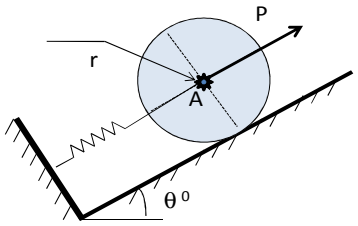
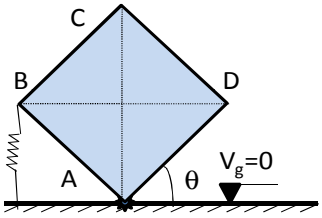
CAIRO UNIVERSITY	Engineering Mechanics II. (MEC 1121)
Faculty of Engineering	Work and Energy Sheet
Eng. Math. and Physics Department	2019-2020
First Year students	
g = 10 m/sec ^{2}	

Prob. (1) : In the shown figure, a constant force P is applied at the rough hinge A of a disc (m kg, r =1.5 m) to roll it upward rough plane inclined to the horizontal with an angle θ . The frictional moment at A is 300 N.m/rad and the disc is attached to spring whose stiffness is k and initially compressed by 20 cm. If the disc moves 50 cm , select the correct answers**:**



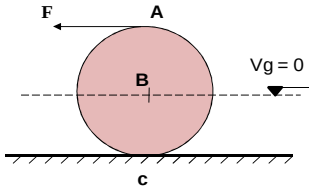
Data		m kg	P kN	k kN/m	θ
		30	1.5	1.2	20
No	Required	A	B	C	D
1	W_{1-2} of the force **P**	750	800	420	900
2	W_{1-2} of gravity force	-17.75	-51.30	-42.75	-29.70
3	The angle rotated by the disc during upward motion (rad)	0.33	0.23	0.25	0.50
4	X_2 in the spring at pos.(2)	0.35	0.25	0.30	0.15
5	W_{1-2} of the spring force	-30.00	-31.50	-150.00	0.00
6	W_{1-2} of the frictional moment	-62.50	-100.00	-75.00	-93.33
7	W_{1-2} of all ext. forces	265.47	819.75	532.25	568.70
8	T_1	12	10.56	50.23	0.00
9	T_2	532.25	265.47	819.75	568.70
10	ω of the disc at pos.(2).	5.43	5.03	5.33	8.84

Problem No.(2): A square plate mass= m kg and side length L m is hinged at A and connected to spring with stiffness k and original length L_o m. The plate is released from rest from the shown position (pos.1). Assuming pos.2 at θ=0, select the correct answers:



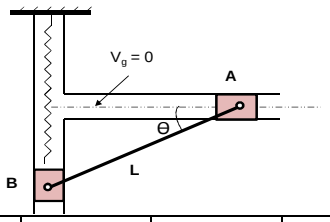
Data		m kg	L m	k kN/m	L_o m
		250	2	2	1.8
No	Required	A	B	C	D
11	T_1	233.5	0	-200	517.5
12	X_1 in the spring	-0.139	-0.232	-0.479	-0.386
13	V_1 (potential energy)	3353.83	1923.75	3684.37	4467.96
14	E_1 (mechanical energy)	3684.370	3353.834	1923.753	4467.963
15	T_2	328.163	269.313	762.531	238.346
16	V_2	3115.489	4139.800	1654.440	2921.839
17	E_2	4467.963	3353.834	3684.370	1923.753
18	W_{1-2}	238.346	328.163	269.313	762.531
19	V_D at pos.(2)	2.119	1.984	3.025	2.183

Problem No.(3): The shown uniform disc (mass=m , radius r) is pulled to roll on a horizontal rough surface with a force F. If the disc is initially at rest (pos.1) and its center covers a distance X (pos. 2), select the correct answers:



