UNIVERSITY OF CALGARY
Schulich School of Engineering
ENGG 202 – ENGINEERING STATICS

FINAL EXAM

April 25, 2012   Time: 12:00 – 15:00 (3 hours)

1. Exam is closed book and worth 50% of final mark.
2. Only the SSE sanctioned, non-programmable, scientific calculator is permitted.
3. There are nine (9) short answer questions and four (4) comprehensive questions.
4. Answer all questions directly on the question sheets. For the short answer questions, write your answer in the space provided.
5. **Separate Free Body Diagrams are required on comprehensive questions to obtain full marks.**
6. For multi-part comprehensive questions, **students unable to solve one part should make a reasonable assumption for the values required and continue to solve** subsequent parts of the question.
7. If students require the use of extra paper, they may obtain paper from the instructor in the examination room and may not use their own. ALL work is to be handed in, including rough work completed on extra paper.
8. No electronic devices other than a calculator are permitted.

Student's Last Name: _____

Student's First Name: _____

Lecture Section: (Circle one)	Raaflaub (L01) TuTh 15:30	Anglin (L02) TuTh 12:30	Lissel (L03) TuTh 11:00	Grozic (L04) TuTh 09:30

EXAMINATION RULES

(1) Students late in arriving will not normally be admitted after 30 minutes of the examination time has passed.
(2) No candidate will be permitted to leave the examination until one-half hour has elapsed after the opening of the examination, nor during the last 15 minutes of the examination. All candidates remaining during the last 15 minutes of the examinations period must remain at their desks until their papers have been collected by an invigilator.
(3) All enquires and requests must be addressed to supervisors only.
(4) **The following is strictly prohibited:**
   (a) Speaking to other candidates or communicating with them under any circumstances whatsoever;
   (b) Bringing into the examination room any textbook, notebook or document not authorized by the examiner;
   (c) Making use of calculators, cameras, cell-phones, computers, head-sets, pagers, PDA's, or any device not authorized by the examiner;
   (d) Leaving answer papers exposed to view;
   (e) Attempting to read other student's examination papers..
   The penalty for violation of these rules is suspension or expulsion or such other penalty as may be determined.
(5) Candidates are requested to write on both sides of the page, unless the examiner has asked that the left hand page be reserved for rough drafts and calculations.
(6) Discarded matter is to be struck out and not removed by mutilation of the examination answer book.
(7) Candidates are cautioned against writing in their answer book any matter extraneous to the actual answering of the question set.
(8) During the examination a candidate must report to a supervisor before leaving the examination room.
(9) Candidates must stop writing when the signal is given. Answer books must be handed to the supervisor-in-charge promptly. Failure to comply with these regulations will be cause for rejection of an answer paper.
(10) If during the course of an examination a student becomes ill or receives word of domestic affliction, the student must report at once to the supervisor, hand in the unfinished paper and request that it be cancelled.

Once an examination has been handed in for marking a student cannot request that the examination be cancelled for whatever reason. Such a request will be denied. Retroactive withdrawals will also not be considered.

Student Last Name: _____ ID#: _____

USEFUL FORMULAE:

Sine Law: $\dfrac{\sin A}{a} = \dfrac{\sin B}{b} = \dfrac{\sin C}{c}$

Cosine Law: $c^2 = a^2 + b^2 - 2ab\cos C$

Quadratic Formula: $\dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Question	Max. mark	Mark
1 to 9	25	
10	10	
11	11	
12	15	
13	16	
Total	77	

Figures modified from:

Q3, Q5, Q7, Q8, Q10: "Engineering Mechanics, Statics", 5th Edition in SI Edition, Bedford and Fowler, Prentice Hall, 2008.

Q4, Q12, Q13: "Vector Mechanics for Engineers, Statics", 7th Edition, Beer, Johnston and Eisenberg, McGraw Hill, 2004.

Q9: "Engineering Mechanics, Statics", SI Edition 3rd Edition, Pytel and Kiusalaas, Cengage Learning, 2010.

