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

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

   (2) Attempt any Three questions from remaining five questions.

Q1 a) Prove that $\left(1 + i\sqrt{3}\right)^8 + \left(1 - i\sqrt{3}\right)^8 = -256$ [5]

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

   a skew symmetric matrix. [5]

c) If $p = y^2 + z^2$, $q = z^2 + x^2$, $r = x^2 + y^2$ then $evaluate\ \frac{\partial(p,q,r)}{\partial(x,y,z)}$. [5]

d) Using Newton-Raphson method for the equation $x^3 - 2x - 5 = 0$,

   find the root starting with $x_0 = 2$ as initial value with an accuracy 0f .0001. [5]

Q2 a) Test for consistency and if possible solve

   $x + 2y - z = 2,\ 3x + 8y + 2z = 10,\ 4x + 9y - z = 12$ [6]

b) Find all the values of $\left(1 - i\sqrt{3}\right)^{\frac{1}{4}}$.

[6]

c) If $u = sin^{-1}\left(\frac{x+y}{\sqrt{x}+\sqrt{y}}\right)$,   P.T $x^2 \frac{\partial^2 u}{\partial x^2} + 2xy \frac{\partial^2 u}{\partial x \partial y} + y^2 \frac{\partial^2 u}{\partial y^2} = \frac{1}{4}(tan^3 u - tan u)$ [8]

Q3 a) Separate into real and imaginary parts $cos^{-1}\left(\frac{3i}{4}\right)$ [6]

b) Find the Rank of the following matrix by reducing to Normal Form

   $A = \begin{bmatrix} 2 & 3 & -1 & -1 \\ 1 & -1 & -2 & -4 \\ 3 & 1 & 3 & -2 \end{bmatrix}$ [6]

c) Examine the function

   $f(x,y) = x^3 + 3xy^2 - 3x^2 - 3y^2 + 4$ for extreme values. [8]

27505   **Page 1 of 2**

Q4 a) Examine whether the vectors

$X_1 = [1, 1, 1], \ X_2 = [2, 3, 8], X_3 = [1, 2, 3]$ are linearly independent [6]

b) If $sin(\propto + i\beta) = x + iy$, then prove that [6]

$$\frac{x^2}{cosh^2\beta} + \frac{y^2}{sinh^2\beta} = 1 \quad and \quad \frac{x^2}{sin^2\alpha} - \frac{y^2}{cos^2\alpha} = 1$$

c) If $y = cosx cos2x cos3x$ then find n^{th} derivative of y [8]

Q5 a) Apply Jacobi's Iterative method to solve the following equations

$20x + y - 2z = 17, \quad 3x + 20y - z = -18, \quad 2x - 3y + 20z = 25$ [8]

b) If $v = (1 - 2xy + y^2)^{\frac{-1}{2}}$ then show that $xv_x - yv_y = y^2 v^3$ [6]

c) Expand $log(1 + x + x^2 + x^3)$ up to x^5 [6]

Q6 a) Considering only the principle values, prove that the real part of

$$\left(1 + i\sqrt{3}\right)^{\left(1 + i\sqrt{3}\right)} is \ 2e^{\frac{-\pi}{\sqrt{3}}} cos\left(\frac{\pi}{3} + \sqrt{3}log2\right)$$ [6]

b) If $u = f(x^2 - y^2, \ y^2 - z^2, \ z^2 - x^2)$, then prove that $\frac{1}{x}\frac{\partial u}{\partial x} + \frac{1}{y}\frac{\partial u}{\partial y} + \frac{1}{z}\frac{\partial u}{\partial z} = 0.$ [6]

c) Prove that $tan5\theta = \frac{5tan\theta - 10tan^3\theta + tan^5\theta}{1 - 10tan^2\theta + 5tan^4\theta}$ [8]

****

[Time: 2 Hours]   **Marks : 60]**

N.B: 1. **Question No. 1 is compulsory.**
              2. **Attempt any three questions from the remaining questions.**
              3. **All questions carry equal marks**
              4. **Atomic weights:**
                  [Ca= 40, C=12, 0=16, H=1, Mg= 24, S=32, Cl= 35.5]

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

   a. What is triple point.Explain it with reference to water system?

   b. What are the drawbacks of natural Rubber?

   c. Write synthesis, properties and uses of Kevlar.

