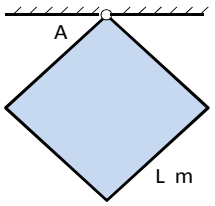
CAIRO UNIVERSITY	Engineering Mechanics II.
Faculty of Engineering	Vibration Sheet
Eng. Math. and Physics Department	2019-2020
First Year students	g = 10 m/sec^2

Problem No. (1): The shown square plate (**m kg, L m**) is hinged at **A** and rest in equilibrium position. The plate is displaced from the equilibrium position with small angle θ^o and released.

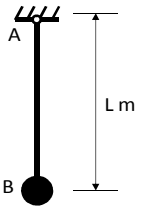
Choose the correct answers:



Data		m kg	L m	θ	
		10	1.5	8	
No	Required	A	B	C	D
1	Type of plate motion	G.P.M	N.C.R.M	T.M	C.R.M
2	Polar Moment of Inertia I_A (kg.m^2)	18.29	15.00	27.31	40.00
3	Natural Circular Freq. ω_n (rad/sec)	2.66	2.30	2.75	2.57
4	Periodical Time τ (sec/cycle)	2.44	2.73	2.36	2.28
5	Angular velocity at $\theta = 0$ (rad/sec)	0.480	0.371	0.402	0.315
6	Vertical Reaction at $\theta = 0$ (N)	153.43	143.20	161.79	101.46
7	Horizontal Reaction at $\theta=0$ (N)	12	0.00	50.23	200.00
8	Approx. Error in θ Calculations %	0.47	0.51	0.33	0.25

Problem No.(2): The shown system is consists of a uniform rod **AB** (**m kg, L m**) and a particle **B** (**m kg**). The system is displaced from the equilibrium position with small angle θ^o, then released.

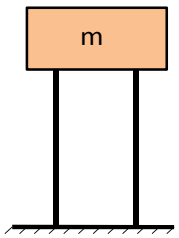
Choose the correct answers.



Data		m kg	L m	θ	
		15	3	5	
No	Required	A	B	C	D
9	Type of motion	G.P.M	T.M	R.T.M	C.R.M
10	The dist. between A and G - AG (m)	2.250	3.000	3.375	2.025
11	Polar Moment of Inertia I_A (kg.m^2)	324.00	170.67	180.00	97.20
12	Natural Circular Freq. ω_n (rad/sec)	2.041	1.936	1.677	1.581
13	Periodical Time τ (sec/cycle)	3.078	3.747	3.974	3.245
14	Angular velocity at $\theta = 0$ (rad/sec)	0.178	0.138	0.169	0.146

Problem No.(3): The shown guard tower with cabinet of mass **m** is supported over **N** steel light cantilever columns. The loading test of a column by a horizontal force **P** applied at its top causes displacement of **X** mm.

Choose the correct answers.

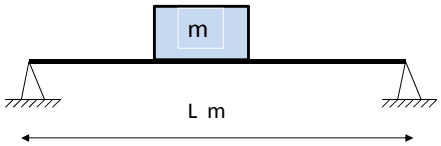


Data		m kg	N	P N	X mm
		900	6	80	2
No	Required	A	B	C	D
15	The horiz. stiff. of each col. k_1 (kN/m)	19.23	40.00	10.00	16.67
16	The horiz. stiff. of the sys. k_e (kN/m)	240.00	70.00	115.38	83.33
17	Natural Circular Freq. ω_n (rad/sec)	17.25	19.61	16.33	14.35

Problem No.(4): A machine of mass **m kg**, is fixed at the center of two simply supported steel beams of rectangular cross section (**bxt cm**) and length of **L** m. The deflection at the beam center is given by:

X = PL^3/48EI , Es=2100 t/cm^2 , I=Area M.I. =AL^2/12

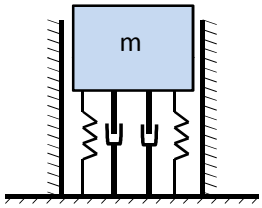
Choose the correct answers :



Data		m kg	L m	b cm	t cm
		2000	4	6	12
No	Required	A	B	C	D
18	The vert. stiff. of each beam k_1 (kN/m)	1034.00	141.75	921.98	1134.00
19	The vert. stiff. of the system k_e (kN/m)	2268.00	1843.97	2068.00	283.50
20	The natural freq. of the system (F) H_z	5.58	5.12	5.36	2.45

Problem No.(5): A machine of mass **m**, is supported by **2** springs each ofstiffness **k1** and **2** dashpots. The dashpot moves by a velocity of **v** due to the application of a force **P**.