Q1. A force with magnitude 600 N has coordinate direction angles $\theta_x = 60^\circ$ and $\theta_z = 40^\circ$.
a) What is the coordinate direction angle θ_y? b) What is the force in Cartesian vector format?

ANSWER: a) $\theta_y = $ _____ degrees   **/1 mark**

              b) **F** = _____ N   **/1 mark**

Q2: In 3D space, if a support restricts rotation about both the x and z axes, and prevents movement along the x and y axes, and allows all other movements/rotations what are the support reactions at this support?

ANSWER: reactions: _____   **/2 marks**

Q3: Hinges at A and B and the cable CE support a plate. The properly aligned hinges do not exert couples on the plate, and the hinge at A does not exert a force on the plate in the direction of the hinge axis. a) Determine the unit vector for the line CE. b) Neglecting the weight of the plate, determine the tension in the cable.
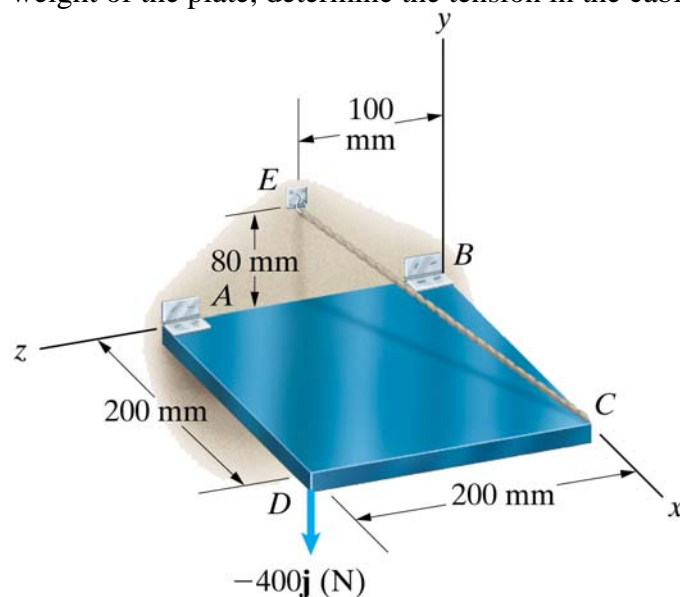
ANSWER: a) $\mathbf{u_{CE}} = $ _____   **/1.5 marks**

   b) $T = $ _____   **/1.5 marks**

Q4. For the loading shown, determine the force in member AG of the truss below and state whether it is in tension or compression.
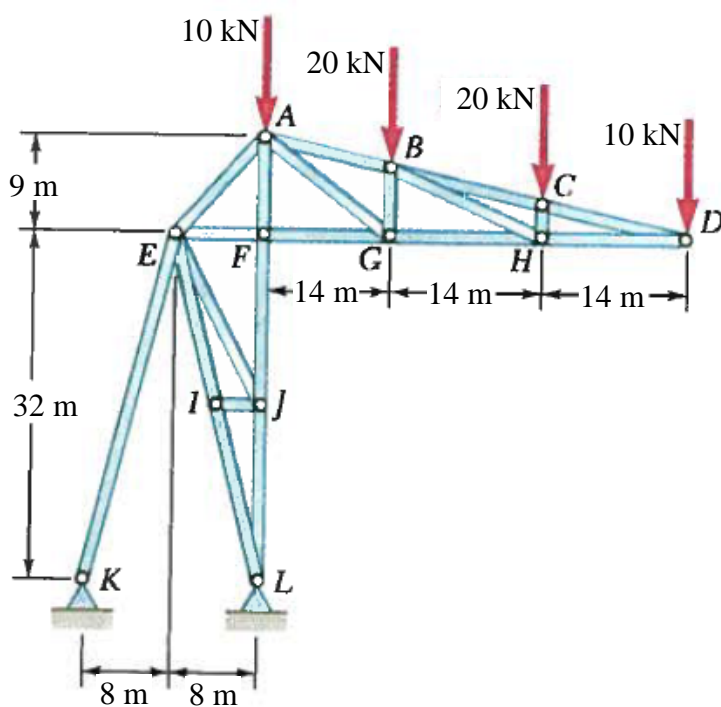
ANSWER: AG = _____ kN   **/2 marks**

