EXAMINATION AND EVALUATION DIVISION
DEPARTMENT OF POLYTECHNIC EDUCATION
(MINISTRY OF HIGHER EDUCATION)

CIVIL ENGINEERING DEPARTMENT

FINAL EXAMINATION

CC205: MECHANICS OF STRUCTURES

DATE : 21 NOVEMBER 2012
DURATION : 2 HOURS (11.15 AM – 1.15 PM)

This paper consists of SIX (6) pages including the front page.
Section A: STRUCTURED (10 questions – answer ALL)
Section B: ESSAY (1 question – answer one)
Section C: ESSAY (2 question – answer one)

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THE CHIEF INVIGILATOR

(The CLO stated is for reference only)
SECTION A

STRUCTURED (40 marks)

Instruction: This section consists of TEN (10) subjective questions. Answer ALL the questions.

QUESTION 1

a. Describe the axial force using appropriate diagrams

(2 marks)

b. Sketch and label the direction of reaction for the following support:
   i. Roller
   ii. Fixed end

(2 marks)

[CLO 1: C1]

QUESTION 2

Calculate the reaction at support B for a beam subjected to the loads as shown in Figure 1.

Figure 1

[4 marks]

QUESTION 3

Calculate the reaction for a simply supported beam subjected to the loads as shown in Figure 2.

Figure 2

[4 marks]
QUESTION 4
A steel rod 300mm in length is subjected to a tensile force of 25N has a diameter of 20mm as shown in Figure 3. Calculate the elongation in the rod. Given Young’s Modulus = 205GPa.

\[ \text{[CLO1:C3]} \]
\[ \text{(4 marks)} \]

QUESTION 5
A load of 40kN is to be raised with the help of a steel wire. Calculate the maximum diameter of the steel wire, if the stress is not to exceed 100N/mm\(^2\).

\[ \text{[CLO1:C3]} \]
\[ \text{(4 marks)} \]

QUESTION 6
A simply supported beam has 150mm breadth and 230mm height is having stress in compression and tension of 100MPa. Calculate bending stress at 40mm from neutral axis.

\[ \text{[CLO 3: C3]} \]
\[ \text{(4 marks)} \]

QUESTION 7
A simply supported beam carries a maximum moment of 50kNm has a rectangular cross section of 300mm x 500mm. Calculate maximum bending stress in the section.

\[ \text{[CLO 3: C3]} \]
\[ \text{(4 marks)} \]
QUESTION 8
A rectangular column as shown in Figure 4, is loaded eccentrically with $P$ kN. Calculate the stresses that occur at the corner of E, F, G and H if $P/A = 2.0$ N/mm$^2$, $M_{xy}/Z_{xx} = 1.5$ N/mm$^2$ and $M_{yy}/Z_{yy} = 1.3$ N/mm$^2$.

Figure 4

[4 Marks]

[CLO3: C3]

QUESTION 9
Calculate the force required to shear a bolt with 8mm diameter. Given the ultimate shear stress is 60MN/m$^2$.

(CLO3:C3)

(4 marks)

QUESTION 10
A rectangular beam as shown in Figure 5 carries a shear force of 30kN. Calculate the shear stress for the shaded area.

Figure 5

(4 marks)

(CLO3:C3)
SECTION B

ESSAY (30 MARKS)

INSTRUCTION: This section consists of ONE (1) structured question. Answer all question.

QUESTION 1

A cantilever beam is subjected to point load and moment as shown in Figure 6. Calculate slope and deflection at free end of the cantilever beam by using Moment area Method.

[CLO 5 : C4]

(30 marks)

Figure 6
SECTION C
ESSAY (30 MARKS)
INSTRUCTION: This section consists of TWO (2) structured questions. Answer ONE (1) question only.

QUESTION 1
Sketch the Shear Force Diagram (SFD) and Bending Moment Diagram (BMD) for the cantilever beam as shown in Figure 7.

![Figure 7](image)

(30 marks)

QUESTION 2
a) Two plates of 8 mm thickness are connected by TWO (2) 20 mm diameter bolts as shown in Figure 8. Calculate the shear stress in the bolts.

![Figure 8](image)

(5 Marks)

b) A T-section beam as shown in Figure 9 is subjected to a shear force of 250kN. Calculate the maximum shear stress at the junction of the web and the flange. Sketch the shear stress distribution diagram for the section.

![Figure 9](image)

(25 Marks)
LIST OF FORMULA FOR CC205 – MECHANICS OF STRUCTURES

1. \( \sigma = \frac{P}{A} \)

2. \( \varepsilon = \frac{\delta l}{l} \)

3. \( E = \frac{pl}{A\delta l} \)

4. \( E = \frac{\sigma}{\varepsilon} \)

5. \( I_{xx} = \frac{bd^3}{12} + Ah^2 \)

6. \( Z = \frac{I}{\gamma_{max}} \)

7. \( \frac{M}{l} = \frac{\sigma}{y} \)

8. \( \tau = \frac{F}{A} \)

9. \( \tau = \frac{V\bar{A}y}{I, b} \)

10. \( \sigma_{\text{max/min}} = \sigma_y \pm \sigma b_x \pm \sigma b_y \)

11. \( \sigma_{\text{max/min}} = \frac{P}{A} \pm \frac{Pe_{y,y}}{I_{xx}} \pm \frac{Pe_{x,x}}{I_{yy}} \)

12. \( \sigma_{\text{max/min}} = \frac{P}{A} \pm \frac{M_{xx}}{Z_{xx}} \pm \frac{M_{yy}}{Z_{yy}} \)
<table>
<thead>
<tr>
<th>Shape</th>
<th>Area, $A$</th>
<th>Centroid, $x$</th>
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</thead>
<tbody>
<tr>
<td>Triangle</td>
<td>$\frac{1}{2}bh$</td>
<td>$\frac{2}{3}b$</td>
</tr>
<tr>
<td>Rectangle</td>
<td>$bh$</td>
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<tr>
<td>Semi parabola</td>
<td>$\frac{2}{3}bh$</td>
<td>$\frac{5}{8}b$</td>
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<tr>
<td>Parabolic spandrel</td>
<td>$\frac{1}{3}bh$</td>
<td>$\frac{3}{4}b$</td>
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</table>
## Maximum Moment

<table>
<thead>
<tr>
<th>Beam</th>
<th>Maximum moment</th>
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</thead>
<tbody>
<tr>
<td><img src="image1" alt="Beam 1" /></td>
<td>$\frac{wL^2}{8}$</td>
</tr>
<tr>
<td><img src="image2" alt="Beam 2" /></td>
<td>$-\frac{wL^2}{2}$</td>
</tr>
<tr>
<td><img src="image3" alt="Beam 3" /></td>
<td>$\frac{PL}{4}$</td>
</tr>
<tr>
<td><img src="image4" alt="Beam 4" /></td>
<td>$-\frac{PL}{2}$</td>
</tr>
</tbody>
</table>