<table>
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<th><strong>PROGRAM</strong></th>
<th>NATIONAL DIPLOMA ENGINEERING: CIVIL</th>
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<tbody>
<tr>
<td><strong>SUBJECT</strong></td>
<td>STRUCTURAL STEEL AND TIMBER DESIGN III</td>
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<tr>
<td><strong>CODE</strong></td>
<td>TSS31-1</td>
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<td><strong>DATE</strong></td>
<td>SUMMER EXAMINATION 2015 7 NOVEMBER 2015</td>
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<tr>
<td><strong>DURATION</strong></td>
<td>(SESSION 1) 08:30 - 12:30</td>
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<td><strong>WEIGHT</strong></td>
<td>40 : 60</td>
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<td><strong>TOTAL MARKS</strong></td>
<td>115</td>
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<td><strong>EXAMINER</strong></td>
<td>MR C BRUWER</td>
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<td><strong>MODERATOR</strong></td>
<td>MR B. RAATH</td>
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<td><strong>NUMBER OF PAGES</strong></td>
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| **INSTRUCTIONS**  | THIS IS A PARTIAL OPEN BOOK TEST, THE FOLLOWING IS ALLOWED:  
|                   | • SANS 10162                           |
|                   | • SANS 10160                           |
|                   | • STEEL TABLES                         |
|                   | • 2 PAGES WITH STUDENT NOTES           |
| **REQUIREMENTS**  | PROGRAMABLE POCKET CALCULATORS ALLOWED. |
QUESTION 1

The figure below shows a beam ABCDE (406x178x74 I section Grade 350W) simply supported at A and E with a lateral support to the compression flange at D. Beam A-E is supporting two columns at B and C, attached to the top flange, which produce the following loads:

- Nominal point load at B: Permanent (Dead) = 55 kN
  Imposed (Live) = 45 kN
- Nominal point load at C: Permanent (Dead) = 85 kN
  Imposed (Live) = 65 kN
- Include the beam’s own weight

Determine if the beam (both segments) is adequate to support the applied loads by checking the following:

- 1.1 Determine the ultimate loads (2)
- 1.2 Draw the ultimate shear force and bending moment diagrams (6)
- 1.3 Determine the class of the beam (6)
- 1.4 Bending for segment A-D
  - 1.4.1 Determine the moment of resistance (9)
  - 1.4.2 Compare the ultimate moment to the moment of resistance (1)
- 1.5 Bending for segment D-E
  - 1.5.1 Determine the moment of resistance (5)
  - 1.5.2 Compare the ultimate moment to the moment of resistance (1)
- 1.6 Shear
  - 1.6.1 Determine shear resistance (6)
  - 1.6.2 Compare the ultimate shear resistance to shear resistance (1)
QUESTION 2

The figure below show a truss with pin-jointed members subjected to the following point loads:

- Nominal point load at G: Permanent (Dead) = 40 kN
  Imposed (Live) = 35 kN
- Neglect the own weight of the structure.

Answer the following questions whilst determining if members CG and CF can resist the ultimate forces.

- 2.1 Determine the ultimate forces in elements BC and CF (5)
- 2.2 Check if the compression member (bolted on the one end and welded on the other), is adequate to resist the generated force by investigating the following:
  - 2.2.1 Slenderness limits (6)
  - 2.2.2 Local buckling (2)
  - 2.2.3 Member buckling due to torsional-flexural buckling (8)
  - 2.2.4 Member buckling due to flexural buckling (2)
  - 2.2.5 Compare the minimum compression resistance force to the ultimate compression force and comment. (1)

- 2.3 Check if the tension member (bolted on the one end and welded on the other) is adequate to resist the generated force by investigating the following:
  - 2.3.1 Slenderness limit (2)
  - 2.3.2 Yielding failure (1)
  - Bolted side of the element
    - 2.3.3 Bolt hole layout is given below, check if it meets the minimum requirements (4)
    - 2.3.4 Bolt shear, also check for reduction of long lap splices (4)
    - 2.3.5 Bearing resistance of the member (3)
    - 2.3.6 Fracture failure (3)
    - 2.3.7 Tension fracture and shear fracture (4)
    - 2.3.8 Tension fracture and shear yielding (4)
  - Welded side of the element
    - 2.3.9 Weld shear failure (2)
    - 2.3.10 Fracture failure (6)
  - Compare minimum tensile resistance against ultimate tensile force.
    - 2.3.11 Determine and name the minimum tensile resistance force and compare it to the ultimate tensile force and comment. (2)

Use the following information:

- All members are 90x90x12 Equal Angle, gas cut to length, grade 350W steel. \( r_w = 48.04 \text{mm}, C_w = 0.05 \times 10^9 \text{mm}^6 \text{ and } \Omega = 0.63 \)
- All bolts are 16mm fully threaded Class 4.8 bolts. One line of 3 bolts. End distance is 25mm, pitch is 45mm, edge distance is 25 mm.
- All holes are drilled.
- Parallel weld (6mm E70XX), 50mm long on both sides.
- Connection plates are 300W steel and 16mm thick
**QUESTION 3**

Determine if a simply supported SA Pine solid beam (50 x 150 grade 07) spanning 3.0m is adequate to resist the load given below. The beam is laterally supported along the length. Determine the following:

- 3.1 The ultimate generated moment
- 3.2 The moment resistance of the beam
- 3.3 Compare the moment resistance of the beam to the ultimate generated moment.

Additional notes:
- Check for flexure only
- The nominal uniformly distributed loads over the entire span of the beam is:
  - Permanent (Dead) UDL = 1.0kNm (Inclusive of the beam’s own weight)
  - Imposed (Live) UDL = 1.2kNm
- This timber beam will carry the above specified loads permanently.
- The SA pine beam is not treated with any preservatives