Q5: The bar shown below is subject to the loading shown and supported by a roller at A and a pin at B. Determine the internal axial/normal force, shear force, and moment at point C (located 2 m to the left of point A). Use the commonly accepted sign convention for internal forces/moments in your answers.
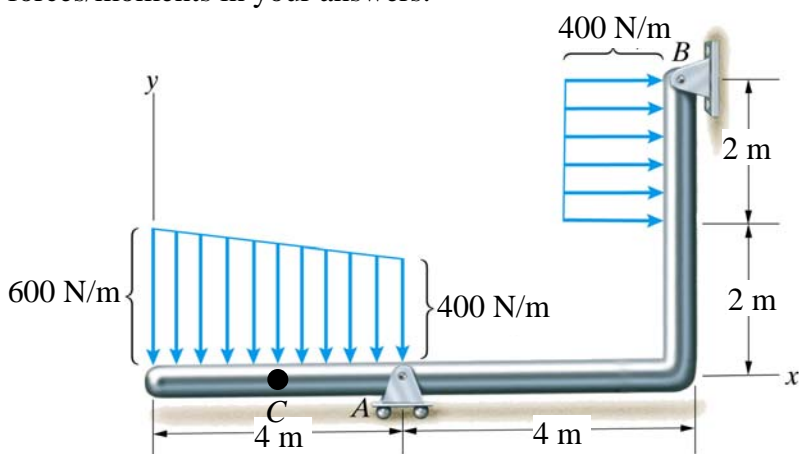
ANSWER: Axial/Normal force = _____ N   **/1 mark**

Shear force = _____ N   **/1 mark**

Moment = _____ N·m   **/1 mark**

Q6. A child is pushing a toy block with a square hole along a table. (a) What is the x-coordinate of the centroid of the block, measured from the bottom left corner of the block? (b) What is the y-coordinate of the centroid measured from the bottom left corner? (c) Will the block tip over if its right edge (point B) is extended 5.2 cm beyond the right edge of the table (point C)?
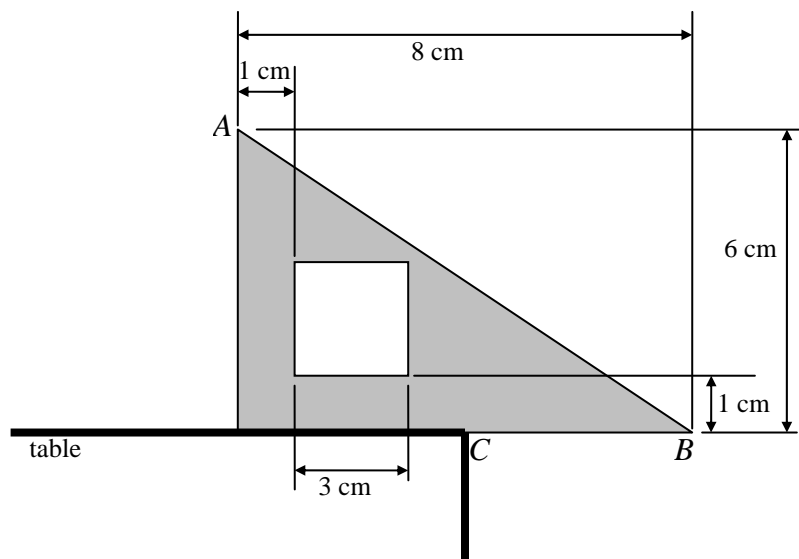

