CALEDONIAN COLLEGE OF ENGINEERING

FINAL EXAMINATION

Programme: B.Sc. Degree in Chemical Engineering

Session: 2013 – 14          Semester: B
Level: 1                     Duration: Three Hours
Date: 10 Jun 2014            Max Marks: 100

ENME110 Engineering Mechanics

Candidates should attempt ANY FIVE Full Questions

Please read the Questions carefully

Materials to be Supplied/Allowed:
Question paper (Supplied)
Blank Examination Script (Supplied)
Non-programmable calculator (Allowed)
Formulae Sheet (Supplied)
Q1(a) Explain the term 'coplanar, concurrent' force systems with the help of a suitable example.

(b) Determine the unknown forces F1 and F2 for the force system shown in Figure Q1(b).

(c) Explain the effect of change in magnitude of any one force of Figure Q1(b) on the equilibrium of point 'O' while the angles remain the same.

Q2(a) Explain the method of determination of total change in length of a composite bar subjected to axial tensile load.

(b) Uniform composite bar made of 3 different materials is subjected to an axial compressive load of 10kN as shown in Figure Q2(b). Determine the following:

\[ \begin{align*} 
\delta & \quad \text{Compressive stress in each section} \\
\varepsilon & \quad \text{Linear strain in each section} 
\end{align*} \]

Modulus of elasticity: E1=210GPa, E2=110GPa and E3=80GPa

(c) Mention the section in Figure Q2(b) that carries minimum stress. Justify your answer.
Q3(a) Explain Hook’s law with a suitable example. [5]

(b) An overhanging beam is subjected to loading as shown in Figure Q3(b). Perform the following.

(i) Determine support reactions;
(ii) Draw shear force diagram. [6]

![Figure Q3(b)](image)

(c) Analyse the effect of equal increase in both the applied loads on horizontal equilibrium of the system given in Q3(b). [3]

Q4(a) Explain parallel axis theorem with a suitable example. [5]

(b) Cantilever beam of length of 4m and square cross section of 12mm x 12mm carries two weights of 500N and 200N at the middle and the free end respectively. Perform the following.

(i) Draw the bending moment diagram;
(ii) Determine maximum bending stress. [6]

(c) Explain the effect of increase in the weight at the free end given in Q4(b) on the maximum bending moment. [3]
Q6(a) Draw the deflection curve of a cantilever beam subjected to a vertical downward load at its free end. Also locate the section with maximum deflection & slope.

(b) Simple supported beam of diameter 20mm and length of 1m is subjected to a vertical downward load at the midspan. Modulus of Elasticity of the material (E) = 210 GPa, Determine the following:

(i) Maximum permissible load 'W' so that maximum deflection is 0.01mm;
(ii) Maximum slope.

(c) Explain the effect of decrease in length of the beam on maximum deflection.

Q6(a) Explain longitudinal and transverse vibration with the help of suitable example.

(b) Six springs of equal stiffness are connected to a mass of 10kg as shown in Figure Q6(b). Determine the Stiffness of the spring if the time period of oscillation of the system is 1 sec.

(c) Analyse the effect of increase in stiffness of the spring on the natural frequency of vibration of the system shown in Figure Q6(b).
Q7(a) Explain the modulus of elasticity and modulus of rigidity with suitable examples. [5]

(b) Hollow circular shaft of inner diameter 10mm and outer diameter 20mm is subjected to a twisting moment of 1kN.m at the free end as shown in Figure Q7(b). Determine the following.

(i) Maximum torsional shear stress; [6]
(ii) Angle of twist per unit length. [4]

Take modulus of rigidity of material (G)=80GPa.

![Figure Q7(b)](image)

(c) Analyse the effect of twisting moment given in Q7(b) on the maximum shear stress developed in the material of the bar. [3]

End of Question Paper
ENME110 Engineering Mechanics

FORMULAE SHEET

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

2. \[ \delta L = \frac{F_1}{A_1E_1} + \frac{F_2}{A_2E_2} + \frac{F_3}{A_3E_3} \]

3. \[ M = \frac{\sigma}{\gamma} = \frac{\varepsilon}{\varepsilon} \]

4. \[ T = \frac{\tau}{R} = \frac{GB}{L} \]

5. \[ Y_{\text{max}} = -\frac{Wl^2}{3EI} \] for cantilever with concentrated load at the end

6. \[ \theta_{\text{max}} = \frac{Wl^2}{2EI} \] for cantilever with concentrated load at the end

7. \[ Y_{\text{max}} = -\frac{Wl^4}{8EI} \] for cantilever with UDL

8. \[ \theta_{\text{max}} = -\frac{Wl^3}{6EI} \] for cantilever with UDL

9. \[ Y_{\text{max}} = \frac{Wl^2}{16EI} \] for simply supported with point load at the middle

10. \[ \theta_{\text{max}} = \frac{Wl^2}{16EI} \] for simply supported with point load at the middle

11. \[ Y_{\text{max}} = -\frac{SWl^4}{384EI} \] for simply supported beam with UDL

12. \[ \theta_{\text{max}} = -\frac{Wl^2}{24EI} \] for simply supported beam with UDL

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