EGERTON UNIVERSITY

UNIVERSITY EXAMINATIONS
NJORO CAMPUS

SECOND SEMESTER 2009/2010

SECOND YEAR EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE IN AGRICULTURAL, INSTRUMENTATION AND MANUFACTURING ENGINEERING

MENT 223:MECHANICS AND MECHANICS II

STREAM: Y2S2 BSc (Eng) **TIME:** 2½ Hours

DAY: THURSDAY, 12.00 – 2.00 P.M **DATE:** 22/04/2010

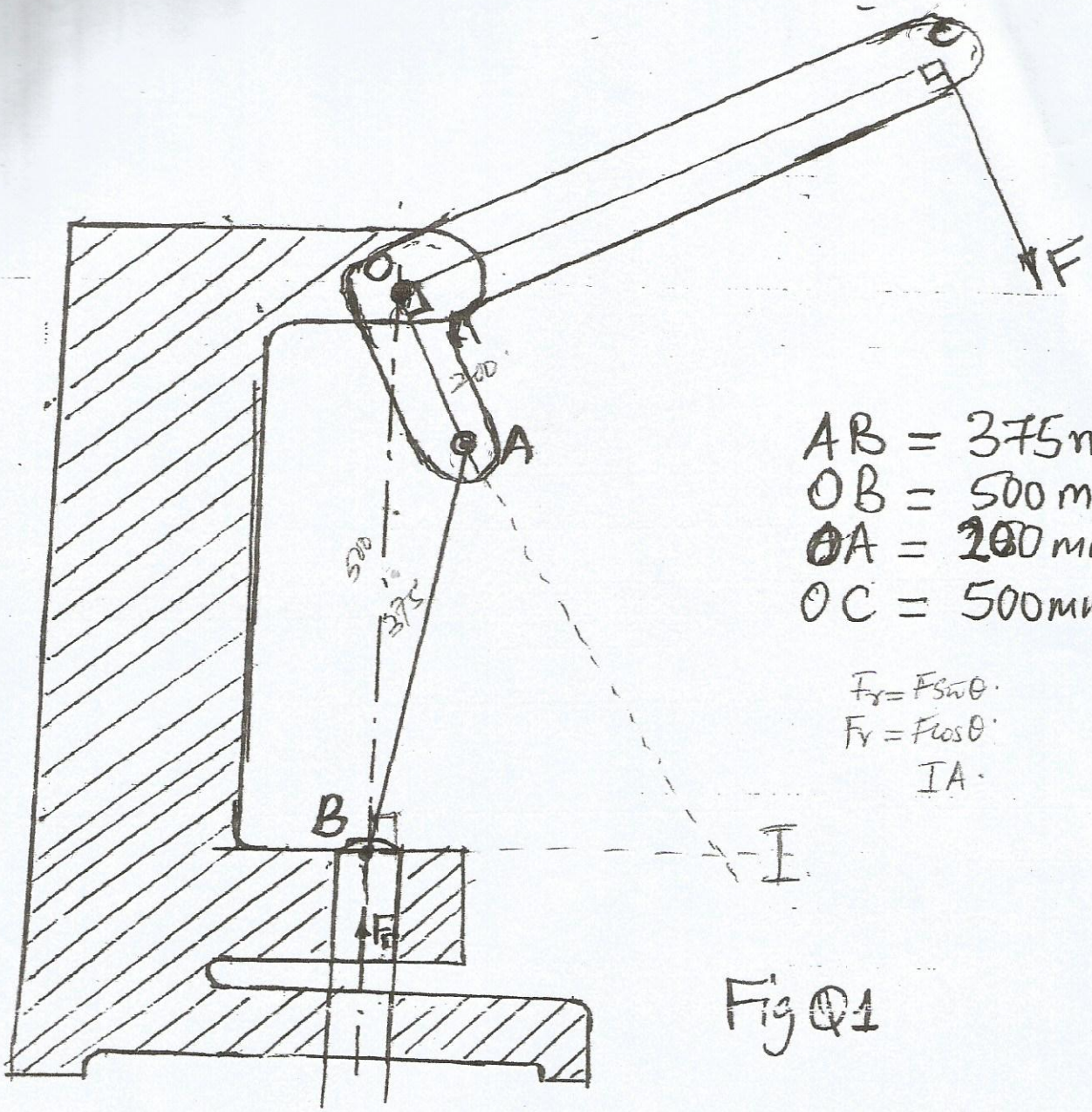
INSTRUCTIONS

1. Attempt any FOUR questions.
2. All questions carry EQUAL maximum marks.
3. Take g = 9.81 ms^{-2} where necessary.

QUESTION ONE.

