



DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY

Examination 2021/2022

**FIRST YEAR SUPPLEMENTARY/SPECIAL SEMESTER EXAMINATION FOR
THE DEGREE OF BACHELOR OF SCIENCE IN EEE, BACHELOR OF
EDUCATION IN TECHNOLOGY (EEE) AND BACHELOR OF SCIENCE IN
TELECOMMUNICATION AND INFORMATION ENGINEERING
EME 1202: FUNDAMENTALS OF MECHANICAL ENGINEERING**

DATE: OCTOBER 2021

TIME: 2 HOURS

INSTRUCTIONS

- i. This examination contains FIVE questions.
- ii. Answer **QUESTION ONE** and any **TWO** questions.

QUESTION 1 (30 Marks) COMPULSORY

- (a) Define the following terms as used in the design of mechanisms and machinery.
 - (i) Degrees of freedom **(1 mark)**
 - (ii) Kinematic link **(1 mark)**
 - (iii) Kinematic pair **(1 mark)**
 - (iv) Kinematic chain **(1 mark)**
- (b) (i) State Grashof's law. **(2 marks)**
(ii) The link lengths of a planar four-bar linkage are given as 25mm, 75mm, 125mm, and 125mm. Verify if the Grashof's condition is satisfied. **(2 marks)**
- (c) Slider crank mechanism is an assembly of piston, cylinder, connecting rod and a crank. This mechanism has been applied widely in engineering e.g. workshops, domestic appliances, automotive or agricultural machinery. With the aid of well labelled sketches, discuss the four possible inversions of this mechanism and in each case, state at least one practical application. **12 marks**
- (d) Discuss at least three advantages and disadvantages of chain drive over the belt drive system **(3 marks)**
- (e) Why is sprocket alignment important in chain drive and how is the alignment done? **(2 Marks)**
- (f) With the aid of a simple sketch, briefly explain the principle of operation of a centrifugal pump. **(5 Marks)**

QUESTION 2 (15 Marks)

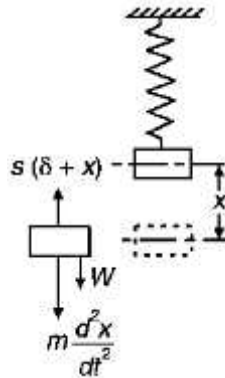
- (b) Describe the following types of vibrations
 - (i) Free vibrations
 - (ii) Forced vibrations

(iii) Damped vibrations

(6 marks)

(c) With the aid of well labelled diagrams, describe the longitudinal, torsional and transverse vibrations. (6 marks)

(d) Obtain an expression for the natural frequency of free longitudinal vibration of an elastic spring carrying mass suspended on it as shown. (3 marks)



QUESTION 3 (15 Marks)

(a) An engine, running at 150 r.p.m., drives a line shaft by means of a belt. The engine pulley is 750 mm diameter and the pulley on the line shaft being 450 mm. A 900 mm diameter pulley on the line shaft drives a 150 mm diameter pulley keyed to a dynamo shaft. Find the speed of the dynamo shaft, when;

- (i) There is no slip.
- (ii) There is a slip of 2% at each drive.

(5 Marks)

(b) Define and compare;
(i) spur gears and helical gears.
(ii) straight and spiral bevel gears.

(5 Marks)

(c) A gearbox has an input speed of 1500 rev/min clockwise and an output speed of 300 rev/min anticlockwise. The input power is 20 kW and the efficiency are 70%. Determine the following.

- (i) Gear ratio
- (ii) Input torque
- (iii) Output power
- (iv) Output torque
- (v) Holding torque

(5 Marks)

QUESTION 4 (15 Marks)

(a) With the aid of a neat sketch, briefly explain how a Bourdon type pressure gauge operates.

(6 Marks)

(b) Consider a pipe with laminar flow in it. Consider a stream tube of length L at radius r and thickness dr. Prove that the boundary layer takes the shape of a parabola.

(5 Marks)

- (c) A capillary tube is 30 mm long and 1 mm bore. The head required to produce a flow rate of $8 \text{ mm}^3/\text{s}$ is 30 mm. The fluid density is 800 kg/m^3 . Calculate the dynamic and kinematic viscosity of the oil.

(4 Marks)

QUESTION 5 (15 Marks)

- (a) During a tensile test, a specimen of diameter 7cm and length 10cm was used. A maximum force of 150KN was applied on the material and the elongation was 0.1cm. Calculate the stress developed and determine Young's modulus of elasticity of the material.

(3 Marks)

- (a) A beam is simply supported at the end A and at a point B, 1 m from the other end C. The distance between the supports A and B is 3 m. The beam is subjected to a uniform distributed load of 1 kN/m.

- (i) Determine the support reactions.
(ii) Sketch the shear force and bending moment diagrams. State the maximum values of the shear force and bending moment and the position at which they occur.

(12 Marks)