes.
    (e) When would solid lubricants are used ?
    (f) 6 ml of waste water was refluxed with 25 ml of $K_2Cr_2O_7$ solution and after refluxing the excess unreacted dichromate required 20ml of 0.1 N FAS solution . A blank of distilled water on refluxing with 25 ml of $K_2Cr_2O_7$ solution required 35 ml of 0.1N FAS solution. Calculate the COD of waste water sample.

2. (a) Calculate the quantity of pure lime and soda required for softening of 40000    6
liters of water containing the following impurities
Ca $(HCO_3)_2$ = 16 ppm , Mg $(HCO_3)_2$ = 7 ppm , $CaSO_4$ =13 ppm , $MgCl_2$= 10 ppm , NaCl = 2 ppm.

    (b) (i) Distinguish between thermoplastics and thermosettings.    3
        (ii) Define flash and fire points.    2

    (c) Write the CVD method for preparation of carbon nanotubes.    4

3. (a) What is meant by fabrication of plastics ? Explain injection moulding with    6
the help of a neat diagram.

    (b) (i) State the condensed phase rule.    3
        (ii) How is gypsum useful in setting and hardening of cement ?    2

**TURN OVER**

(c) The hardness of 85000 liters of water sample was removed by passing it through a zeolite softener. The zeolite required 2000 liters of NaCl solution containing 190 mg/lit of NaCl for regeneration. Calculate the hardness of water sample.    4

4. (a) How is activated sludge process carried out for the treatment of waste water ? Explain with flow sheet diagram.    6

(b) (i) 1.4 gm of oil required 1.8 ml of 0.01 N KOH for neutralization. Calculate the acid value and mention whether the oil is suitable to be used or not.    3

(ii) Write the applications of fullerenes.    2

(c) What are the functions of fillers and plastisizers in the compounding of plastics ?    4

5. (a) Write the preparation, properties and uses of PMMA and Buna-S.    6

(b) (i) What are the advantages of ion exchange process ?    3
     (ii) What is oilness ? What is its importance in lubrications ?    2

(c) What is the application of phase rule to one component water system ? Explain with the help of phase diagram.    4

6. (a) Define lubricants and lubrication. Discuss the hydrodynamic lubrication in detail.    6

(b) (i) Define phase, component and degree of freedom.    3
     (ii) What are the industrial applications of ultrafiltration ?    2

(c) What is RCC ? Write the advantages of it.    4

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Applied Physics - I

QP Code:803504

(2 Hours)　　　　　　　[ Total Marks : 60

**N.B. :** (1) Question. **1** is **compulsory**.
　　　(2) Attempt any **three** questions from the remaining questions No. **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) What are crystal imperfections? Mention any two significance of it.
　　(b) Write schrodinger's time dependent and time independent wave equations of matter waves in one dimension and state physical significance of these equations.
　　(c) Draw the I-V characteristics of a photo-diode. What is meant by dark current?
　　(d) Define super conductivity and critical temperature. Plot the variation of resistance versus temperature in case of superconducting state of the material.
　　(e) What is reverberation time? Discuss sabine Formula
　　(f) State 'magnetostriction effect.' Mention any two applications of ultrasonic waves.
　　(g) Calculate conductivity of a germanium sample if a donar impurity atoms are added to the extent to one part in $10^6$ germenium atoms at room temperature.
　　　　Assume that only one electron of each atom takes part in conduction process.

　　Given: Avogadro's number- $6.023 \times 10^{23}$ $\text{atoms}/_{gm-mole}$
　　Atomic weight of Ge=72.6
　　Mobility of electrons = 3800 cm²/volts sec.
　　Density of Ge = 5.32 gm/cm³

2.　(a) Describe with necessary theory the Davisson and Germer experiment **8** establishing wave nature of electrons. calculate the de-broglie wavelength of an aplha particle accelerating thorugh a potential difference of 200 volts Given- Mass of alpha particle = $6.68 \times 10^{-27}$kg.
　　(b) Define the terms drift current and mobility of a charge carriers. Calculate **7** the current product in a germanium sample of area of cross section 1 cm² and thickness of 0.01 m, when a potential difference of 2 V is

[Turn Over

applied cross it. Given- The concentration of free electrons in germanium is $2 \times 10^{19}/m^3$ and mobilities of electrons and holes are 0.36 $m^2$/volts sec and 0.17 $m^2$/volts sec respectively.