(a) Explain at least THREE reasons why in an actual machine the energy delivered is less than the energy supplied, both amounts of energy being measured over the same interval of time. (6 marks)

(b) A toggle mechanism such as might be used in a small hand punch is shown in Fig Q1. The effort F is applied to the point C on the bell – crank lever COA and a resistance F_r = 50N to the block B which is guided along a vertical path. Determine the least value of F for the given position and data of the mechanism. What is the mechanical advantage of the mechanism and how can it be increased? (14 marks)



AB = 375mm
OB = 500mm
OA = 200mm
OC = 500mm

$F_T = F \sin\theta$
$F_r = F \cos\theta$
IA

Fig Q1

Balancing

QUESTION TWO

(a) Explain why it is not possible to fully balance a reciprocating inertia force with a revolving mass attached on extensions of the crank webs in a reciprocating engine. (4 marks)

(b) A single-cylinder horizontal oil engine has a crank 190mm long and a connecting rod 800mm long. The revolving parts are equivalent to 5.5kg at crank radius and the piston and gudgeon pin mass 4.5kg. The connecting rod mass 6kg and its centre of gravity is 260mm from the crank pin centre. Revolving balance masses are introduced at a radius

of 200mm, on extensions of the crank webs in order to balance all the revolving parts and one-half of the reciprocating parts. Determine:

(i) The masses of the reciprocating and revolving parts. (4 marks)

(ii) The magnitude of the total balance mass. (6 marks)

(iii) The magnitude of the residual unbalanced force on the machine operating at 300 r.p.m when the crank makes an angle of 45^0 with the line of stroke. (6 marks)

QUESTION THREE

(a) Briefly explain the following as concerns a vibrating system.

(i) Free vibration

(ii) Damped free vibration

(iii) Forced vibration

(iv) Natural frequency , ω_n (8 marks)

(b) Show that logarithmic decrement is also given by the equation. $\delta = \frac{1}{n}\ln\left(\frac{x_0}{x_n}\right)$ where x_n represents the amplitude after n cycles have elapsed. (4 marks)

(c) The following data are given for a vibrating system with viscous damping: m = 4.56 Kg, K = 5270 N/m, C = 21 N/m.s. Determine the logarithmic decrement and the ratio of any two successive amplitudes. (8 marks)

QUESTION FOUR

(a) Explain the following

(i) Critical speed, ω_c or whirling speed.

(ii) Resonance

(iii) Beating phenomenon (6 marks)

(b) A solid disc of mass 4.5kg is keyed to the centre of a 12.7mm diameter steel shaft 600mm between bearings.

Determine:

(i) The lowest critical speed (Assume shaft to be simply supported at the bearings and E = 207, GPa, ρ = 7800Kg/m^3 for steel).

(ii) The amplitude of vibration of the disc at a speed of 2400 r.p.m if the eccentricity is 15μm and damping ratio ζ = 0.01.

(iii) What would be the amplitude if the damping ratio is increased to ζ = 0.1?

(12 marks)

QUESTION FIVE

(a) A pair of mating gears has 14.5^0 full depth teeth of 10mm module. The pitch diameter of the pinion is 160mm. If the transmission ration is 2:1, determine:

(i) Pitch diameter of the gear

(ii) Number of teeth on the pinion and gear

(iii) Dedendum

(iv) Radius of base circle for pinion and gear. (8 marks)

(b) Gear A of the gear train in Fig Q5 is driven at 200 r.p.m clockwise as viewed from above. The shafts of gears A, G, K, and I are located in grounded bearings. Determine N_G, N_K and N_I given the of teeth on each gears as indicated in the figure. Also determine the direction of rotation of these three gears as viewed from the right. (12 marks)

