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UNIVERSITY OF TORONTO

Faculty of Applied Science and Engineering

CIV100F and APS160F – MECHANICS

Final Examination – Sections 1, 2, 3, 4, 5, 6, 7, 8 and Online

Wednesday, 12th December 2018

Examiner: Staff in Civil Engineering

Time allowed: 2-½ hours

SURNAME: _____ GIVEN NAME(S): _____

(Please print clearly)

STUDENT NUMBER: _____ DEPT. (ECE, Track One, etc.)_____

CIRCLE YOUR SECTION AND THE NAME OF YOUR INSTRUCTOR:

1. El-Diraby, Tamer	5. Bruun, Edvard	Online. Seica, Michael
2. Packer, Jeffrey	6. Saxe, Shoshanna	
3. Seica, Michael	7. Mercan, Oya	
4. Packer, Jeffrey	8. Panesar, Daman	

CIRCLE YOUR CALCULATOR TYPE:

CASIO 991   SHARP 520

Notes: 1. Ensure that you have all 14 pages of the examination paper. Page 14 is blank.

2. Answer all five questions. The value of the questions is indicated below.

3. If you need more space for a question, continue on the page indicated at the bottom.

4. The only calculators permitted 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 **not** remove the staple.

DO NOT WRITE IN THIS SPACE.
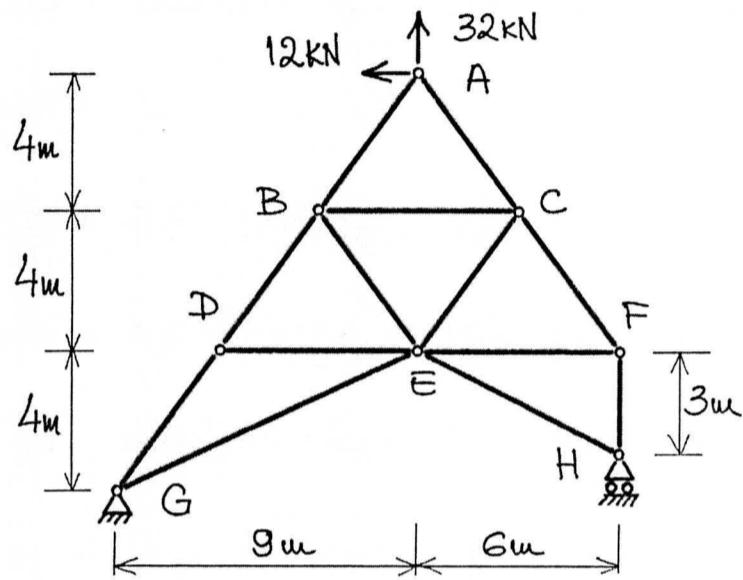
1	/12
2	/12
3	/12
4	/12
5	/12
TOTAL	/60

NAME: _____

1. For the truss shown, determine the force in each of the members *AB*, *BD*, *CF* and *EH*. Indicate if the members are in tension or compression. Members *AB*, *AC* and *CF* must have the same rectangular cross-section and are made of Grade 6061-T4 aluminium with a yield stress of 110 MPa. They are cut from 6 mm thick aluminium plate using a saw which can be adjusted to cut the plate in width multiples of 6 mm. Determine the width, *b*, of the single cross-section for these members assuming a load factor for axial tension of 1.8. What will be the elongation of member AC, if the modulus of elasticity for aluminium is 69,000 MPa?

NAME: _____

Question 1 can be continued on this page.
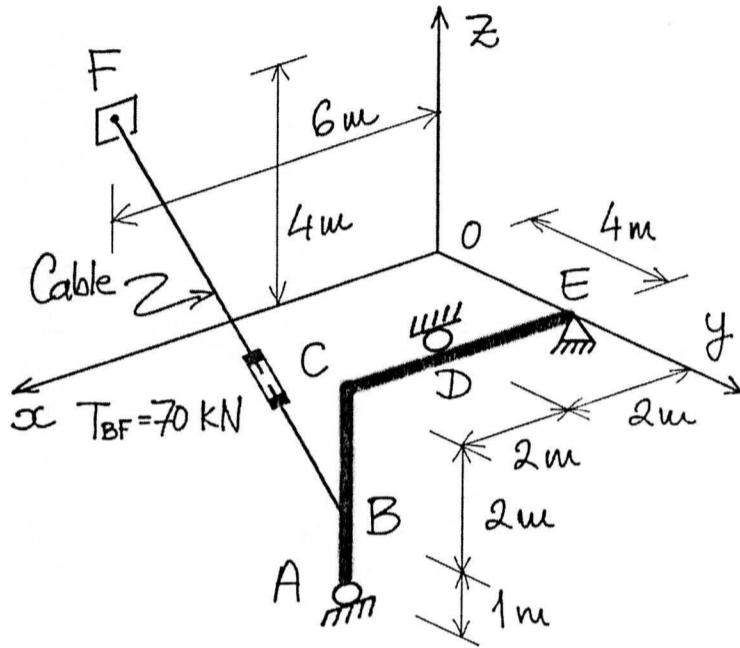
NAME: _____   Page 4 of 14