   d. 20ml of waste water was refluxed with 30ml of potassium dichromate solution. After
       refluxing the excess unreacted dichromate required 11 ml of 0.1N FAS solution. A blank
       of 20ml distilled water on refluxing with 30ml of dichromate solution required 14ml of
       0.1 N FAS solution. Calculate the COD value of the waste water.

   e. Define Cloud point and Pour point. Discuss its significance.

   f. List the applications of carbon nanotubes.

   g. What are the limitations of Phase rule? (Any 3 points)

   h. What are the drawbacks of natural rubber (Any 3 points)

Q.2 a. Calculate the amount of lime (90% pure) and soda (95%) required for softening of 50,000
             liters of hard water containing the following impurities: **6**
             $Ca(HCO_3)_2$= 81 mg/L, $MgCl_2$= 95 mg/L, $CaSO_4$ = 68mg/L, SiO_2= 50mg/L,
             $Mg(HCO_3)_2$= 146 mg/L,H_2SO_4 = 49 mg/L

     b. (i) Explain the term 'Glass transition temperature'. What is its significance?   **3**

         (ii) Define and write significance of viscosity index.   **2**

     c. Explain with the help of chemical reactions 'setting and hardening 'process of cement.   **4**

Q.3 a. Write short notes: a) Polymer in medicine and surgery b) Conducting polymers   **6**

     b. (i) State the limitations of phase rule.   **3**

         (ii)Write composition of Portland cement.   **2**

     c. Calculate total hardness in ppm in given water sample (i) 50ml standard hard water containing **4**
         1mg of pure CaCO3 per ml, consumed 20ml EDTA solution. (ii) 50ml water sample consumed
         35ml EDTA solution using Erio-Black T indicator.

43565   **Page 1 of 2**

Q.4 a. Explain the Ion exchange process of softening of hard water. What are its advantages and
disadvantages. **6**

b. (i) Find acid value of vegetable oil whose 6ml required 2.6ml of 0.02N KOH for titration. **3**
(density of oil= 0.91 g/ml). State whether the oil is suitable for lubrication or not.

(ii) Write a note on Deccay of concrete. **2**

c. Explain the functions of the following constituents in the compounding of plastics (Any two) **4**
a) Plasticizers b) Lubricants c) Stabilizers

Q.5 a. (i) What is meant fabrication of plastics? Explain Transfer moulding with labelled diagram. **6**

b. (i) Explain Reverse Osmosis. **3**

(ii) Give the important characteristics of a good Lubricant. **2**

c. What is a condensed phase system? Draw a neat labelled phase diagram of Pb-Ag system **4**

Q.6 a. What is Lubrication? Discuss the mechanism of Boundary Film lubrication **6**

b. (i) Define Phase, Component and Degree of freedom. **3**

(ii) Distinguish between Alkaline hardness and Non-Alkaline hardness. **2**

c. Describe the wet process for manufacture of Portland cement. **4**

———————

Time: 03 hours   Max. Marks: 80

==

Note to the students: -1) Q1 is compulsory.
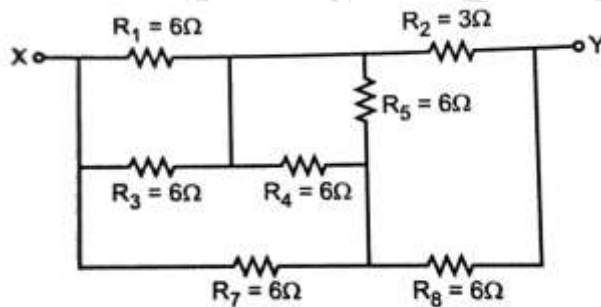
                             2) Solve any Three questions from the remaining Five questions.

Q1   Solve **any Four**   **20**
  a)   Using delta-star transformation, find resistance between X & Y.   **5**

  b)   A sinusoidally varying alternating current has a peak value of 9.2 A and a   **5**
         frequency of 50 Hz. What will be the instantaneous value at
         (i)   0.003 sec after passing through zero in the positive direction &
         (ii)   0.0045 sec after passing through its positive peak value.
  c)   A coil draws 10 A current and takes 1000 W power from a 220 V, 50 Hz A.C   **5**
         supply. Find (i) Impedance (ii) Power Factor (iii) Reactive and Apparent
         Power.
  d)   Explain the principle of operation of DC motors.   **5**
  e)   Explain the construction and working of single phase transformer.   **5**