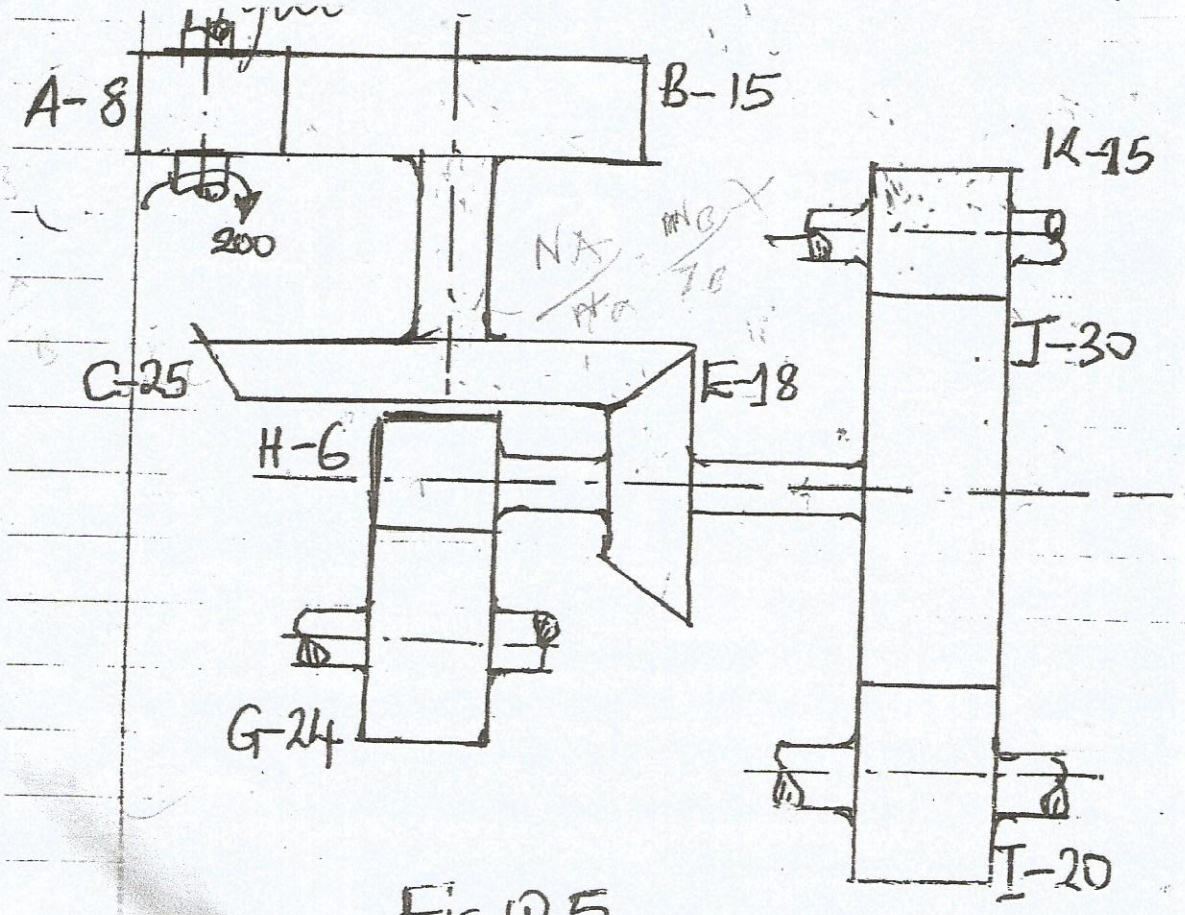


Fig Q5

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NJORO CAMPUS

SECOND SEMESTER 2010/2011

SECOND YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN AGRICULTURAL, INSTRUMENTATION AND MANUFACTURING ENGINEERING

MENT 223: MECHANICS AND MACHINES II

STREAM: BSc (Engineering) **TIME:** 2½ HOURS

DAY: TUESDAY, 12.00 – 2.00 P.M **DATE:** 19/04/2011

INSTRUCTIONS

1. ***Attempt any four questions.***
2. ***All questions carry equal maximum marks***
3. ***Take g=9.81 ms^2 where necessary.***

→ Gearing involute teeth can be generated easily and accurately in gear cutting mechanisms
→ pressure angle is constant
→ all gears having the same pitch and pressure angle will run correctly together
→ face and flank of the tooth form a continuous curve.

