2st Semester 1442/1443 (2020/2021)
Date of Exam:15/9/1442(27/04/2021)

Department of Mechanical Engineering
College of Engineering
King Saud University

ME 323 – Mechanical Engineering LAB2

Final Examination

Time allowed: 2:00 Hours
Closed book
Attempt all questions
Instructors: Dr. Ahmed Fouly
Dr. Eyyup Aras

Student Name: .....

Student No.: .....

Section No.:

Final Exam. Mark (20): …….
Term Work Mark (80): …….
Total (100): ……. **Grade:** …….

Course Learning Objectives:

Students completing this course successfully will be able to:

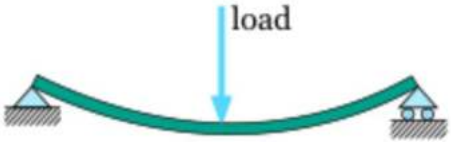
1. Operate and collect data using standard and non-standard experimental apparatus and procedures.
2. Interpret, organize and present the results of acquired data, and discuss the outcome of experiments.
3. Illustrate and identify the theoretical engineering concepts related to the carried-out experiments
4. Employ computational techniques and tools necessary for simulating physical experiments and use it in real time experiments.
5. Develop the ability to work in a team to conduct an experiment, collect experimental data.
6. Present professional reports of the experiments and term paper communicate the same in the class.

Question	Full Mark	Student Mark
1	15 %	
2	15 %	
3	15 %	
4	20 %	
5	20 %	
6	15 %	
Total	**100 %**	

Question-1 (15%):

The simply supported beam, with square cross section with edge length 10 mm, as shown in the Figure is subjected to load P at x=L/2, L is the beam length 600 mm, and the corresponding deflection Δ, mm is recorded as shown in table below,

P; N	3	6	9	12	15	18
Δ; mm	0.2	0.4	0.6	0.8	1.2	1.4



1. Determine the modulus of elasticity E for the material of the beam.
2. If the beam is to be replaced by a new beam made of a material that has modulus of elasticity E = 250 GPa, what would be the optimal edge length in which the deflection will not be changed.

Question-2 (15%):

A rod with dimensions 3×25×600 mm is mounted on a machine so as to the rod is subjected to buckling. The rod is made of steel with Young's modulus 200 GPa. Based on the motion occurred in the machine, the rod some time is pinned-pinned and other time is pinned-fixed. Calculate the critical load using Euler's theory.

When the same rod was tested on a buckling test, the following data were recorded,

	L_1; mm	L_2; mm
pinned-pinned	290	295
pinned to fixed	665	681

Calculate the critical load and compare it with Euler's results.

Hanger weight (G) =15 N

The Load from lever (F_v)= 59N

Question-3 (15%):

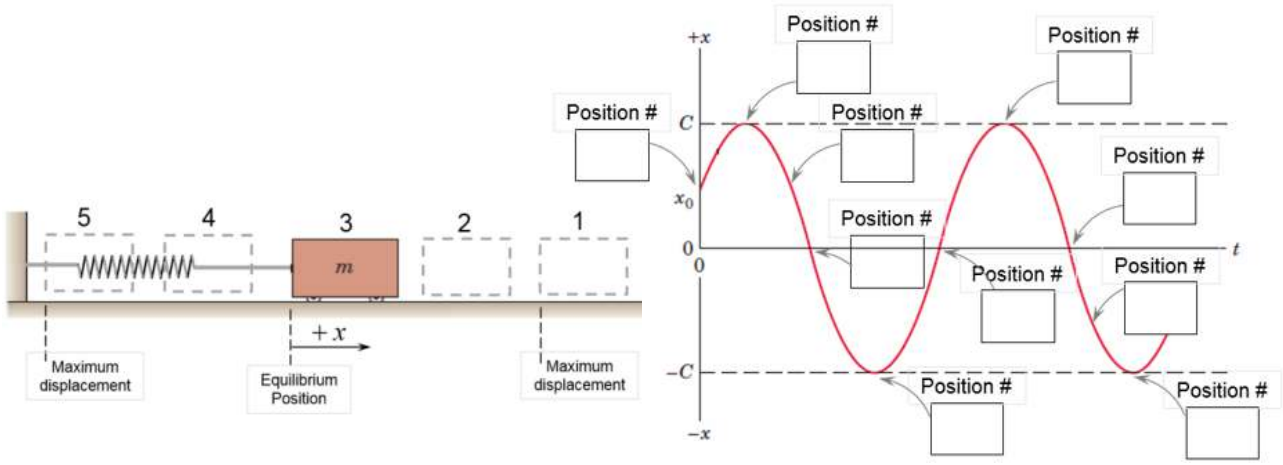
A thin walled pressure vessel has a length of 40 mm, outer and inner diameters of 76 mm and 70mm. The vessel was made of aluminum with Young's modulus of 72 GPa and Poisson's ratio of 0.33. Determine the hope and longitudinal stresses resultant from a pressure of 20 bar inside, theoretically and experimentally if the strains recorded during the experiment were as follow,