ANSWER: (a) $\overline{x}$ = _____ cm   **/1 mark**

(b) $\overline{y}$ = _____ cm   **/1 mark**

(c) tip? _____   **/1 mark**

Q7. The mass of block A is 20 kg, and the mass of block B is 50 kg. The walls are smooth (i.e. frictionless) and the coefficient of static friction between blocks A and B is 0.20. a) If the minimum force, F, required to maintain equilibrium is applied, what is the magnitude of the friction force between blocks A and B? b) What is this minimum force, F?
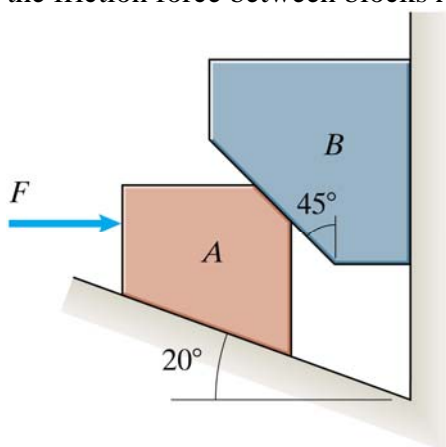
ANSWER: a) f_{fric}= _____   **/1 mark**

b) F_{min} = _____   **/2 marks**

Q8. The four-bar linkage operates the forks of a forklift truck. If W = 100 kN, draw the FBD(s) that would be required to determine the reactions on member CDE (label and show direction of all forces on the FBD(s)). Do NOT perform any calculations.

/3 marks
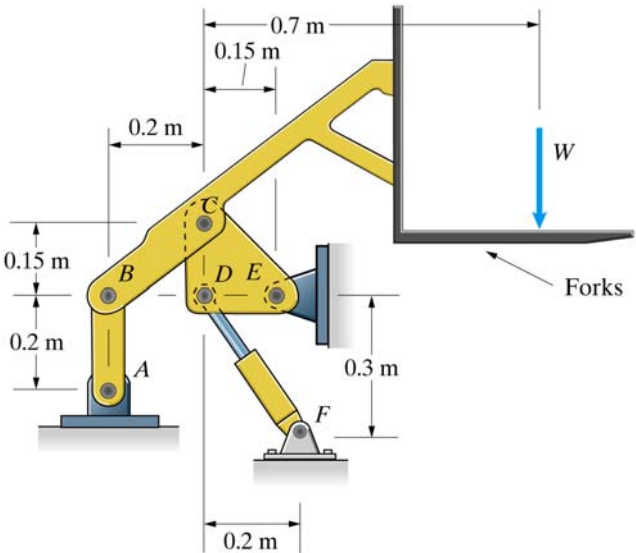
Draw in the space below

Q9: Draw the load diagram and the bending moment diagrams that correspond to the given shear force diagram. Assume no couples are applied to the beam. Indicate the load magnitudes and directions on the load diagram. Indicate the values at A, B, C, D, and E on the bending moment diagram.
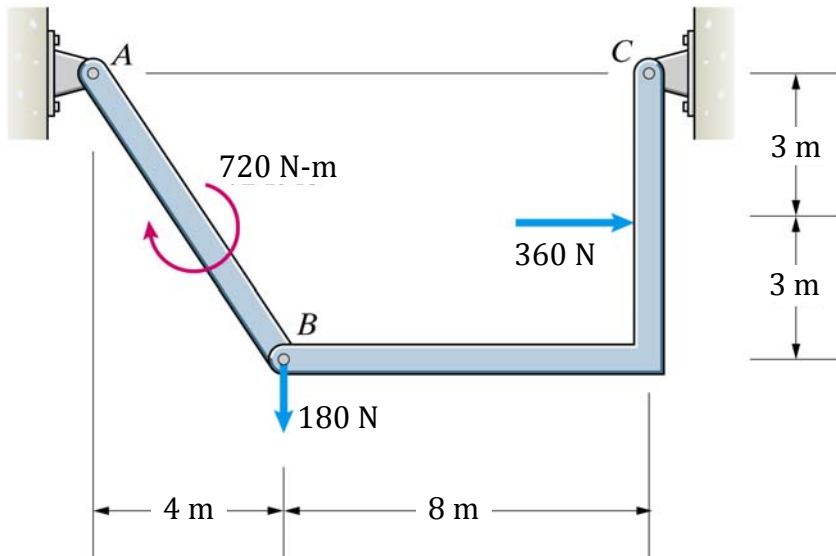
ANSWER: Draw in the space below.

