The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Mechanical Engineering

Study Programme	:	Bachelor of Technology Honours in Engineering
Name of the Examination	:	Final Examination
Course Code and Title	:	**DMX5201 Advanced Engineering Mechanics**
Academic Year	:	2020/21
Date	:	12th February 2022
Time	:	1400 hours -1700 hours
Duration	:	**3 hours**

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Eight (08)** questions in **Five (05)** pages.
3. Answer any **Five (05)** questions.
4. Answer for each question should commence from a new page.
5. This is a Closed Book Test (**CBT**).
6. Answers should be in clear handwriting.
7. Do not use Red colour pen.

Question 01 – *(20 Marks)*

The point of suspension of a simple pendulum is given by a harmonic motion $x_0 = X_0 \sin \omega t$ along a horizontal line, as shown in figure Q01.

a) Write the differential equation of motion for a small amplitude of oscillation using the coordinates shown in the figure Q01.
b) Determine the solution for x/x_0, and
c) show that when $\omega = \sqrt{2}\ \omega_n$, the node is found at the midpoint of l.
d) Show that in general the distance **h** from the mass to the node is given by the relation $h = l\ (\omega_n / \omega)^2$, where $\omega_n = \sqrt{g/l}$.

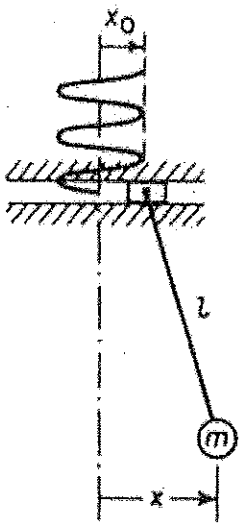

Figure Q01

Question 02 - *(20 Marks)*

An electric motor of mass ***68 kg*** is mounted on an isolator block of mass ***1200 kg*** as shown in figure Q02 and the natural frequency of the total assembly is ***160 cpm*** (cycle per minute) with a damping factor of $\beta = 0.10$. If there is an unbalance in the motor that results in a harmonie force of $F = 100 \sin 31.4t$, determine,

a) the amplitude of vibration of the block and
b) the force transmitted to the floor.

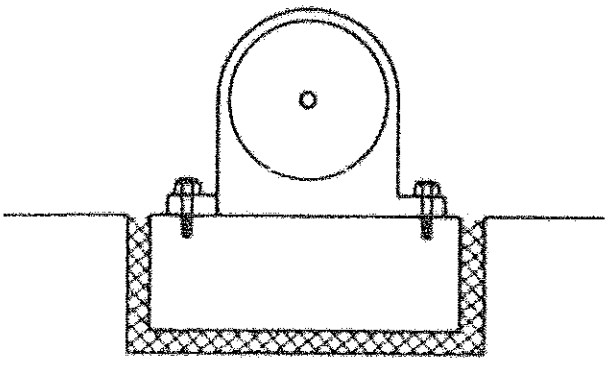

Figure Q02

Question 03 - *(20 Marks)*

In a mining place, there is a motor which is connected to cable drum as shown in figure Q 03. Using following details and notations, determine expression for the frequency of torsional vibration of the system.

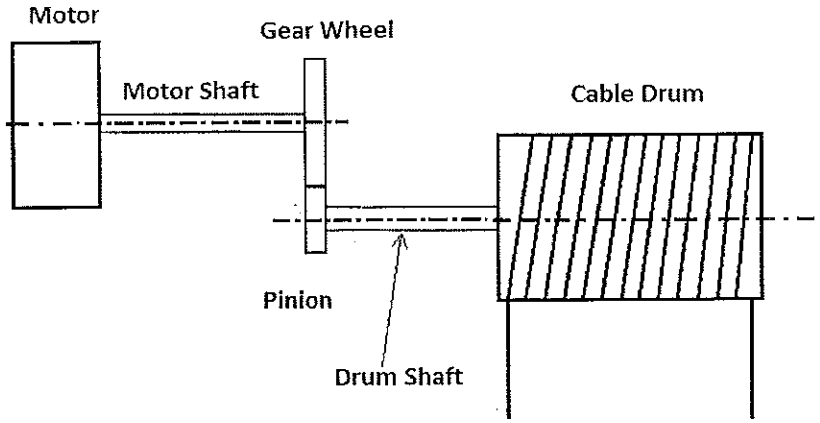

Figure Q03

Where;

- Inertia of motor = $\mathbf{I_m}$
- Inertia of cable drum = $\mathbf{I_c}$
- Inertia of gear = $\mathbf{I_g}$
- Inertia of pinion = $\mathbf{I_p}$
- Torsional stiffness of motor shaft = $\mathbf{K_1}$
- Torsional stiffness of cable drum shaft = $\mathbf{K_2}$

Question 04 - *(20 Marks)*

A light elastic shaft is held vertically in bearings placed at its ends. A non-uniform horizontal disc of mass m is fixed to the shaft at its centre so that the mass centre of the disc is 'e'units away from the axis of the shaft. During rotation of the shaft about its axis at angular velocities ω_1 and ω_2, it was observed that the radii of rotation of the centre of the shaft were r_1 and r_2 respectively.

a) Show that the critical speed of rotation of the shaft (ω)

$$\omega^2 = \frac{(r_1 + r_2)\omega_1^2\omega_2^2}{r_1\omega_2^2 + r_2\omega_1^2}$$

Where; $\omega_1 < \omega < \omega_2$

b) When the angular velocities of the shafts are ω_1 = **50 rad/s** and ω_2 = **300 rad/s,** the radii of rotation of the centre of the shaft are $r_1 = 5\ mm$ and $r_2 = 3\ mm$ respectively. Find the value for 'e'.