Choose the correct answers:

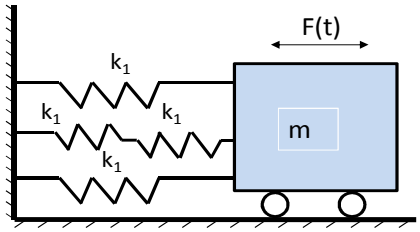


Data		m kg	k1 kN/m	v cm/sec	P N
		1500	160	2	100
No	Required	A	B	C	D
21	Natural Circular Freq. ω_n (rad/sec)	20.00	14.61	11.38	18.26
22	Critical damping (kN.sec/m)	43.82	80.00	54.77	45.54
23	Damping ratio D	0.176	0.228	0.150	0.274
24	Damped frequency ω_d (rad/sec)	17.56	11.21	14.22	19.77
25	Min. No. of dashpots to prevent Vibration	14	12	8	9

Problem No.(6): The shown block **m** is connected by four springs each of stiffness **k** and acted upon by a dynamic force given by:

F(t)= F_o sin (Ω t) N

Choose the correct answers:



Data		m kg	k kN/m	F_o N	Ω
		500	200	400	35
No	Required	A	B	C	D
26	Stiffness of the system ke (kN/m)	375.00	750.00	550.00	500.00
27	Natural Circular Freq. ω_n (rad/sec)	35.36	27.39	31.62	26.22

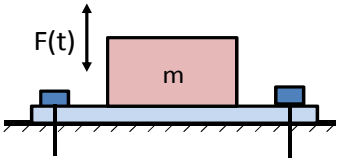
28	Magnification Factor MF	4.44	1.58	3.57	3.24
29	Maximum block response X_{max} (mm)	2.94	3.56	1.26	2.38
30	Add. mass to reduce resp. by 40%	61.22	87.50	N79	129.25
31	Spring stiff. to reduce resp. by 50%	55.00	152.00	216.00	155.00

Problem No.(7): A mechanism **m** is supported on a light squire base **LxL** fixed in elastic ground as shown. The operation of the machine produces a dynamic vertical load given by:

$F(t)=F_o \sin(\Omega t)$ N

The plate loading test using a force P=270 N measures average deflection of 3mm under plate (30x30 cm).

Choose the correct answers:



Data	m kg	L m	F_o N	Ω
	800	2	400	35

No	Required	A	B	C	D
32	Stiffness of the system ke (kN/m)	2592.59	2518.52	740.74	1407.41
33	Natural Circular Freq. ω_n (rad/sec)	44.02	30.43	41.94	40.25
34	Magnification Factor MF	3.10	1.84	2.38	3.44
35	Max. vertical response X_{max} (mm)	1.09	0.84	0.71	1.67
36	Base mass to reduce resp. by 30%	101.59	125.40	83.71	241.27
37	Base area to reduce resp. by 60%	0.74	2.06	2.26	1.47

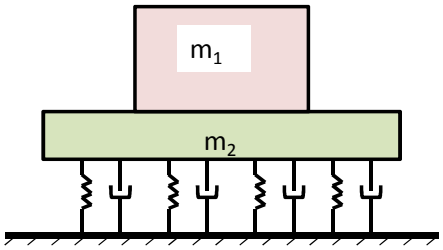
Problem No. (8): An electric generator $\mathbf{m_1}$ is supported on a base $\mathbf{m_2}$. The base is fixed in the ground by **8** springs each of $\mathbf{k_1}$ and **4** dashpots each of damping factor $\mathbf{C_1}$. The operation of the generator produces a vertical dynamic force of:

$F(t)= F_o \sin(\Omega t)$ N

Choose the correct answers in the following two cases:

Case (1): the dashpots are removed and the base mass m_2 is chosen to make MF=0.5.

Case(2): m_2 = 500 kg and the dashpot damping factor C1 is chosen to make MF=0.3.



Data	m_1 kg	k_1 kN/m	F_o N	Ω
	1200	52.083333	300	25

No	Required	A	B	C	D
	Case (A)				
38	Stiffness of the system ke (kN/m)	2040.00	416.67	2613.33	720.00
39	Natural Circular Freq. ω_n (rad/sec)	17.32	40.41	14.43	34.64
40	Base mass (kg)	900.00	800.00	1200.00	850.00
41	Max. vertical response X_{max} (mm)	0.0383	0.2083	0.0980	0.3600
	Case (B)				
42	Natural Circular Freq. ω_n (rad/sec)	38.87	15.66	20.58	46.67
43	Damp. Fact. of dashpot (kN.sec/m)	8.17	7.91	6.45	4.29
44	Damp. Fact. of dashpot to stop free vib.	17.49	26.24	13.31	28.00