Load
Diagram

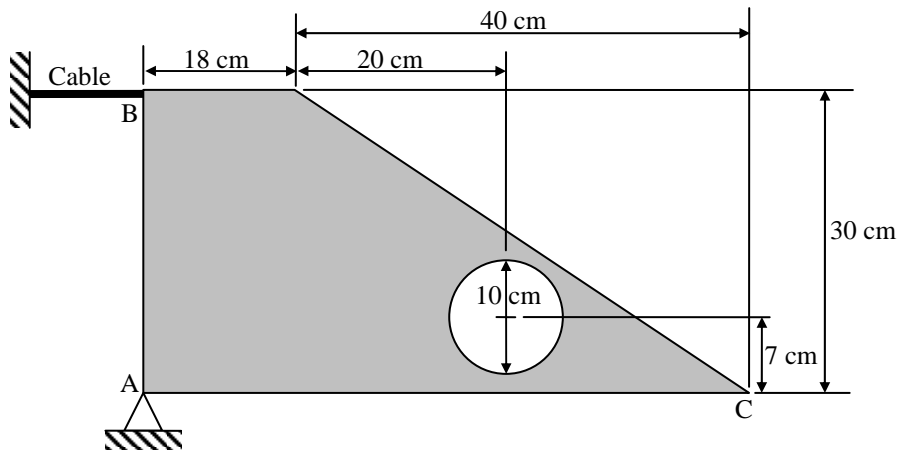**/2 marks**

SFD

BMD

/2 marks

6
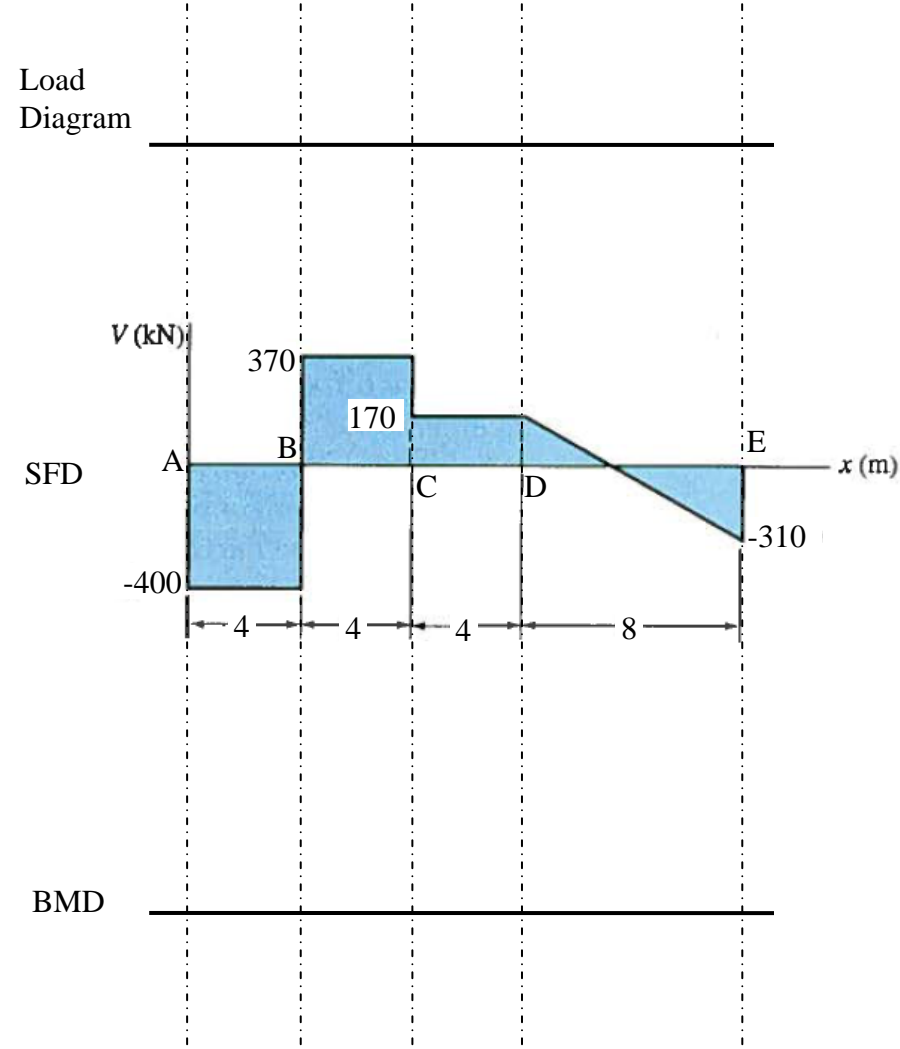
Q10. The members of the frame shown, *AB* and *BC*, are joined by a pin at *B* and are supported by pins at *A* and *C*. Determine the reactions at *A* and *C*. Express your answers in Cartesian vector format.