Q2   Solve **any Four**   **20**
  a)   State and derive the condition for Maximum Power transfer.
  b)   Prove that the power consumed by pure inductor is zero.
  c)   A capacitor of 35 µF is connected in series with a variable resistor. The circuit
         is connected across 50 Hz mains. Find the value of the resistor for a condition
         when the voltage across the capacitor is half the supply voltage.
  d)   1000/230 V, 15 KVA, 50 Hz, 1-phase transformer has a core loss of 1.4 kW and
         full load copper loss 1.6 kW. Find the efficiency at half full load at 0.8 p.f
         lagging.
  e)   Derive the expression to convert delta network to its equivalent star network.

33636   Page **1** of **3**

Q3   Solve **any Two**   **20**
a)   A resistance of 20 ohms and a pure inductance of 0.2 H is connected in parallel
      with 200 µF capacitor with variable frequency, 230 V supply. Find the resonant
      frequency and the total current from the supply.

b)   Show that $I_L = \sqrt{3}\, I_{ph}$ for three phase delta connection. Draw the necessary phasor
      diagram.
c)   State and explain the Thevenin's theorem with an example.

Q4   Solve **any Two**   **20**
a)   Draw and explain the phasor diagram of Transformer for inductive load.
b)   A delta connected load draws a line current of 15 A at lagging p.f of 0.85 from a
      400 V, 50 Hz, 3-phase supply. Find the resistance and inductance of each phase.
      If the same load is now connected in star, calculate the line current and total
      power consumed.
c)   The following results were obtained on a 40 KVA, 2400/120 V, 50 Hz
      transformer are as under:

OC test (LV side):	120 V	9.56 A	396 W
SC test (LV side):	92 V	20.8 A	810 W

      Calculate the parameters of approximate equivalent circuit referred to H.V side.

Q5   Solve any Two   **20**
a)   Reduce given circuit into a voltage source in series with a single resistance.
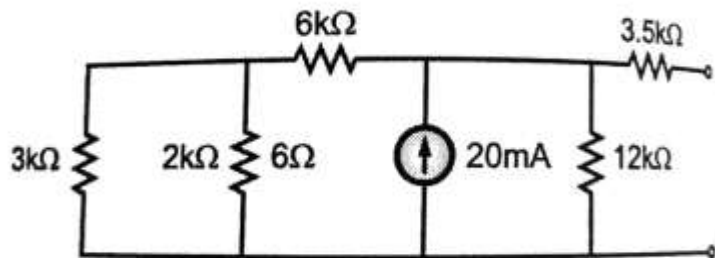
b)   If two impedances $Z1 = (10+j5)\ \Omega$ and $Z2 = (6 - j8)\ \Omega$ are connected in parallel
      with each other. The total current supplied is $I_y = 15$ A. What is the power taken
      by each branch?
c)   Derive the formula for resonant frequency of the circuit with a pure capacitor in
      parallel with a coil having resistance and inductance.

33636   Page **2** of **3**

Q6   Solve **any Two**   **20**
a)   Find the value of RL for abstracting maximum power. Also find the maximum
      power.
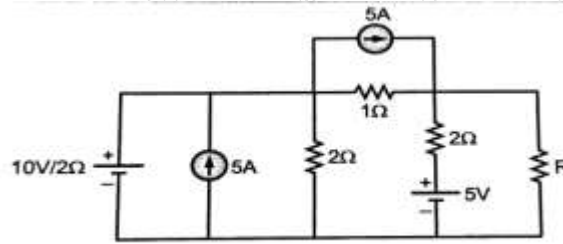
b)   A coil takes a current of 1 A at 0.3 p.f lagging when connected to a 100 V, 50
      Hz supply. Determine the value of a capacitance which when connected in
      parallel with the coil will reduce the supply current to a minimum. Also
      calculate the impedance of the parallel circuit at this condition of minimum
      current.
c)   Draw the equivalent circuit of transformer with primary referred to secondary.
      State the formula of each and every element shown in the equivalent circuit.

****

(Time: 2 Hours)   **[Total Marks: 60]**

N.B.:   (1) **All** questions are **compulsory**.

          (2) Draw **neat diagrams** wherever **necessary**.

