UNIVERSITY OF TORONTO

Faculty of Applied Science and Engineering

CIV100S – MECHANICS

Final Examination

26th April 2018

Examiner: Prof. Michael Seica

Time allowed: 2-½ hours

FAMILY NAME:_____ **GIVEN NAME(S):**_____
(Please print clearly)

STUDENT NUMBER: _____

CIRCLE THE MODEL NUMBER OF YOUR CALCULATOR:

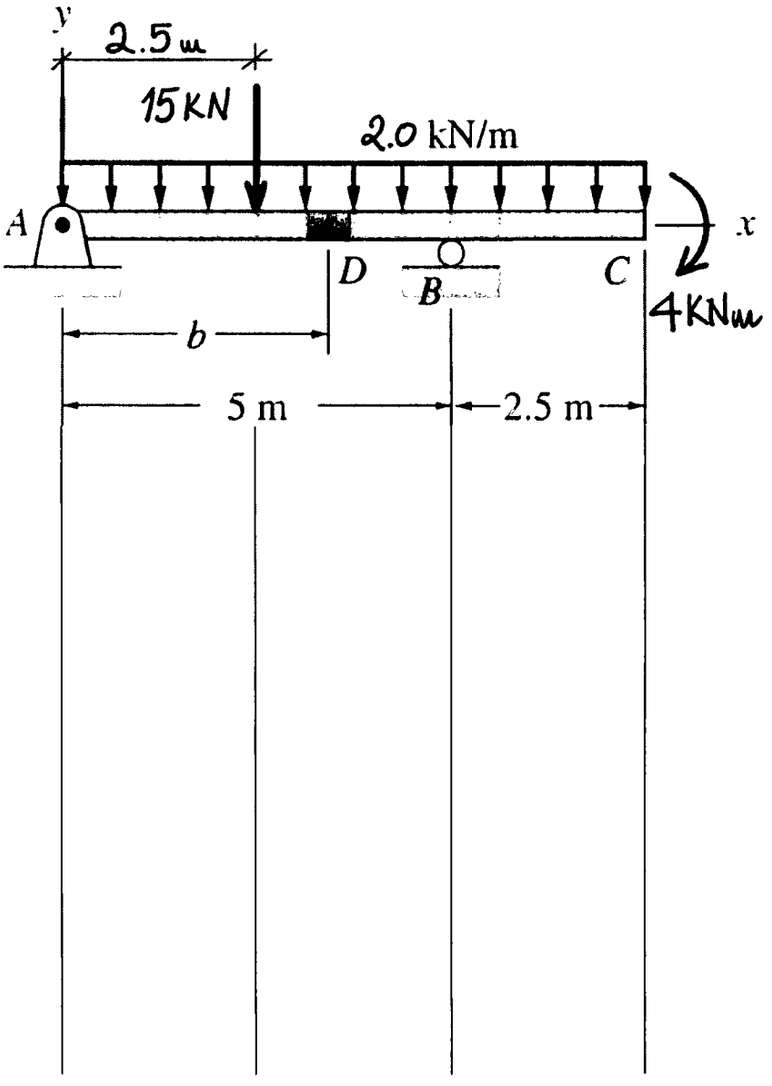
CASIO FX991 **SHARP EL520**

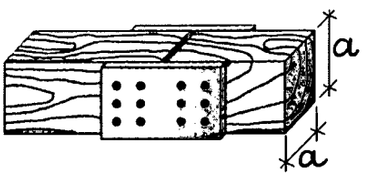
NOTES:
1. **Ensure that you have all 7 sheets of the examination paper. Page 7 is blank.**
2. **Answer <u>all</u> five questions. The value of the questions is indicated below.**
3. **If you need more space for a question, please use the back of the preceding question. In all cases, please <u>indicate clearly</u> where your calculations are continued.**
4. **The only calculators permissible are listed above. Please circle your model.**
5. **This is a closed-book examination. No other paper will be allowed on the desk.**
6. **Do <u>not</u> remove the staple.**

DO NOT WRITE IN THIS SPACE.