3.  (a)  Draw and explain the unit cell of sodium chloride (NaCl) crystal. Determine effective number of NaCl molecules per unit cell and co-ordination number.          8

    (b)  State applications of Hall effect. In a Hall effect experiment a potential difference of 4.5 $\mu$V is developed across a foil of zink of thickness 0.02 mm, when a current of 1.5A is carrying in a direction perpendicular to applied magnetic field of 2 tesla. Calculate          7
        (a)  Hall coefficient for zinc
        (b)  Concentration of electrons

4.  (a)  Discuss formation of cooper pairs and energy gap in superconductor on the basis of BCS theory.          5

    (b)  State any five factors affecting the acoustics of the building and give the remedies for each.          5

    (c)  An ultrasonic pulse of 0.09 M Hz sends down towards the sea-bed which returns after 0.55 seconds. The velocity of ultrasonic waves in sea water is 1800 m/sec. Calculate the depth of sea and wavelength of ultrasonic pulse.          5

5.  (a)  How does the position of Fermi energy level changes with increasing doping concentration in p-type semi-conductors? sketch the diagram.          5

    (b)  Explain analysis of crystal structure using Bragg's X ray spectometer.          5

    (c)  Find the minimum energy of neutron confined to a nucleus of size of the order of $10^{-14}$m.          5
        Given mass of neutron = $1.675 \times 10^{-27}$ kg.

6.  (a)  Calculate the critical radius ratio of an ionic crystal in ligancy -6. What is the maximum size of cation in ligancy-6 configuration, when size of anion is 2.02A$^0$?          5

    (b)  What do you mean by group and phase velocity? Show that the de-Broglie group velocity associated with the wave packet is equal to the velocity of the particle.          5

    (c)  Explain the formation of potential barrier across the unbaised p-n junction region.          5

Q.P. Code : 803200

K.G.C.E.
EXAM
KARJAT, RAIGAD

(3 Hours)                                                                [Total Marks 80]

N.B:- (1) Question No.1 is compulsory.
      (2) Attempt any 3 questions from remaining five questions.
      (3) Assume suitable data if necessary, and mention the same clearly.
      (4) Take g = 9.81 m/s², unless otherwise specified.

Q-1 a. Find the force F4, so as to give the resultant of the force system shown below.                [4]
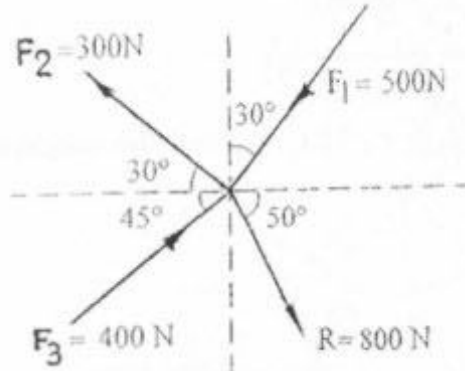


b. A particle starts from rest from origin and its acceleration is given by,
$a = \dfrac{k}{(x+4)^2}$ m/s². Knowing that V = 4 m/s when x = 8m, find (i) value of k and
(ii) Position when V = 4.5m/s.                                                                [4]

c. Rod AB of length 3m is kept on smooth planes as shown in fig. The velocity of
end A is 5m/s along the inclined plane. Locate the ICR and find the velocity of end B.        [4]
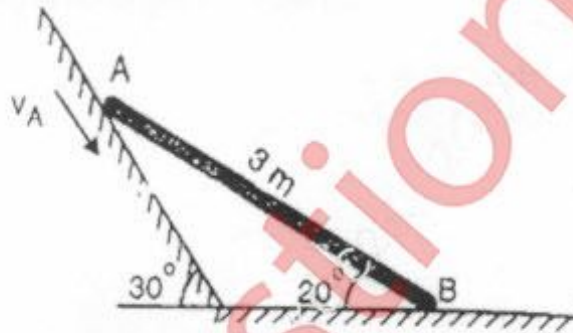


d. What is Zero force member in a Truss. With examples state the conditions for a zero
force member.                                                                                [4]

e. A glass ball is dropped onto a smooth horizontal floor from which it bounces to a
height of 9m. On the second bounce it rises to a height of 6m. From what height the
ball was dropped and what is the coefficient of restitution between the glass and the
floor.                                                                                        [4]