2. The light (i.e. its weight can be neglected) bent bar *ABCDE* is supported by a ball-and-socket joint at *E*. The ball support at *D* provides a translational restraint only in the *y* direction, while the guided roller support at *A* allows translation only in the *x* direction. The bar lies in a plane parallel to the *x-z* plane (*ABC* is parallel to the *z* axis and *CDE* is parallel to the *x* axis) and the support at *F* is in the *x-z* plane. Using a turnbuckle, the cable *BF* is tightened until the tension in it has a magnitude of 70 kN. Determine the reaction force components at *A*, *D* and *E*, and express the reaction forces in Cartesian vector format.

NAME: _____

Question 2 can be continued on this page.
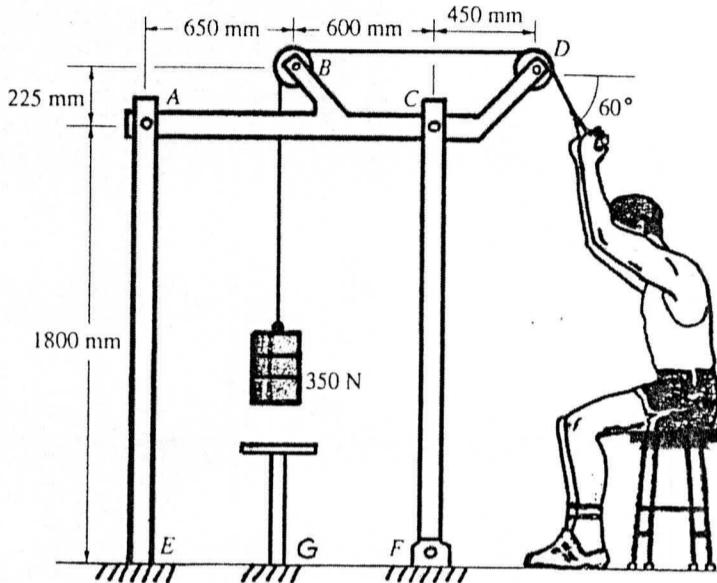
NAME: _____

3. The man using the exercise machine is holding the 350 N weight stationary in position, as shown. Determine all of the reaction components at the supports of the machine. The supports at E and G are fixed, and the frame is pinned at F. Note that A and C are pin connections and the two pulleys at B and D are frictionless.

NAME: _____

Question 3 can be continued on this page.
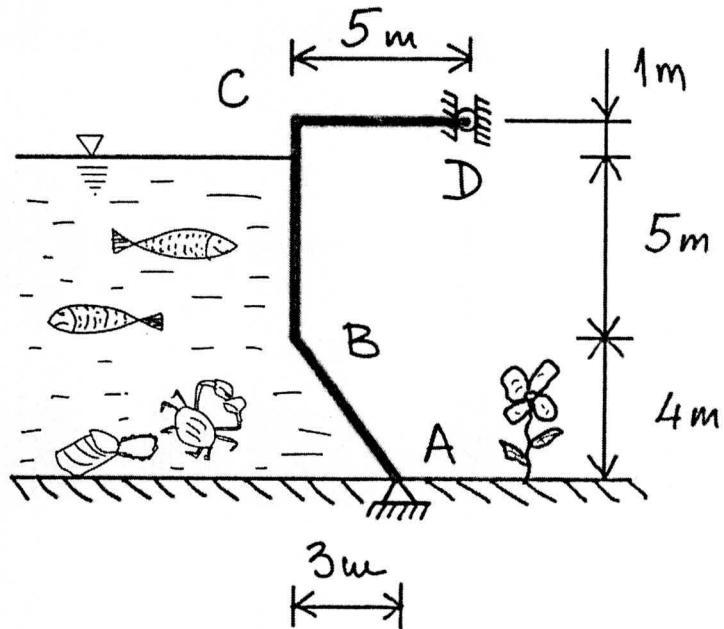
NAME: _____

