CALEDONIAN COLLEGE OF ENGINEERING

FINAL EXAMINATION

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

Session: 2014 – 15
Semester: A
Level: 1
Duration: 2 hours
Date: 07 January 2011
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)
Formula sheet (Attached)
Section A (Answer any Two Full Questions)

Q1(a) Explain the terms:
(i) Resultant;
(ii) Equilibrium;
(iii) Centroid.

(b) Three forces $F_1$, $F_2$ and 10 kN maintain the point O in equilibrium as shown in Figure Q1(b). Determine the forces $F_1$ and $F_2$.

(c) "Point O will not be in equilibrium if $F_1$ is only increased". Justify this statement.

Q2(a) Explain the equilibrium of 3 coplanar concurrent forces with a suitable example.

(b) Determine the forces in the members of the pin jointed frame of equilateral triangle shape as shown in Figure Q2 (b).

(c) "Forces in members of the pin jointed frame as shown in Figure Q2 (b) increase if the external load is increased". Justify this statement.
Q3(a) Explain the method for obtaining the moment of inertia of a rectangle about an axis passing through the base parallel to its horizontal centroidal axis.

(b) Determine the moment of inertia of the area shown in Figure Q3 (b) with respect to the x axis. All dimensions are in mm.

![Figure Q3(b)](image)

(c) “The moment of inertia of the area shown in Figure Q3 (b) with respect to the x axis decreases as the height and width of the area decrease”. Justify this statement.

Section B (Answer any Two Full Questions)

Q4(a) Explain the stress distribution with respect to the neutral axis for the circular cross section of a cantilever beam subjected to bending.

(b) An overhanging beam with a 12mmx12mm cross section is subjected to point loads as shown in Figure Q4 (b). Determine the following:
   (i) support reactions;
   (ii) maximum bending moment;
   (iii) maximum bending stress.

![Figure Q4(b)](image)

(c) "Maximum bending stress is lowered if the height of the beam is increased". Justify this statement.
Q5(a) Explain the following terms with suitable examples:
   (i) coefficient of static friction;
   (iii) coefficient of kinetic friction.

(b) Determine the weight of block B for the system shown in Figure Q5 (b) so that the block A with mass of 50 kg starts moving up the inclined plane. The coefficient of friction for all surfaces is 0.20.

(c) "In Figure Q5 (b), lowering the mass of block A results in lowering the mass of block B in order to just start the system in motion". Justify this statement.

Q6(a) Explain what is meant by dynamic equilibrium with a suitable example.

(b) Seven springs of equal stiffness of 1kN/m are connected to a mass of 10kg. Perform the following,
   (i) Determine the natural frequency of vibration of the system if the springs are connected in series to the mass;
   (ii) Determine the natural frequency of vibration of the system if the springs are connected in parallel to the mass.

(c) Explain the effect of doubling the stiffness of all the springs on the natural frequency of vibration for the system given in Q6(b)/(ii).
FORMULAE SHEET

\[
\frac{F_1}{\sin A} = \frac{F_2}{\sin B} = \frac{F_3}{\sin C}
\]

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

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

\[
I_{xc, rectangle} = \frac{bh^3}{12} \quad I_{yc, rectangle} = \frac{bh^3}{12}
\]

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

\[
R = \sqrt{\left(F_1^2 + F_2^2 + 2F_1F_2 \cos \theta \right)}
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