QUESTION ONE

(a) Briefly explain at least **FOUR** advantages of using involute gears for general purpose in precision engineering. (8 marks)

(b) Show that the law of gear action requires that the common normal to the tooth profiles of two mating gears, at the point of contact, must always pass through a fixed point called pitch point on the line of centres and the speed ratio is given by:

$\frac{\omega_x}{\omega_y} = \frac{O_y P}{O_x P}$ where P is the point on intersection of the common normal with the line of centres $O_x O_y$ of the two rigid bodies X and Y. (6 marks)

(c) Determine the addendum of the teeth of a gear pair consisting of two spur wheels each having 30 teeth to have a minimum contact, ratio equal to 2. The circular pitch is 2.5 cm and the pressure angle is 20^0. (6 marks)

QUESTION TWO

(a) Briefly explain the following as concerns toothed gearing:

(i) A gear train

(ii) A simple gear train

(iii) A compound gear train

(iv) Train value (8 marks)

(b) A train of spur gears is required to give a total reduction of 250 to 1 in four steps. No pinion is to have less than 20 teeth and the diametrical pitches are to be 5 for the first step, 3.5 for the second, 2.5 for the third and 1.5 for the fourth. Find:

(i) The number of teeth (3 marks)

(ii) The pitch-circle diameters (5 marks)

(iii) The centre distances for a suitable train of gears. (4 marks)

$$Pd = \frac{T}{D} \text{ (teeth/Inch)}$$

QUESTION THREE

(a) Explain the following as used in dynamics of machines:

(i) Equivalent dynamical system

(ii) Primary inertia force in a reciprocating engine

(iii) Partial primary balance of a reciprocating engine. (6 marks)

(b) A single-cylinder reciprocating engine has a stoke of 40cm and the crank makes 250 rpm. The reciprocating parts mass is 60kg and the mass of revolving parts at 20cm radius is 40kg.

(i) Determine the primary and secondary disturbing forces in the engine with a connecting rod length 100cm. (7 marks)

(ii) If two thirds of the reciprocating parts and all the revolving parts are to be balanced find: The balance mass required at radius of 40cm; and the residual unbalanced force: when the crank has rotated 60^0 from the top dead centre. (7 marks)

QUESTION FOUR

(a) Differentiate the following terms:

(i) Static and dynamic balance

(ii) A reciprocating and a revolving unbalance

(iii) Full and partial primary balance of a reciprocating engine. (6 marks)

(b) The masses of M_1, M_2 and M_3 located in planes 1, 2 and 3 are to be balanced by correcting masses in planes 3 and R as shown in Fig. Q4. Determine the balancing masses at radius 4 cm. (14 marks)