Q-2 a. Figure shows a beam AB hinged at A and roller supported at B. The L shaped portion is
welded at D to the beam AB. For the loading shown, find the support reactions.                [8]
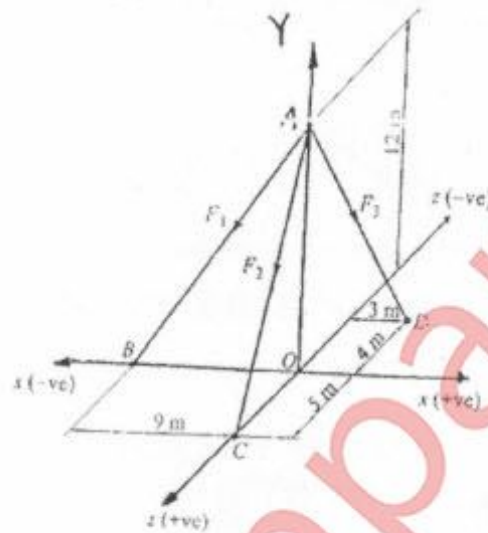


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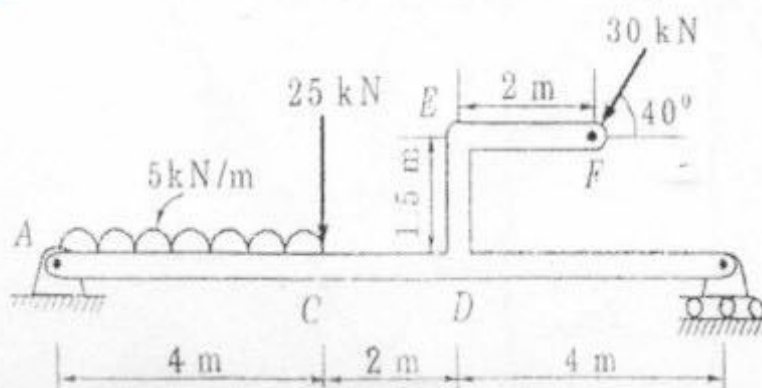
b. The acceleration-time diagram for linear motion is shown. Construct velocity-time diagram and displacement-time diagram for the motion assuming that the motion starts with initial velocity of 5m/s from starting point. [6]
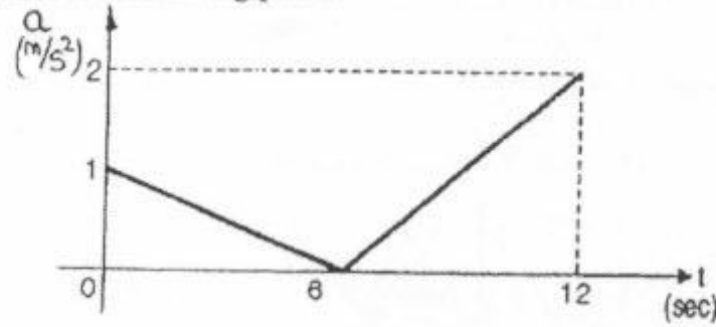


c. The resultant of three concurrent space forces at A is $\overline{R} = (-788j)N$. Find the magnitude of F1, F2 and F3 forces. [6]



Q-3 a. Two spheres A and B of weight 1000N and 750N respectively are kept as shown in fig. Determine the reactions at all contact points 1, 2, 3 and 4. Radius of A is 400mm and Radius of B is 300mm. [8]
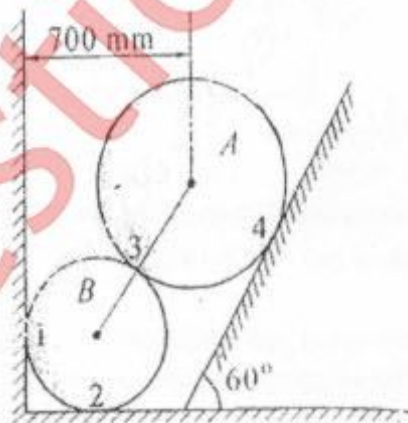


b. A circle of diameter 1.5m is cut from a composite plate. Determine the centroid of the remaining area of the plate. [6]