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

Q.1	**Attempt the following:-**	**15**
a	How does Biomass and Energy flow are related in Ecological pyramid?	
b	With suitable example explain the concept of food -web.	
c	Explain the classification of Eco system.	
d	Explain the global environmental crisis caused on account of growing population.	
e	What are the feature of ecological succession.	

Q.2	**Attempt the following:-**	**15**
(a)	Explain in brief, what is food chain.	**05**
(b)	List out objectives of Environmental Education.	**05**
(c)	Draw a neat and labeled diagram of venturi scrubber used for purification of air pollutants. Give the principle involved in venturi scrubber. Give advantages and disadvantages of venturi scrubber.	**05**

Q.3	**Attempt the following:-**	**15**
(a)	What are power and function of State Pollution Control Board?	**05**
(b)	Explain what are the reasons and impact of depleting nature of forest resources.	**05**
(c)	What is solid waste management? How solid waste management is done by land filling?	**05**

Q.4	**Attempt the following:-**	**15**
(a)	Define solar energy. Give the principle involved in photovoltaic cell. Give advantages and disadvantages of solar energy.	**05**
(b)	Explain Socio-Economical aspects of Sustainable development.	**05**
(c)	What is ecological pyramid? How energy flow across pyramid?	**05**

Q.5	**Attempt the following:-**	**15**
(a)	In what way appropriate technology can lead to better Sustainable development.	**05**
(b)	How is environmental education important for sustainable development?	**05**
(c)	Define E-pollution. State sources of E-pollution. State effects of E-pollution.	**05**

Q.6	**Attempt the following:-**	**15**
(a)	Explain the concept and objectives of green building.	**05**
(b)	What are the reason for depleting nature of our mineral resources?	**05**
(c)	What are reasons and effects of global warming?	**05**

43259   **Page 1 of 1**

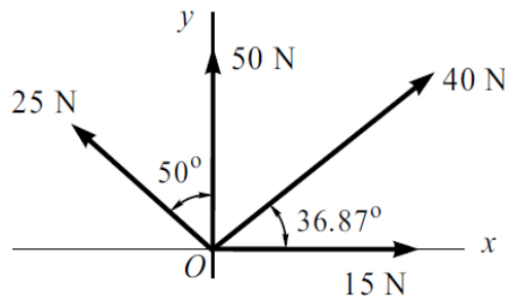**Time: 3Hrs.**   **Marks: 80**

Q.1 Solve Any Four [5x4]

a) State and prove Varignon's theorem.

b) Determine the resultant of the three forces acting on a hook as shown in Fig.

c) A block of weight 200 N rests on a horizontal surface. The coefficient of friction between the block and the horizontal surface is 0.4. Find the frictional force acting on the block if a horizontal force of 40 N is applied to the block.

d) Rectilinear motion of a particle is defined by the equation $v^3 = x^2$ Determine velocity and acceleration at x=8 m

e) Explain general plane motion and ICR with example.

Q2 a) Find the support reactions at A and B for the beam loaded as shown in figure.   [8]
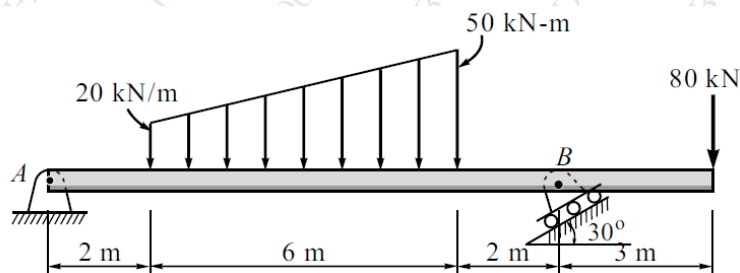
b) A ball is projected from the top of a tower of 110 m height with a velocity of 100 m/s and at an angle of elevation 25 degrees to the horizontal. determine   [6]

(a) The maximum height the ball will rise from the ground.

(b) The horizontal distance it will travel just before it strikes the ground.

