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Entry No. _____

Group No. _____

AML110 MECHANICS MAJOR

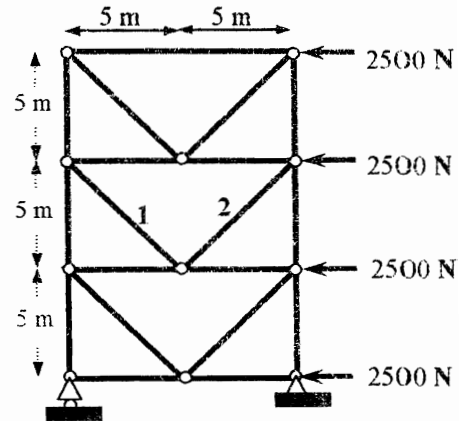
23rd Nov. 2008

1.00 pm to 3.30 pm

Please answer all the questions. The marks for each question are indicated alongside. The ordering of the questions is arbitrary. **PLEASE ANSWER IN THE SPACE PROVIDED BELOW/ALONGSIDE THE QUESTIONS (Max. marks: 120)**

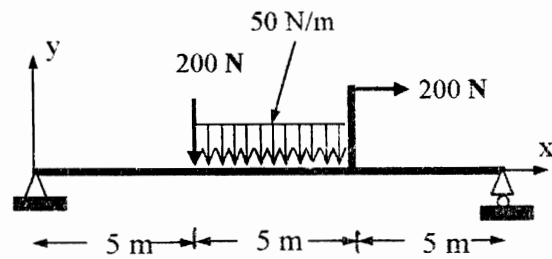
Q1) Find the forces in members 1 and 2.

(10)



Q2) Find the axial force, shear force and bending moment at the centre of the beam.

(8)



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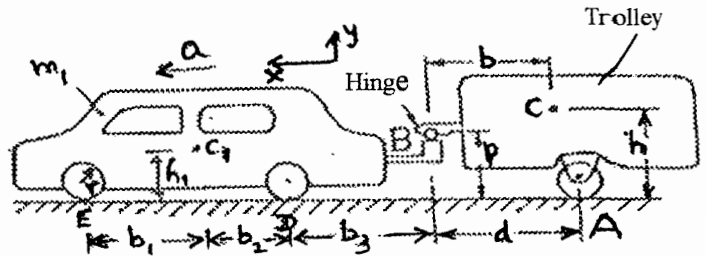
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Q3) A rear wheel driven pick-up truck has driving moment M and is connected to a trolley of mass m by a hinge joint. The inertia of the wheels is negligible.

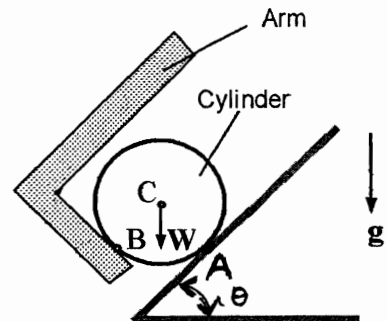
- (i) Draw FBDs of the rear wheel of the pick-up truck, pick-up truck with wheels and trolley with wheels.
- (ii) Set-up equations to determine acceleration 'a' and reactions at A, B, D, E.

(DO NOT SOLVE THE EQUATIONS) (12)



Q4) A cylinder of weight W is to be raised up an incline by an arm as shown in the figure. Find the force exerted at B by the arm on the cylinder for impending motion up the incline for $\theta = 60^\circ$. Coefficient of friction for both the contact surfaces is μ .

(10)

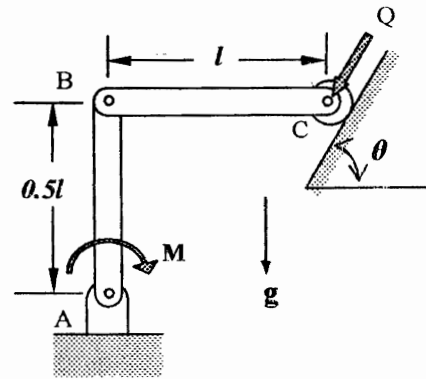


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Q5) The linkage shown in is frictionless. The roller at C rests on a smooth inclined bed as shown. Determine the couple M required to maintain equilibrium using the principle of virtual work. All the components are light. Take $l=0.5\text{m}$, $Q=40\text{N}$ and $\theta = 60^\circ$. (6)

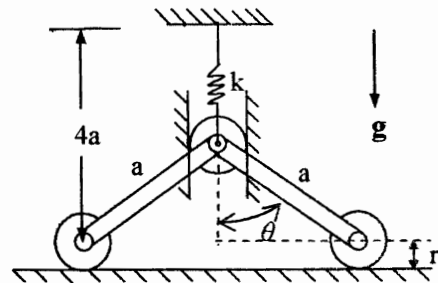


Q6) For the frictionless system shown, the un-deformed length of the spring is $2a$. The weight of each roller and each rod is $W/2$.

a) Prove that $\theta = 0^\circ$ is an equilibrium position for all values of W and

$\theta = \cos^{-1}(2 - W / ka)$ is another equilibrium position if $3ka > W > ka$.

b) Determine the stability of these equilibrium positions. (12)



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Q7) For an n d.o.f. system given that $\delta^{(0)}T = \left[\frac{\partial T}{\partial \dot{q}_i} \dot{\eta}_i + \frac{\partial T}{\partial q_i} \eta_i \right] \epsilon$ and $\delta W = Q_i \eta_i \epsilon$, using Hamilton's Principle

derive Lagrange's equations of motion: $\frac{d}{dt} \left(\frac{\partial T}{\partial \dot{q}_i} \right) - \frac{\partial T}{\partial q_i} + \frac{\partial V}{\partial q_i} = Q_i^{nc}$ for $i = 1, 2, \dots, n$. Clearly state the

conditions on $\vec{\eta}$ and $\dot{\vec{\eta}}$.

(10)

Q8) While Chandrayaan I was being placed in orbit around the Moon, the following change in orbit was made.

Initial orbit: Perigee = 1924km; Apogee = 1992km.

Final orbit: Perigee = 1837km; Apogee = 1992km (The change in orbit was made at the apogee.)

i) Find the change in speed that was required given that $\Delta \vec{V}$ is parallel to \vec{V} .

ii) If the mass of Chandrayaan I was 700Kg at the time of this manoeuvre and if its engines are capable of developing a thrust of 440N, how long were the engines fired?

$GM_{\text{Moon}} = 4909 \text{ km}^3/\text{s}^2$; Radius of the Moon = 1737 km.

(10)