(TURN OVER)
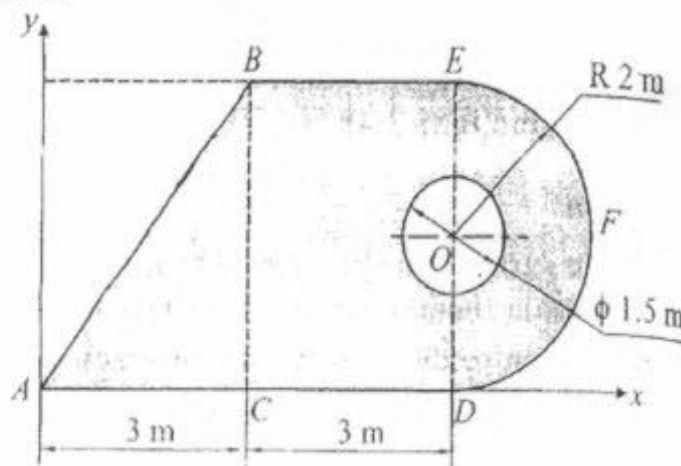
c. A rod AB has an angular velocity of 2 rad/sec, counter clockwise as shown. End C of rod BC is free to move on a horizontal surface. Determine (i) Angular velocity of BC and (ii) Velocity of C [6]
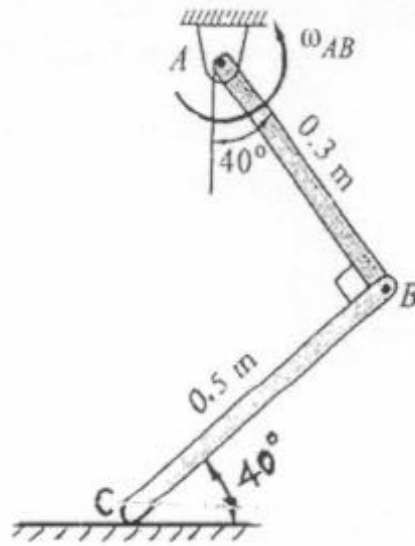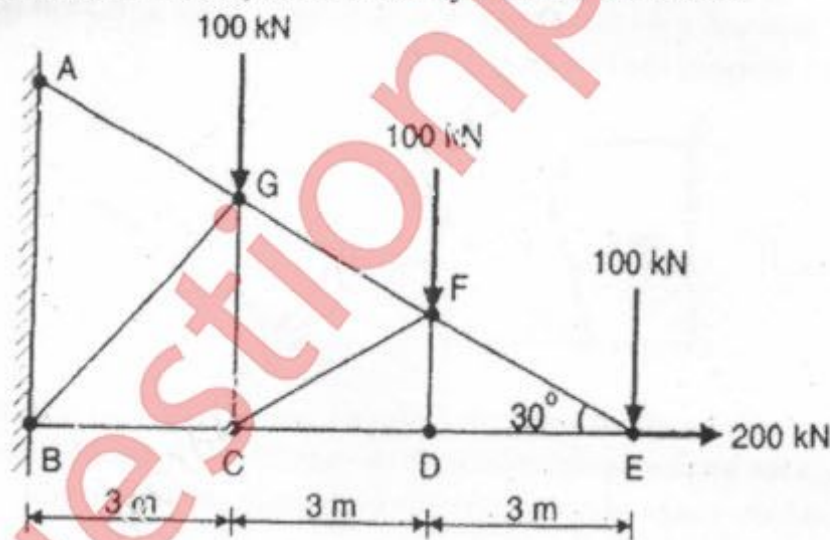