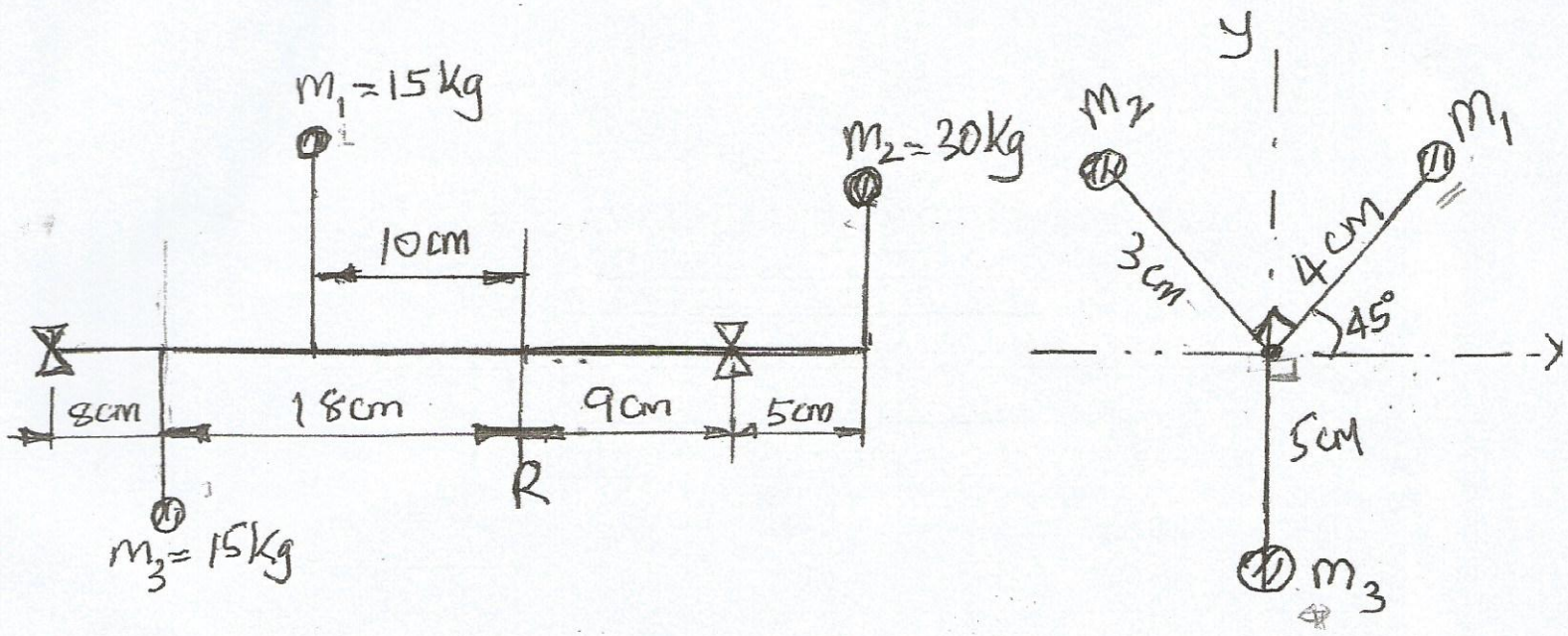

Fig Q4

QUESTION FIVE

(a) Explain at least THREE methods of minimizing the forces transmitted from an operating machine to the foundation. (6 marks)

(b) A rotating machine of mass 650kg, operating at a constant speed of 1500 r.p.m, has an unbalance of 0.12kgm. If the damping in the isolators is given by damping ratio of $\xi = 0.08$, determine the stiffness of the isolators, so that the transmissibility at the operating speed is less than or equal to 0.15. Also determine the magnitude of the force transmitted. (8 marks)

(c) A 55 kg compressor rotor is mounted on a shaft of stiffness 1.4×10^7 N/m. Determine the critical speed of the rotor assuming, the bearings to be rigid. If the rotor has an eccentricity of 1000 micron and its operating speed is 6000 r.p.m determine the unbalanced response. The damping in the system can be assumed to be $\xi = 0.05$ (6 marks)

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MENT 223

EGERTON UNIVERSITY

UNIVERSITY EXAMINATIONS

NAKURU TOWN CAMPUS

SECOND SEMESTER 2008/2009

FIRST YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF INDUSTRIAL TECHNOLOGY

MENT 223 – MECHANICS OF MACHINES II

STREAM: B.I.T. Y_1S_2 **TIME:** 2½ HRS

DAY: MONDAY: 9.00 A.M. – 12.00 NOON **DATE:** 18-05-2009

INSTRUCTIONS:

1. **Attempt any FOUR questions**
2. **All questions carry EQUAL maximum marks**
3. **Take g=9.81ms^{-2} where necessary**

QUESTION ONE

(a) In an ideal machine the energy delivered would be exactly equal to the energy supplied. But in an actual machine this state of affairs does not exist for two reasons: Briefly explain these two reasons. [4 marks]

(b) The lengths of the links of a four-bar chain are AB=63.5mm, BC=177.8mm, CD=114.3mm and AD=203.2mm. Link AD is fixed and AB turns at a uniform speed of 180r.p.m. clockwise. The link BC has a mass 2.273kg its centre of gravity is 101.6mm from C and its radius of gyration about an axis through the c.g is 73.66mm. The link CD is of mass 1.364kg, its c.g is 38.1mm from C and its radius of gyration about an axis through D is 88.9mm.