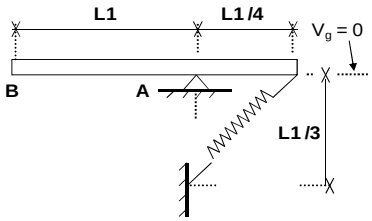
Data		m kg	r m	F N	X m
		400	1.5	200	2.4
No	Required	A	B	C	D
20	T_1	5.00	0.00	122.50	1000.00
21	V_1	-23.67	0.00	1000.00	122.50
22	θ_{1-2} the angle rotated by the disc rad	2.40	1.80	1.50	1.60
23	W_{1-2}	2880.00	648.00	810.00	960.00
24	E_2	960.00	810.00	648.00	2880.00
25	ω_2	1.37	1.17	1.19	1.55

Problem No.(4): In the shown mechanism, the rod AB (m , L) is connected with two similar blocks A, B (mass = m/5). The block B is connected to a spring (stiff. k) unstretched at θ=0 (pos2). The system released from rest at angle θ (pos.1), select the correct answers:



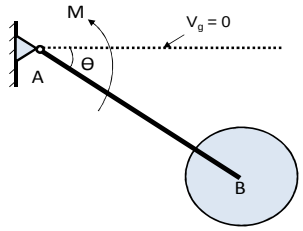
Data		m kg	L m	k kN/m	θ
		60	3	1.2	45
No	Required	A	B	C	D
26	T_1	0.00	-200.00	175.32	1050.00
27	V_1	1809.04	303.92	1069.29	401.75
28	E_1	1069.29	1809.04	303.92	401.75
29	W_{1-2} of nonconservative forces	175.32	-1050.00	0.00	-200.00
30	V_2	303.92	0.00	1809.04	401.75
31	ω_2 angular velocity of the rod at pos. 2	0.68	1.05	0.79	3.54

Problem No.(5): The shown uniform rod AB (m, L) is connected to spring (stiff. k, L_0). The rod is released from rest from the shown position (pos.1), and at the vertical position (pos.2), Select the correct answers:



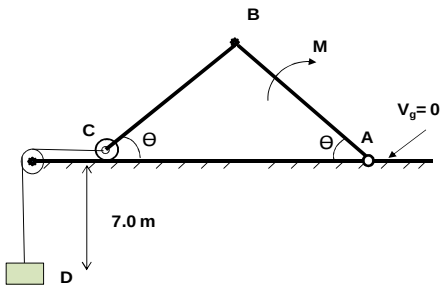
Data		m kg	L m	k kN/m	Lo m
		80	2.5	10	0.3
No	Required	A	B	C	D
32	T_1	1422	0	25.6	800
33	V_1	1422	1530	781	540
34	E_1	540	1422	1530	781
35	W_{1-2} of non-conservative forces	1060	-313	0	1100
36	T_2	280	180	255	733
37	V_2	285	1250	601	689
38	ω_2	1.73	5.11	4.11	2.40
39	α of the ro in Pos. 2 rad/sec^2	-1.73	0.00	2.50	3.00
40	Rx at A in Pos. 2 N	0	-450	313	250
41	Ry at A in Pos. 2 N	-823.08	-1288.46	-1548.72	-461.54

Problem No.(6): The rod AB (m , L) is welded to a uniform disc C (m , r = L/3). The system released from rest from horizontal position (pos.1), and the angular velocity of the system at θ (pos.2) becomes ω rad./sec. A frictional moment at hinge A (assuming it is constant) resists the rod motion, select the correct answers:



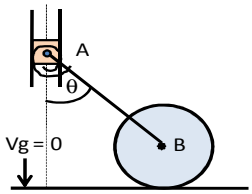
Data		m kg	L m	θ	ω
		60	3	30	1.5
No	Required	A	B	C	D
42	I_A	640.00	320.00	2250.00	750.00
43	T_1	0.00	100.00	-12.50	125.60
44	V_1	800.00	160.00	0.00	-400.00
45	T_2	843.75	230.40	1125.00	1036.80
46	V_2	-3818.38	-1018.23	-1440.00	-1350.00
47	E_2	-403.20	-506.25	-787.83	-2693.38
48	W_{1-2} of non-conservative forces	-2693.38	-403.20	-787.83	-506.25
49	M	1003.10	966.87	770.05	3429.31
50	α of the ro in Pos. 1 rad/sec^2	3.30	1.37	0.88	2.31
51	Rx at A in Pos. 1 N	80.00	0.00	250.00	-125.60
52	Ry at A in Pos. 1 N	603.40	650.52	576.07	1127.04