4. The 6-metre long light (i.e. its weight can be neglected) gate *ABCD* retains sea water having a mass density of 1,050 kg/m^3. Determine the components of the reaction forces on the gate at the hinge at *A* and the vertical roller support at *D*. Neglect any potential effects of the marine fauna and objects.
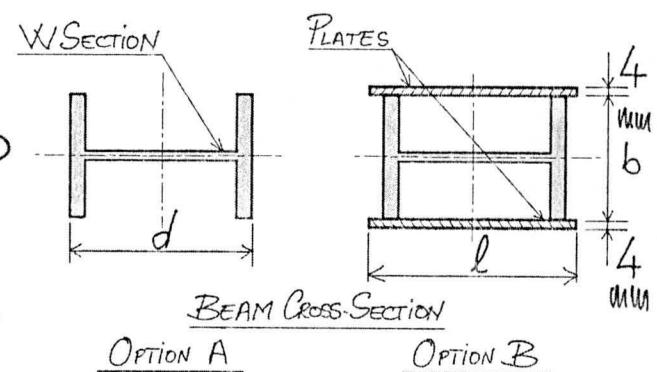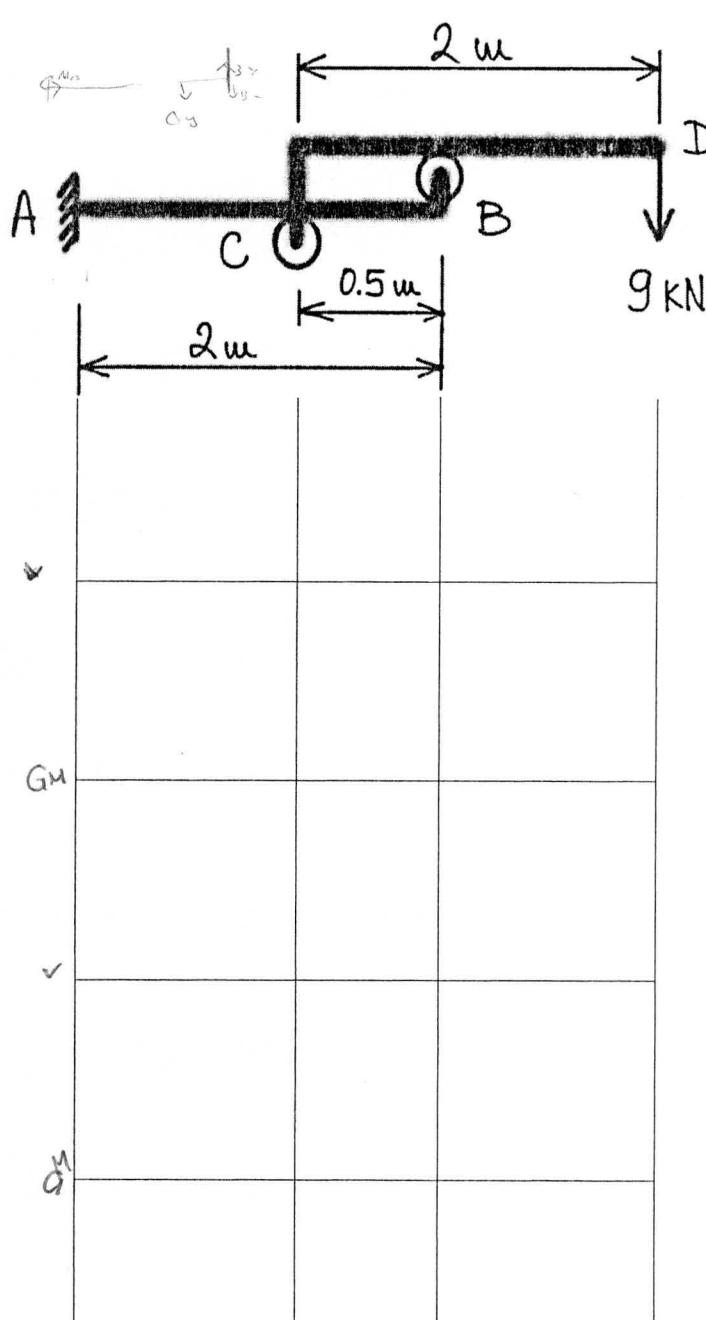
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5. The device shown is used in a factory to support a load at *D*. In the space provided draw shear force and bending moment diagrams for the beams *AB* and *CD*, indicating the values of the internal forces at relevant points. Neglect the size of the rollers at *B* and *C*.

The device must be made from the same wide-flange steel section which, due to space limitations, must be oriented as shown and must not have a depth, *d*, that exceeds 200 mm. Determine the same efficient wide-flange section for the two beams using *Option A*. Reinforce the wide-flange section, where necessary, using *Option B*. In the latter case, determine the minimum length, *l*, of the additional steel plates welded to the W-section. The yield stress for this steel is 300 MPa and the load factor for bending is 2.0. Section properties for wide-flange sections are provided on page 12.