When BA is at right angles to AD and B and C lie an opposite sides of AD.

(i) Sketch the assembled mechanism and show that it obeys Grashof's criterion. [3 marks]

(iii) Given that the angular acceleration of the output and coupler links are 107.85 rad s^{-2} and 110.124 rad s^{-2} clockwise respectively. Determine the torque exerted on AB to overcome the inertia of the link C and the forces which act on Pins B and C. [13 marks]

QUESTION TWO

(a) Explain at least THREE effects of lack of balance in revolving and reciprocating part of an engine. [6 marks]

(b) A shaft carries three rotating masses A, B, C of magnitude 9, 8 and 15kg with their centres of gravity 100mm, 125mm and 50mm respectively from the axis of rotation. The distance between the planes of rotation of A and B is 0.9m and between B and C is 1.5m. The angular positions of the masses are B 60° and C 35° from A in the same direction. Find the magnitude and position of the blance weights required in planes L and M, situated midway between the planes A and B, and B and C respectively. The radius of the balance weight is 125mm. [19 marks]

QUESTION THREE

(a) (i) A body of mass mkg is attached to two light springs in parallel as shown in Fig.Q3. If the spring stiffness are K_1 and K_2 calculate the natural frequency of the system given that m=10kg $K_1=1.5\times10^4$ N/M and $K_2=2\times10^4$ N/M. [3 marks]

(ii) If the springs are then connected in series, what is the natural frequency of the system? [3 marks]

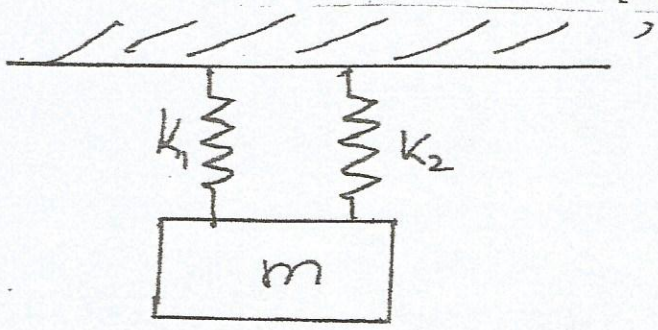

Fig Q3.

(b) A spring-mass system with viscous damping is displaced a distance Xo and released. Determine the equation of motion when the damping ratio $\xi=2$. Sketch the result in a non-dimensional form. [19 marks]

QUESTION FOUR

(a) Show that for small damping coefficient ratio the logarithmic decrement is given by the expression $\delta = 2\pi\xi$ [6 marks]

(b) Determine the natural frequencies and modes in the system shown in Fig Q4.

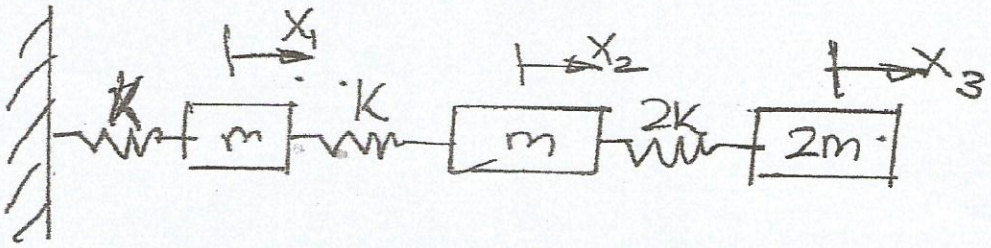

Fig Q4

[19 marks]

QUESTION FIVE

(a) Show that the minimum number of teeth required on the gear wheel in order to avoid interference between the flanks of the pinion and tips of the wheel teeth is given by the expression:

$$T = \frac{2K}{\left[\sqrt{(1 + A\sin^2\phi)} - 1\right]}$$

[10 marks]

(b) A crane is required to hoist the load at a speed of 76.2 mm/s. The barrel on which the rope is wound is 609.6mm diameter and the hoisting motor runs at 450 r.p.m. The rope is arranged that the speed at which the rope is wound on the barrel is 5 r.p.m. Determine the number of teeth on gears to achieve this.

[15 marks]