Q-4 a. A truss is loaded and supported as shown. Determine the following: [8]
  (i)     Identify the zero force members if any.
  (ii)    Find the forces in members EF, ED and FC by method of joints.
  (iii)   Find the forces in members GF, GC and BC by method of sections.
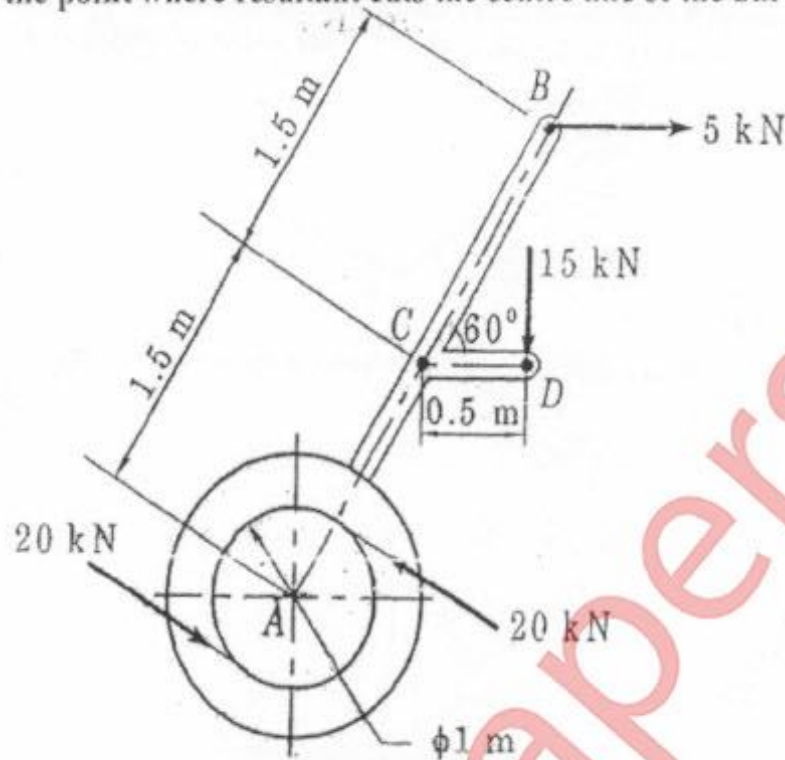


b. A cylinder has a mass of 20kg and is released from rest when h=0 as shown in the figure. Determine its speed when h=3m. The springs each have an unstretched length of 2m. Take k=40N/m. [6]
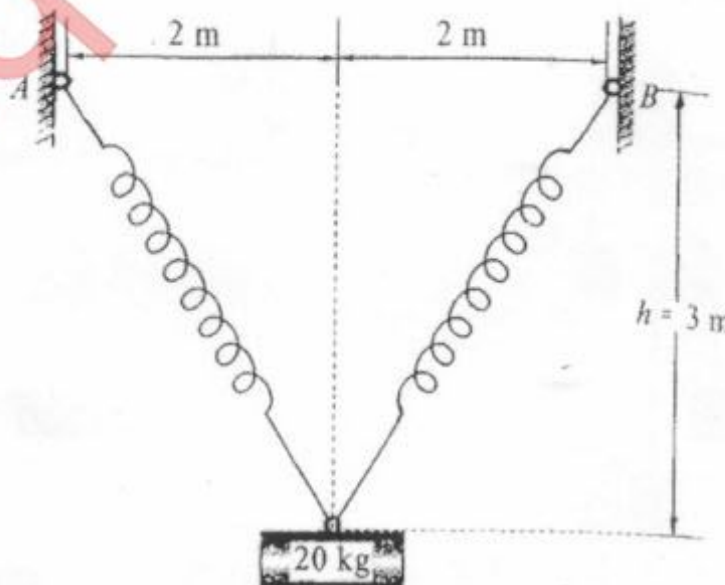
c. A machine part is subjected to forces as shown. Find the resultant of force in magnitude and direction. Also locate the point where resultant cuts the centre line of the bar AB. [6]