/10 marks

Q11. The plate shown below has a circular hole (diameter 10 cm) and is held in equilibrium by the pin support at A and a horizontal cable at B. The plate is 2 cm thick and is constructed of material which has density $= 7.85$ g/cm^3.

(a) Determine the coordinates of the centroid of the plate measured from point A.   **/5 marks**

(b) Determine the magnitude and direction of the reactions at the supports A and B.   **/6 marks**

Q12. Member ACDBE supports the loading shown below. Neglecting the weight of the member:

(a) Determine the magnitude and direction of the reactions at points *A* and *D*.   **/3.5 marks**

(b) Determine the internal axial force, shear force, and bending moment at point
H by sectioning the member at point *H* and drawing the Free Body Diagram of
segment *EH*.   **/3.5 marks**

(c) Draw the shear force and bending moment diagrams for the horizontal part of
the member (*ACDB*). Calculate and indicate the values for shear force and bending
moment at points *A, C, D* and B and any maximums or minimums that may occur
in between these points.   **/8 marks**
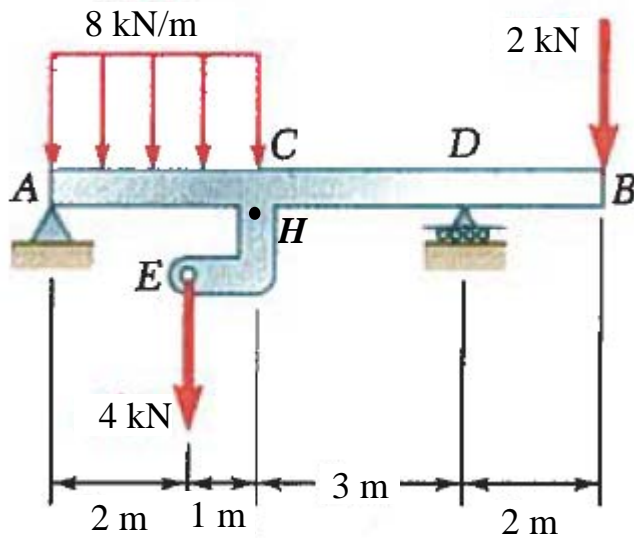
Q13: The 100 mm radius cam shown is used to control the motion of the plate CD. Neglect the friction between the rollers and the plate. The coefficients of static and kinetic friction between the cam and the plate at point B are μ_s=0.45 and μ_k=0.4, respectively.

(a)   Determine the minimum force **P** required to start the motion of the plate, if the plate is 20 mm thick.   **/5.5 marks**

(b)   Knowing that the magnitude of the reaction at A cannot exceed 400 N, determine
    (i) the force **P** and   **/6.5 marks**
    (ii) the corresponding thickness of the plate, t,   **/4 marks**
    for which motion of the plate is maintained.