ε_0	ε_{45}	ε_{90}
-88.30	97.10	280.20

Question-4 (20%):

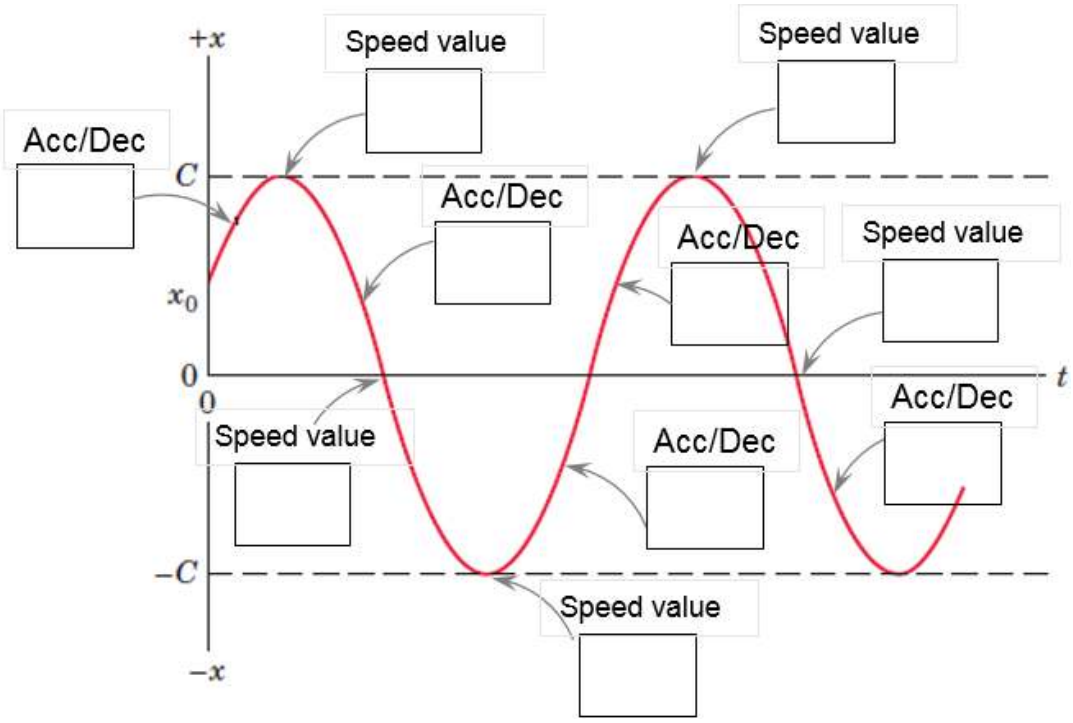
A spring-mounted body is disturbed from its equilibrium position

Fill the boxes with the corresponding position numbers.



Given that the speed of the mass at the equilibrium position is 25 m/s.

Fill the following boxes with the corresponding speed values, and Acc for the acceleration, Dec for the deceleration.

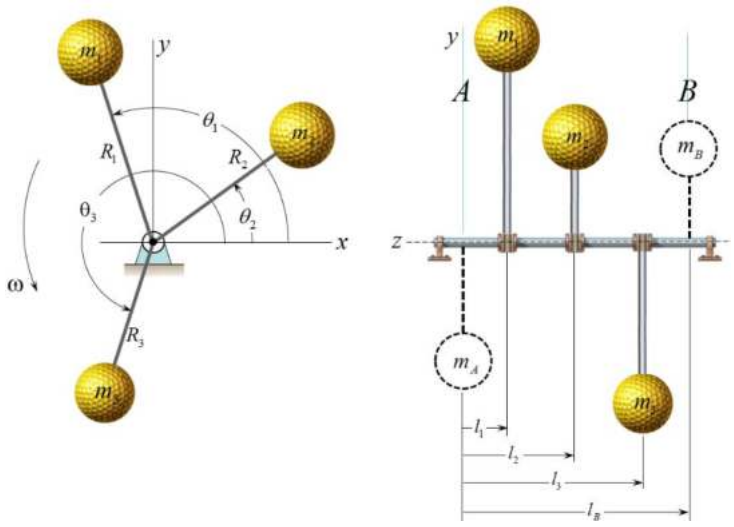


Question-5 (20%):

