CALEDONIAN COLLEGE OF ENGINEERING

FINAL EXAMINATION

Programme: B. Eng. (Honours) in CAME/MT/POM/EI/EPE

Session: 2014 – 15
Level: 1
Date: 23 June 2015

Semester: B
Duration: 2 Hours
Max. Marks: 100

M1H321458: Mechanical Principles

Candidates Should Attempt Two Full Questions from Section A and Two Full Questions from Section B

Please read the Questions carefully

Materials to be Supplied/Allowed:
Question paper (Supplied)
Blank Examination Script (Supplied)
Non-programmable calculator (Allowed)
Formulae sheet (Supplied)
Section A (Answer any Two Full Questions)

Q1(a) Explain Lami’s theorem with the help of a suitable example. [6]

(b) Determine the resultant of the forces as shown in Figure Q1 (b). [16]

(c) Evaluate the effect of the forces on the eyebolt shown in Figure Q1 (b). [3]

Q2(a) Explain the conditions of equilibrium of coplanar concurrent force system with a suitable example. [6]

(b) Determine the second moment of area with respect to the horizontal and vertical axis passing through the center of a 40mmx40mm square plate with a 10mm diameter central hole. [16]

(c) The width and height of the square plate given in Q2 (b) is decreased. Evaluate the effect on the second moment of the area. [3]

Q3(a) Explain the following terms with one example for each;
   (i) Neutral axis of a beam, [3]
   (ii) Second moment of an area about an axis. [3]
(b) The beam shown in Figure Q3 (b) is subjected to point load. Perform the following:

(i) Draw the free body diagram, [3]
(ii) Determine the support reactions, [6]
(iii) Draw the bending moment diagram, [5]
(iv) Determine the maximum bending moment. [2]

![Beam Diagram]

Figure Q3(b)

(c) Evaluate the effect of decrease in the applied load on the maximum bending moment for the system as shown in Figure Q3 (b). [3]

Section B (Answer any Two Full Questions)

Q4(a) Explain the difference between rectilinear translation and curvilinear translation with suitable examples. [6]

(b) A block of mass 50 kg which is initially at rest is pulled along a straight horizontal floor by a horizontal force of 100N. The coefficient of kinetic friction between the block and the floor is 0.20. Perform the following:

(i) Draw the free body diagram of the block, [6]
(ii) Determine the friction force between the block and the floor, [3]
(iii) Determine the acceleration of the center of mass of the block, [3]
(iv) Determine the velocity of the block after covering 1m distance using work-energy principle. [4]

(c) Explain the effect on the acceleration of the center of mass of the block, when there is an increase in coefficient of friction between the block and the floor. [3]
Q5(a) Explain the laws of friction. [6]

(b) Block 1 of mass 30 kg is resting on block 2 of mass 80 kg as shown in Figure Q5(b). Perform the following:

(i) Draw the free body diagram of block 1 and 2, [6]
(ii) Determine the normal reaction on block 1 and block 2, [5]
(iii) Determine the force P1 required to start the motion of block 1 and P2 required to start the motion of block 2. [5]

![Figure Q5(b)](image)

(c) Evaluate the effect on the force P1 required to start motion for the system shown in Figure Q5(b) when there is an increase in mass of block 1. [3]

Q6(a) Explain the following terms with one example of each;

(i) Damped vibration, [3]
(ii) Undamped vibration. [3]

(b) A spring mass system consists of springs of equal stiffness of 1kN/m each connected in parallel to a mass of 10kg. The natural frequency of vibration of the system is 6.37Hz. Perform the following:

(i) Draw the arrangement of the spring mass system, [4]
(ii) Determine the number of springs required, [6]
(iii) Determine the natural frequency of vibration of the system if the springs are connected in series. [6]

(c) Evaluate the effect of increase in mass on the natural frequency of the system given in Q6(b). [3]

End of Question Paper
FORMULAE SHEET

\[
\frac{F_1}{\sin \alpha} = \frac{F_2}{\sin \beta} = \frac{F_3}{\sin \gamma}
\]

\[
\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}
\]

\[
f = \frac{1}{2\pi} \sqrt{\frac{S}{m}}
\]

\[
l_{xc,\text{rectangle}} = \frac{bh^3}{12}
\]

\[
l_{yc,\text{rectangle}} = \frac{hb^3}{12}
\]

\[
l_{xc,\text{circle}} = l_{yc,\text{circle}} = \frac{\pi d^4}{64}
\]

\[
R = \sqrt{F_1^2 + F_2^2 + 2F_1F_2 \cos \theta}
\]