Q-5 a. Two blocks A and B are resting against the wall and floor as shown in the figure. Find minimum value of P that will hold the system in equilibrium. Take μ=0.25 at the floor, μ=0.3 at the wall and μ=0.2 between the blocks. [8]
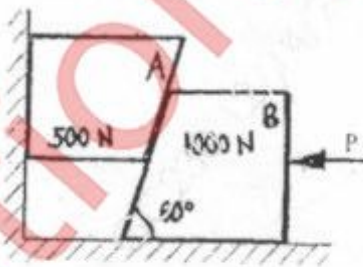


b. A shot is fired with a bullet with an initial velocity of 20m/s from a point 10m infront of a vertical wall 5m high. Find the angle of projection with the horizontal to enable the shot to just clear the wall. Also find the range of shot where the bullet falls on the ground. [6]

c. Three blocks A, B and C of masses 3kg, 2kg and 7kg respectively are connected as shown. Determine the acceleration of A, B and C. Also find the tension in the strings [6]
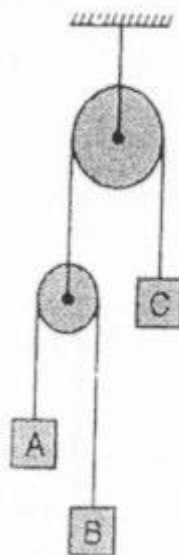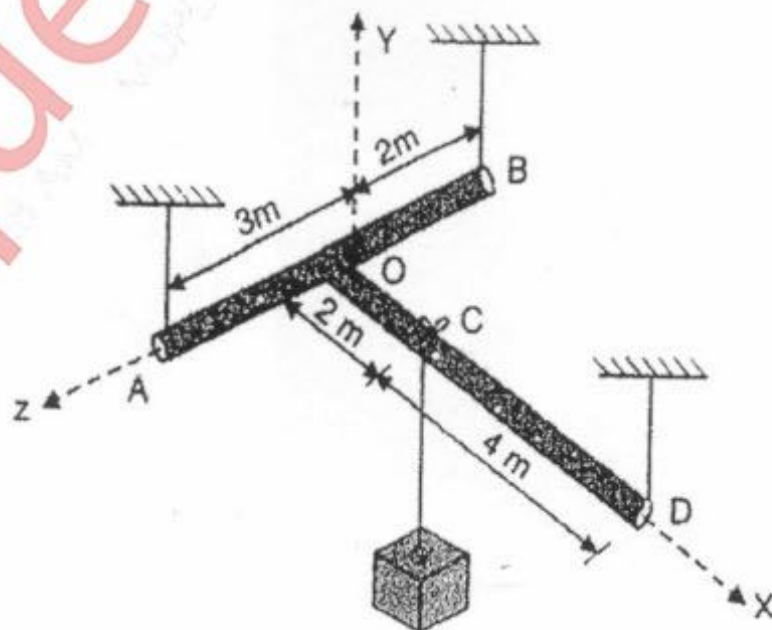
Q-6  a. Block A of weight 2000N is kept on an inclined plane at 35°. It is connected to weight B
by an inextensible string passing over smooth pulley. Determine the weight of pan B so
that B just moves down. Assume μ=0.2. [5]
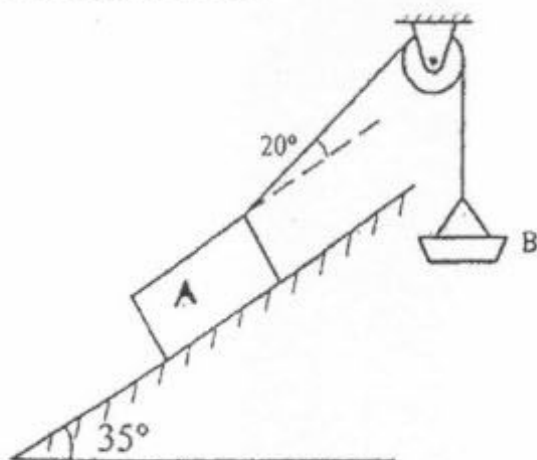
b. A particle falling under gravity travels 25m in a particuiar second. Find the distance
travelled by it in next three seconds. [5]

c. A rod AD of length 40cm is suspended from point D as shown in fig. If it has a weight of
25N and also supports a 40N load, find the tension in the cable using the method of virtual
work. Take AC=30cm. [5]
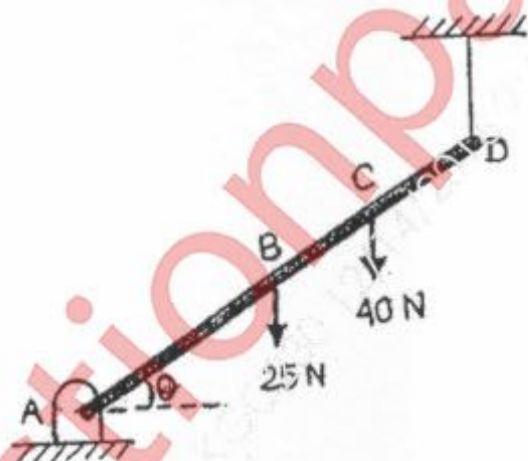
d. A T-shaped rod is suspended using three cables as shown. Neglecting the weight of the rods,
find the tension in each cable. [5]