43294   **Page 1 of 5**

c) For the system shown in fig. find resultant and its point of application with respect to point O on the X axis (X intercept). [6]
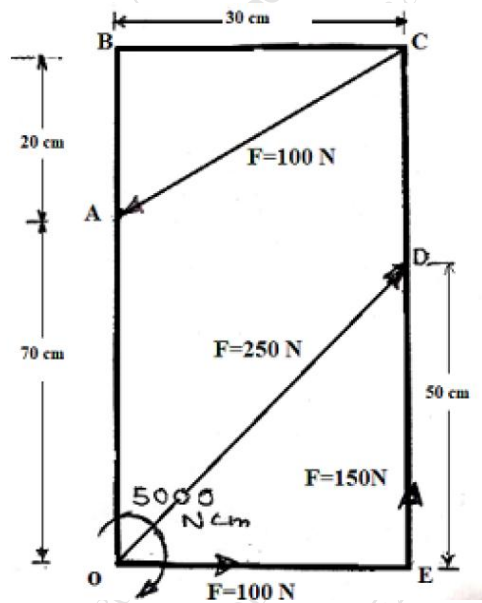
Q.3 a) A The truss is loaded and supported as shown in figure. Identify zero force members, find forces in members EF, ED and FC by method of joint, find forces in members GF,GC,and BC by method of section [8]
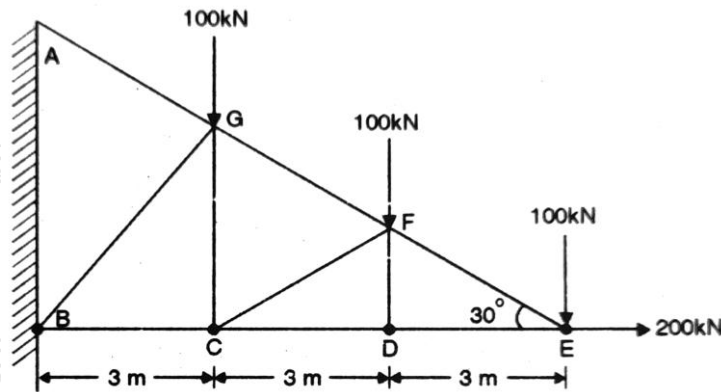

b) The tripod shown in figure supports a vertical load W=100 KN. Find the compressive force acting on each member. All joints are ball and socket type. [6]

43294 **Page 2 of 5**
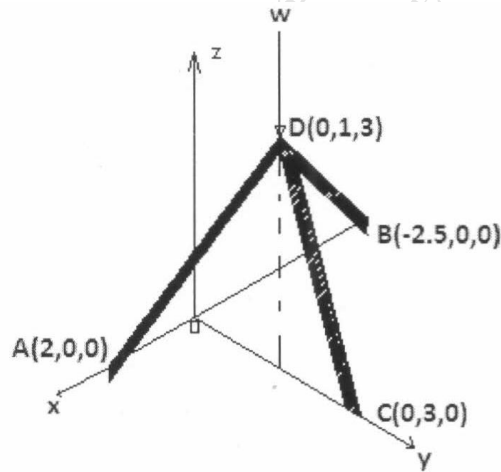
c) A particle travels on a curved path whose arc distance travelled is defined by moves along a circle of radius 20 cm so that $x = 0.5t^3 + 3t$ m. If the total acceleration is 10 m/s² at t=2 sec, find radius of curvature. [6]

Q.4a) Two 10^0 wedges of negligible weight are used to move a block of mass 100 kg. If μ=0.25 at all surface of contact. Find the smallest force P that should be applied to one of the wedges.

[8]
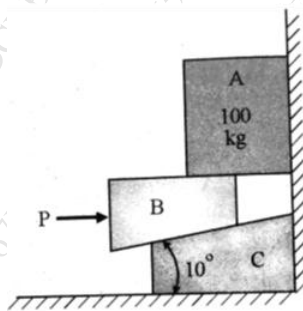
b) In the mechanism shown in fig angular velocity of rod DC is 30 degrees / sec. Determine angular velocity of CD and AB [6]
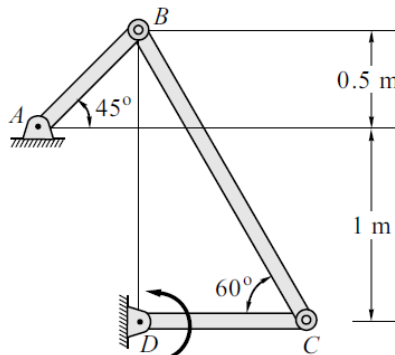
c) Derive equation of trajectory followed by projectile. [6]