Question 05 - *(20 Marks)*

Briefly explain the followings.

(a) The ideal membrane
(b) Electrodynamic relative vibration pickup
(c) Frahm tachometer
(d) Noncontact displacement transducers
(e) Periodic forcing function

Question 06 - *(20 Marks)*

If the plate gears A and B are rotating with the angular velocities *5 rad/s* and *15 rad/s* respectively as shown in figure Q06, determine the angular velocity of gear C about the shaft DE. What is the angular velocity of DE about the y axis?

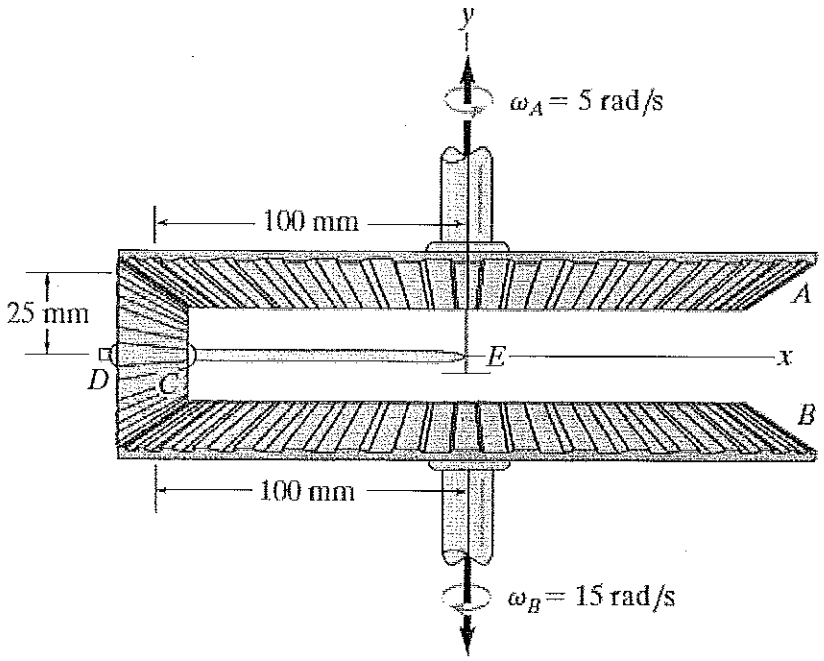

Figure Q06

Question 07 - *(20 Marks)*

The disk shown in figure Q07, rotates about a shaft ***S***, while the shaft is turning about the z axis at a rate of $\mathbf{v}_z = 4$ ***rad/s***, which is increasing at a rate of ***2 rad/s***^{2}. Determine the velocity and acceleration of a point ***B*** on the disk at the instant as shown in figure Q07. Assume that no slipping occurs.

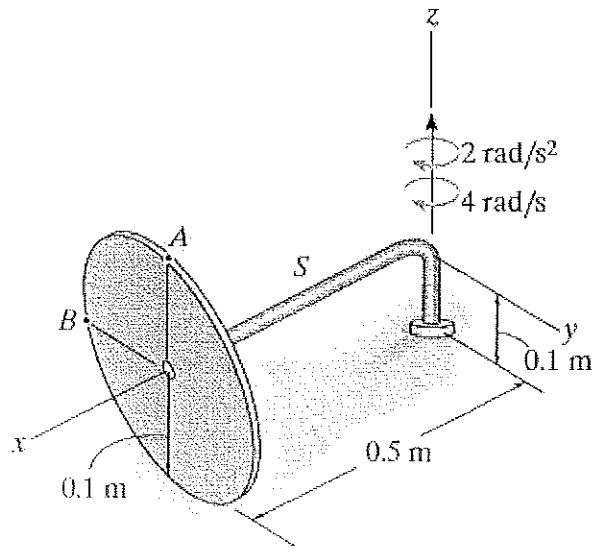

Figure Q07

Question 08 - *(20 Marks)*

Consider the cone given in figure Q08. Determine the moment of inertia of the cone with respect to a vertical $\bar{y}$ axis passing through the cone's center of mass. What is the moment of inertia about a parallel axis y' that passes through the diameter of the base of the cone? The cone has a mass m.

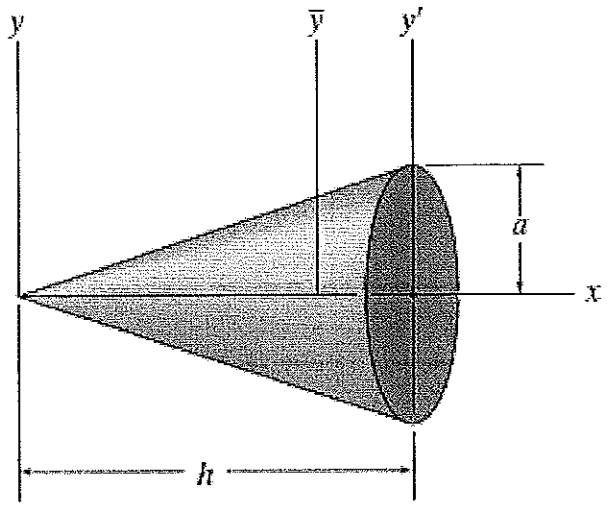

Figure Q 08