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In the diagram of Q 2 (a), the right end of the beam must be labeled as " B " (besides the right side triangle)

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QP Code: 803200 (2$^{nd}$ query)

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Q 6 (d) In the diagram the weight of the suspended block can be taken as 100N

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Query Update time: 14/12/2016 11:30 AM

Q.P. Code :803301

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

**N.B. :** (1) Question No.1 is compulsory.
(2) Answer any **THREE** questions from remaining five questions.
(3) **Figures** to right indicate **full** marks.
(4) Assume suitable data if required.

1.  A)  State Maximum Power Transfer Theorem                                    2
    B)  Derive the formula to convert a delta circuit into an equivalent star   4
    C)  Define Average value and RMS value of an alternating quantity          4
    D)  Prove that power in a 3-phase delta connected system is 3 times that of a  4
        star connected system.
    E)  Explain the working principle of a single phase transformer.           4
    F)  What is the use of commutator in a DC machine.                         2

2.  A)  Obtain current through 1 Ω resistance by using Super position theorem, in  10
        fig 2.A.



Fig 2.A

    B)  A coil is connected across a non-inductive resistance of 120 Ω. When a  10
        240 V, 50 Hz supply is applied to this circuit the coil draws a current 5 A
        and total current is 6 A. Determine the power and power factor of
        i)  the coil
        ii) the whole circuit

3.  A)  Obtain Norton's equivalent circuit of the network shown in fig. 3.A, across  10
        the terminals A and B



Fig.3.A.
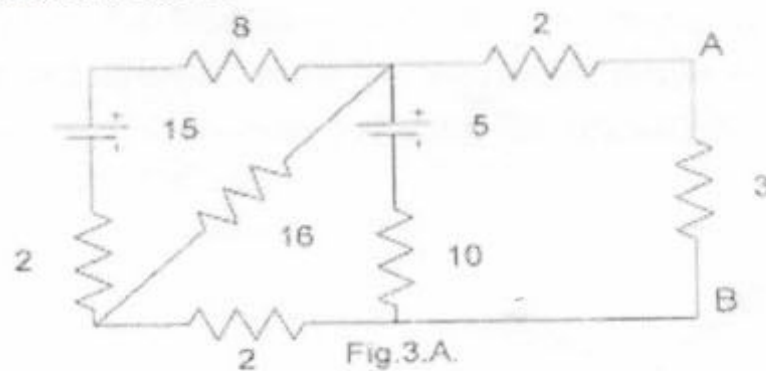
**[ TURN OVER]**

B) A series RLC circuit, if $\omega_0$ is the resonant frequency, $\omega_1$ and $\omega_2$ are the half power frequencies, prove that $\omega_0 = \sqrt{(\omega_1 \, \omega_2)}$  5

C) Derive the equivalent circuit of a 1-phase transformer.  5

4. A) Obtain current through 15 $\Omega$ resistance by nodal analysis in fig.4.A. Take reference node as marked.  10



Fig.4.A.
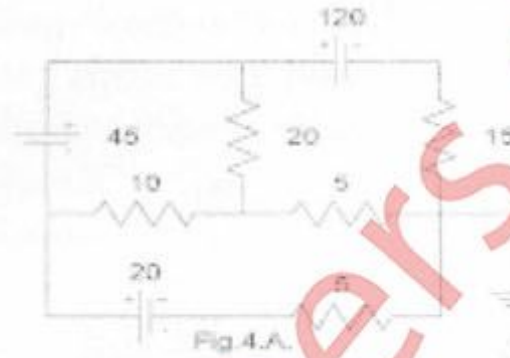
B) In a balanced 3 phase, star connected system, a wattmeter is connected with its current coil in series with Y line and pressure coil between Y and R lines. Draw a neat circuit digram showing the above watmeter connection. Assuming a lagging power factor, draw the corresponding phasor diagram and derive the watmeter reading in terms of line voltage, line current and phase angle.  10