Problem No.(7): The shown mechanism is composed of two similar uniform rods AB and BC each of mass m kg length L m. To lift the block D of mass m_1 kg, a couple M KN.m is applied when the system at rest $\theta = 20^{o}$ (pos.1). The position at $\theta = 60^{o}$ is called pos. 2 , select the correct answers:



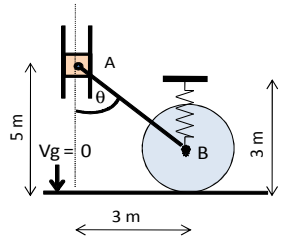
Data		m kg	L m	m1 kg	M kN.m
		20	1.8	120	3000
No	Required	A	B	C	D
53	T_1	88.19	56.79	0.00	70.55
54	V_1	-7935.40	-8276.87	-6550.00	-6325.00
55	E_1	-8276.87	-6236.81	-6479.45	-7878.61
56	$W_{1\text{-}2}$ of non conservative forces	2094.39	3665.19	3665.19	4188.79
57	$H_{1\text{-}2}$ distance moved by the block	3.29	2.58	2.64	1.58
58	Velocity of the block in terms of ω_r in pos (2)	5.07	7.79	3.12	6.24
59	T_2	333.62	770.94	488.62	6.28
60	V_2	-3585.20	-4547.04	-6188.76	-2536.64
61	E_2	-4213.42	-2048.02	-6182.48	-2814.26
62	V_D (velocity of the block in pos.2)	2.83	0.31	2.18	3.61

Problem No. (8): The shown system is composed of a disc B (mass m1 kg , r =1.0 m) , a rod AB (mass m2 kg and length L) and a block A (mass 5 kg).The rod AB is connectd to the block A by torsional spring (stiffness k).The system is released from rest at θ=30 (pos. 1) where the spring is untwisted. At θ=60 (pos.2) the angular velocity of the disc becomes ω . Choose the correct answers.



Data		m 1 kg	m 2 kg	L	ω
		30	60	6	2
No	Required	A	B	C	D
63	E1	1250	2319	2416	2769
64	Ang. Velocity of the rod at pos. 2 rad/sec	1.33	0.96	0.67	1.20
65	T2 K.E. of the system at pos.2	147	280	333	382
66	V2 P.E. of the system at pos. 2	2489	2034	1986	1102
67	Vs P.E. of the spring at pos. 2	127	259	161	489
68	Torsional spring stiffness (k) kN.m/rad	1.173	1.889	3.565	0.929

Problem No. (9): The shown system is composed of a block A (mass= m), a uniform rod AB (mass = 5m) and disc (radius = r, mass =2 m). The center of the disk is connected to spring (stiff. k , Lo). If the system released when B is vertically below A (pos.1), and passes the shown position (pos.2), select the correct answers:



Data		m kg	k N/m	Lo	r
		10	60	2	1.2
No	Required	A	B	C	D
69	T_1	210.50	500.00	-600.00	0.00
70	V_1	4054	2722	2353	7520
71	The velocity of the block in terms of w_D in pos 2	0.95	1.69	0.95	1.17
72	The ang. velocity of the rod in term of w_D in pos 2	0.56	0.32	0.39	0.32
73	T_2	368	381	606	544
74	V_2	3510	1984	6914	2341
75	E_2	2353	4054	2722	7520
76	ω_D in pos.(2)	2.68	1.46	2.82	2.89
77	V_A the velocity of the block in pos.(2)	2.46	2.74	2.67	3.13