1	/12
2	/12
3	/12
4	/12
5	/12
TOTAL	**/60**

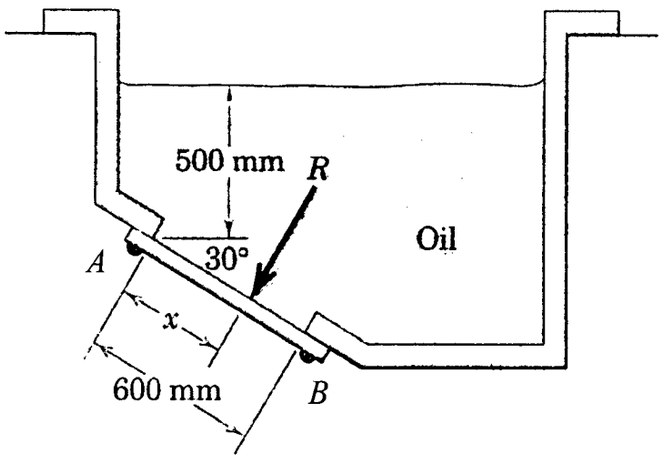
1. The 7.5 m-long timber floor beam, having a 180x180 mm square cross-section (a = 180 mm), is loaded as shown. Because only 5 m-long timbers are available, the beam was fabricated from two pieces connected together by a nailed joint, *D*. You are required to:
(a) In the space provided, draw the shear force and bending moment diagrams for the beam, indicating the values at points *A*, *B*, and *C*, and any potential local maxima and minima;
(b) If the distance b = 4.2 m, determine whether the location selected for joint D is advantageous, knowing that nailed joints are strong in shear but weak in bending.
(c) If wood has a strength of 20 MPa in both tension and compression, determine whether the beam as designed can carry the loads safely? What is the implied load factor?



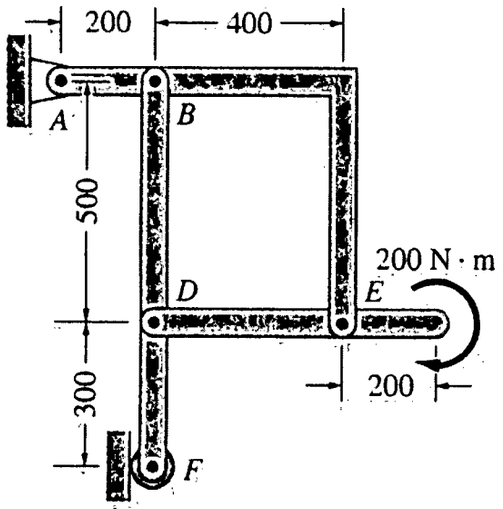


Detail of joint at *D*

2. A vertical section of an oil sump is shown. The access plate at the bottom covers a rectangular opening which has dimensions of 600x400 mm. Calculate the total force R exerted by the oil on the plate and the location x of R. If the plate is attached to the sump wall with two bolts at A and two bolts at B, calculate the force in each of the bolts. The distance from the centre of the bolts to the edge of the wall opening is 75 mm (i.e. $AB = 750$ mm). The oil has a density of 900 kg/m^3.

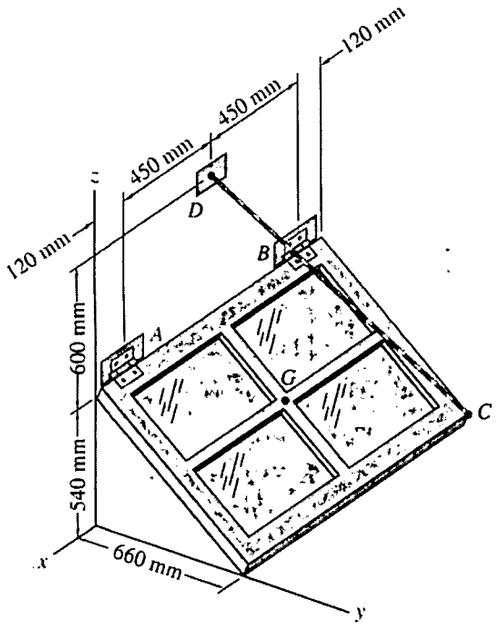


3. Neglecting the weight of the members, determine the magnitude of the pin reaction force components at *B*, *D* and *E* when the frame illustrated is loaded by the couple shown. Show your final answers on a summary sketch of the members of the frame.



Dimensions in mm

4. The window below has a mass of 20 kg, which acts at the geometric centre of the window, at *G*. The window is attached at A and B by two hinges which can be idealized as ball-and-socket supports. Find all forces acting on the window when it is held open in the position shown by the rope attached to it at *C*. The hinge at *B* has been modified to allow translation along its own axis of rotation (i.e. in the *x* direction).



NAME: _____

5. Determine the force in members *BC*, *CJ*, *IJ*, *FH* and *HI*, and state if the members are in tension or compression. From a different loading condition than that shown, the *tension* force in member *DF* has a magnitude of 31.4 kN, and this member is fabricated using a circular solid section made of steel with a yield stress of 200 MPa and a modulus of elasticity of 200,000 MPa. Knowing that the load factor for members in axial tension is 2.0, determine the minimum diameter of the circular cross-section, *d*, such that member *DF* is safe. The diameter of the section can be selected in 0.20 mm increments. Also, what is the elongation of member *DF*, as designed?