5. A) Obtain current through 60 $\Omega$ resistance by Mesh analysis in fig.5.A.  6



Fig.5.A.
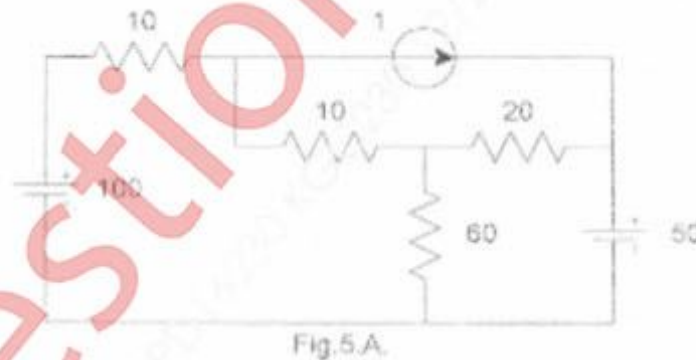
B) Develope the phasor diagram of a single transformer supplying to a resistive load.  8

C) Derive the emf equation of a DC generator.  6

6. A) A resistor and a pure reactance are connected in series across a 150 V ac supply. When the frequency is 40 Hz, the circuit draws 5 A. When the frequency is increased to 50 Hz, the circuit draws 6 A. Find the value of resistance and the element value of the reactance. Also find the power drawn in the second case.  10

**[ TURN OVER]**

B) A single phase 10 KV A, 500 V/250 V, 50 Hz transformer has the following  10
constants.

Resistance       :       primary = 0.2 ohms,      secondary = 0.5 ohms

Reactance       :       primary = 0.4 ohms,      secondary = 0.1 ohms

Resistance of equivalent exciting circuit w.r.t. primary = 1500 ohms

Reactance of equivalent exciting circuit w.r.t. primary = 750 ohms

What will be the reading of the instruments placed in primary side when
the transformer is connected for OC and SC tests ?

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Q.P. Code : 803601

(2 Hours) [ Total Marks : 60

**N.B. :** (1) Question No.1 is **compulsory**.
(2) **Attempt** any **three** question from **Q.2** to **Q.6**.
(3) Draw **neat labelled** diagram wherever **applicable**.
(4) Figure to **right** indicate **full** marks.

1. Attempt **any five** from following :- 15
   a) What is sustainable development? Why there is need for sustainable development?
   b) Differentiate between : Renewable and Non-renewable sources of energy.
   c) What are the causes and effects of E-pollution ?
   d) Write important functions of Central Pollution Control Board (CPCB).
   e) Explain concept of Carbon Credit.
   f) What is Nuclear pollution? What are its sources and effects?
   g) What is Ecological Sucession?

2. a) Explain Social and Economic aspects of sustainable development. 5
   b) Draw a neat labelled diagram of Electrostatic Precipitator and explain how it is useful to control gaseous particulate emissions? 5
   c) What is Hydropower? Draw a suitable diagram and explain how hydropower is generated. 5

3. a) What is solid waste? Explain solid waste management by incineration. 5
   b) Write important functions and powers of State Pollution Control Board. 5
   c) Write a case study on Cloudburst and Landslides at Kedarnath in June 2013. 5

4. a) Explain global environmental crisis pertaining to population. 5
   b) Explain environmental consent and authorization mechanism. 5
   c) Draw a neat diagram of wind turbine and explain how it helps in energy production. 5

[ TURN OVER]

5.  a)  Explain how resource utilization as per carrying capacity is an important    5
        control measure for sustainable development.
    b)  Write a case study on pollution of Ganga River.    5
    c)  Draw a schematic and explain principle and working of photovoltaic cells.    5

6.  a)  Explain the causes and effects of depletion of natural water resources.    5
    b)  Write a note on industrial waste water treatment.    5
    c)  What is Disaster Management? Explain how techniques of disaster    5
        management are implemented in the event of earthquake.

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