The system shown in the figure has the following data:

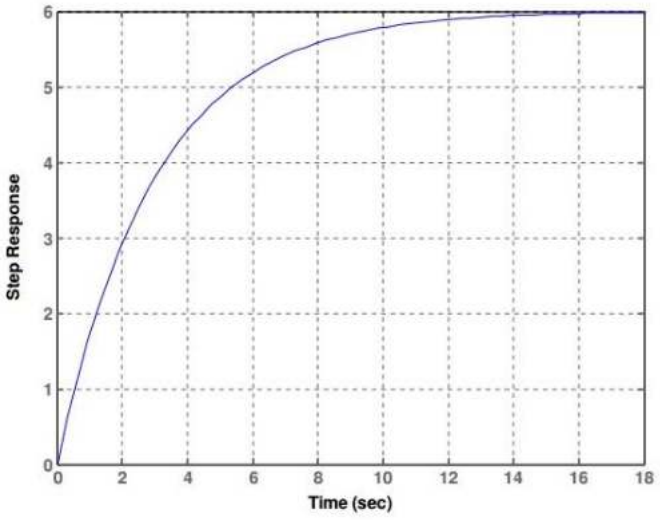
$m_1 = 2$ kg , $m_2 = 1.5$ kg , $m_3 = 3$ kg
$R_1 = 1.5$ m , $R_2 = 1$ m , $R_3 = 1.2$ m
$\theta_1 = 110^0$, $\theta_2 = 40^0$, $\theta_3 = 260^0$
$l_1 = 0.8$ m , $l_2 = 1.5$ m , $l_3 = 2$ m , $l_B = 2.5$ m
$\omega = 20$ rad/s

[**Showing your detailed calculations]** Calculate the mass-radius products and their angular locations needed to dynamically balance the system using the correction planes *A* and *B*.



Question-6 (15%):

The response of liquid level control system to a unit step input was as shown in Figure, find the transfer function of the system and steady state error.



Allowed Data

Deflection:

$$\Delta = \frac{PL^3}{48EI}$$

Buckling:

$$P_{cr} = \frac{\pi^2 EI}{L_k^2}$$

$$(P_{cr})_{exp} = \frac{(L_1 + L_2)}{2}\frac{G}{100mm} + F_V$$

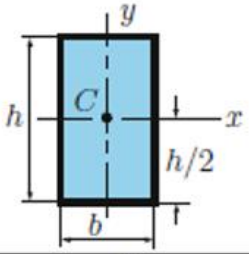
Thin walled pressure vessel:

$$\gamma_{xy} = 2\varepsilon_{45^o} - (\varepsilon_{0^o} + \varepsilon_{90^o})$$

$$\varepsilon_{1,2} = \frac{\varepsilon_x + \varepsilon_y}{2} \pm \sqrt{\left(\frac{\varepsilon_x - \varepsilon_y}{2}\right)^2 + \left(\frac{1}{2}\gamma_{xy}\right)^2}$$

$$\sigma_1 = \frac{E}{1-\nu^2}(\varepsilon_1 + \nu\varepsilon_2) \qquad \sigma_1 = \frac{Pr}{t}$$

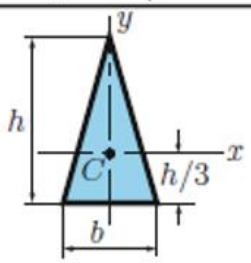
$$\sigma_2 = \frac{E}{1-\nu^2}(\varepsilon_2 + \nu\varepsilon_1) \qquad \sigma_2 = \frac{Pr}{2t}$$



$$A = bh$$

$$I_{xx} = \frac{bh^3}{12} \qquad I_C = \frac{bh}{12}(b^2 + h^2)$$

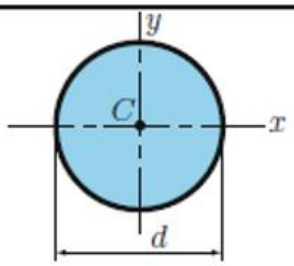
$$I_{yy} = \frac{b^3 h}{12}$$



$$A = \frac{bh}{2}$$

$$I_{xx} = \frac{bh^3}{36} \qquad I_C = \frac{bh}{36}(b^2 + h^2)$$

$$I_{yy} = \frac{b^3 h}{36}$$



$$A = \frac{\pi d^2}{4}$$

$$I_{xx} = I_{yy} = \frac{\pi d^4}{64}$$

$$I_C = \frac{\pi d^4}{32}$$