Q.5 a) The velocity time graph for a particle moving along a straight line is shown in figure, Plot x-t and a-t diagram. [8]
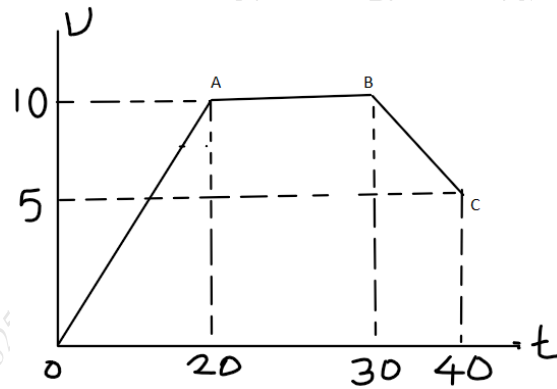

b) Determine Centroid of shaded area w.r.to given coordinates. [6]
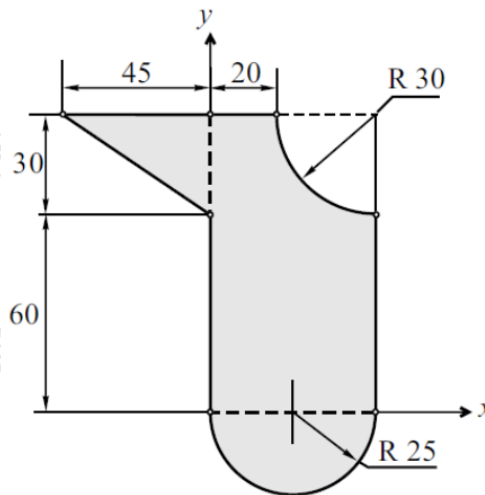
c) Determine the acceleration of blocks shown in figure.If the coefficient of kinetic friction is 0.2 at all surfaces.The block A and B have masses of 90 Kg and 45 Kg. [6]
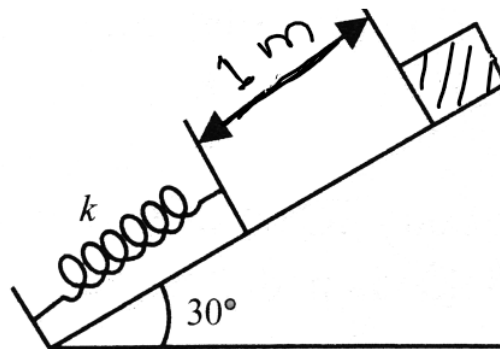

43294 **Page 4 of 5**
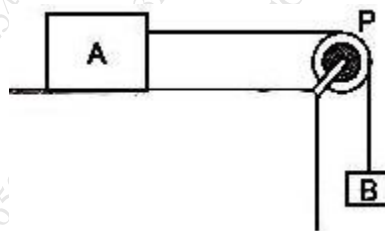
Q.6 a) Two smooth spheres 1 and 2 having a mass of 2 kg and 4 kg respectively collide with initial velocities 2 m/s and 4 m/s respectively as shown in figure. If the coefficient of restitution for the spheres is 0.8, determine the velocities of each sphere after collision. [8]
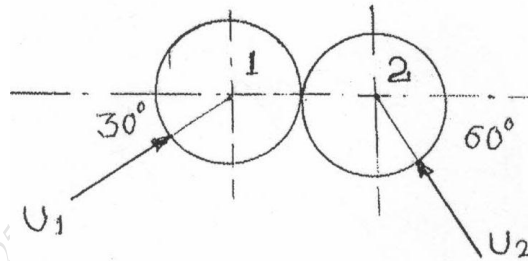
b)Two identical rollers of mass 50 Kg are supported as shown in fig. To maintain the equilibrium, determine support reactions. [6]
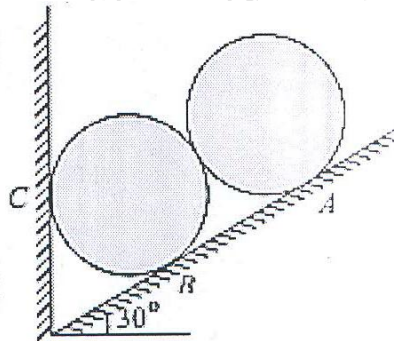
c) A 20 N block is released from rest. It slides down the rough incline of coefficient of friction 0.2. Determine the maximum compression of the spring. Take stiffness of spring, k as 1000 N/m. [6]

****