ELEVATION OF BEAM SYSTEM

NAME: _____

Question 5 can be continued on this page.
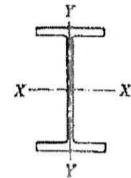
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Wide-Flange Beams (SI Units)

Desig-nation*	Area (mm²)	Depth (mm)	FLANGE Width (mm)	FLANGE Thick-ness (mm)	Web Thick-ness (mm)	AXIS X–X I (10⁶ mm⁴)	AXIS X–X S (10³ mm³)	AXIS X–X r (mm)	AXIS Y–Y I (10⁶ mm⁴)	AXIS Y–Y S (10³ mm³)	AXIS Y–Y r (mm)
W914 × 342	43610	912	418	32.0	19.3	6245	13715	378	391	1870	94.7
× 238	30325	915	305	25.9	16.5	4060	8880	366	123	805	63.5
W838 × 299	38130	855	400	29.2	18.2	4785	11210	356	312	1560	90.4
× 226	28850	851	294	26.8	16.1	3395	7980	343	114	775	62.7
× 193	24710	840	292	21.7	14.7	2795	6655	335	90.7	620	60.7
W762 × 196	25100	770	268	25.4	15.6	2400	6225	310	81.6	610	57.2
× 161	20450	758	266	19.3	13.8	1860	4900	302	60.8	457	54.6
W686 × 217	27675	695	355	24.8	15.4	2345	6735	290	184	1040	81.5
× 140	17870	684	254	18.9	12.4	1360	3980	277	51.6	406	53.8
W610 × 155	19740	611	324	19.1	12.7	1290	4230	257	108	667	73.9
× 125	15935	612	229	19.6	11.9	985	3210	249	39.3	342	49.5
× 92	11750	603	179	15.0	10.9	645	2145	234	14.4	161	35.1
W533 × 150	19225	543	312	20.3	12.7	1005	3720	229	103	660	73.4
× 124	15675	544	212	21.2	13.1	762	2800	220	33.9	320	46.5
× 92	11805	533	209	15.6	10.2	554	2080	217	23.9	228	45.0
W457 × 144	18365	472	283	22.1	13.6	728	3080	199	83.7	592	67.3
× 113	14385	463	280	17.3	10.8	554	2395	196	63.3	452	66.3
× 89	11355	463	192	17.7	10.5	410	1770	190	20.9	218	42.9
W406 × 149	18970	431	265	25.0	14.9	620	2870	180	77.4	585	64.0
× 100	12710	415	260	16.9	10.0	397	1915	177	49.5	380	62.5
× 60	7615	407	178	12.8	7.7	216	1060	168	12.0	135	39.9
× 39	4950	399	140	8.8	6.4	125	629	159	3.99	57.2	28.4
W356 × 179	22775	368	373	23.9	15.0	574	3115	158	206	1105	95.0
× 122	15550	363	257	21.7	13.0	367	2015	154	61.6	480	63.0
× 64	8130	347	203	13.5	7.7	178	1025	148	18.8	185	48.0
× 45	5710	352	171	9.8	6.9	121	688	146	8.16	95.4	37.8
W305 × 143	18195	323	309	22.9	14.0	347	2145	138	112	728	78.5
× 97	12325	308	305	15.4	9.9	222	1440	134	72.4	477	76.7
× 74	9485	310	205	16.3	9.4	164	1060	132	23.4	228	49.8
× 45	5670	313	166	11.2	6.6	99.1	633	132	8.45	102	38.6
W254 × 89	11355	260	256	17.3	10.7	142	1095	112	48.3	377	65.3
× 67	8580	257	204	15.7	8.9	103	805	110	22.2	218	51.1
× 45	5705	266	148	13.0	7.6	70.8	531	111	6.95	94.2	34.8
× 33	4185	258	146	9.1	6.1	49.1	380	108	4.75	65.1	33.8
W203 × 60	7550	210	205	14.2	9.1	60.8	582	89.7	20.4	200	51.8
× 46	5890	203	203	11.0	7.2	45.8	451	88.1	15.4	152	51.3
× 36	4570	201	165	10.2	6.2	34.5	342	86.7	7.61	92.3	40.9
× 22	2865	206	102	8.0	6.2	20.0	193	83.6	1.42	27.9	22.3
W152 × 37	4735	162	154	11.6	8.1	22.2	274	68.6	7.12	91.9	38.6
× 24	3060	160	102	10.3	6.6	13.4	167	66.0	1.84	36.1	24.6
W127 × 24	3020	127	127	9.1	6.1	8.87	139	54.1	3.13	49.2	32.3
W102 × 19	2470	106	103	8.8	7.1	4.70	89.5	43.7	1.61	31.1	25.4

*W means wide-flange beam. followed by the nominal depth in mm, then the mass in kg per meter of length

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