70

(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS

2023/2024 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER EXAMINATIONS

FOR THE DEGREE
OF
BACHELOR OF SCIENCE IN MECHANICAL AND INDUSTRIAL ENGINEERING

COURSE CODE: MIE 341

COURSE TITLE: MECHANICS OF MACHINES III

DATE: 15/12/2023   **TIME:**   8:00 AM – 10:00 AM

INSTRUCTIONS TO CANDIDATES

This paper contains **FOUR** Questions
Answer **question ONE (1)** and any **OTHER TWO** questions

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 3 Printed Pages. Please Turn Over. ▶

1. (a) (i) State any two applications of Gyroscopic effect **(2 marks)**

   (ii) Define the coefficient of fluctuation of energy **(2 marks)**

   (b) (i) Explain why a multi-cylinder engine usually have a smaller flywheel than a single-cylinder engine **(2 marks)**

   (ii) Give reasons why a flywheel is required in machines that exhibit intermittent torque requirement such as a punching press. **(3 marks)**

   (c) The turbine rotor of a ship has a mass of 8 tons and a radius of gyration 0.6 m. It rotates at 1800 rpm clockwise when looking from the stern. Determine the gyroscopic couple if the ship travels at 100 km/hr and steer to the left in a curve of 75 m radius **(6 marks)**

   (d) A cross compound steam engine rated at 30 kW runs at 100 rpm . The speed of the engine is to be maintained within 1% of the speed . The flywheel has a mass of 2 tonnes with radius of gyration of 100cm. Determine the co-efficient of fluctuation of energy. **(7 marks)**

   (e) The turning moment diagram of a four-cylinder four stroke internal combustion engine has been drawn to a scale 1cm = 60 Nm turning moment 1 cm=10° of crank. The fluctuation of energy is determined to be 6.5 cm² from the turning moment diagram. Determine the mass of the fly-wheel for the following specifications mean speed of the engine = 1500 rpm fluctuation of speed =0.5% of mean speed. The radius of gyration of flywheel is 20 cm. **(8 marks)**

2. (a) An electric motor drives a punching press, which is capable of punching 40 holes in 3 minutes the radius of gyration of the flywheel fitted to the press is 500 mm. The flywheel is running at 250 rpm. Each punching operation requires 12 kNm of work and takes 1.5 sec. Determine: (i) The rating of machine in KW and (ii) Mass of the flywheel if the speed of the flywheel does not drop to below 230 rpm. **(10 marks)**

   (b) In a spring loaded Hartnell type governor, the extreme radii of rotation of the balls are 80 mm and 120 mm, the ball arm and the sleeve arm of the bell crank lever are equal in length. The mass of each ball is 2 kg.If the speed at the two extreme position are 400 and 420 rpm. Find the initial compression of the central spring, and the spring constant **(10 marks)**

3. (a) Give three causes of unbalance in a rotating machine elements **(3 marks)**

(b) State any four benefits of balancing rotating machine components **(4 marks)**

(c) The cranks and connecting rods of a four cylinder in-line engine running at 1800 rpm are 50 mm and 250 mm each respectively and the cylinders are spaced 150 mm apart. If the cylinders are numbered 1 to 4 in sequence from one end, the cranks appear at intervals 90° in an end view in the order 1-4-2-3. Reciprocating mass per each cylinder is 1.5 kg. Show that all **primary forces** are balanced. Determine the unbalance primary and secondary couples with reference to the central plane of the engine. **(13 marks)**

4. (a) An airplane makes a complete half circle of 80 metre radius towards the left when flying at 200 km//hr. The rotary engine and the propeller of the plane have a mass of 400 kg and a radius of gyration of 0.3 m. The engine rotates at 2400 rpm, clockwise when viewed from the rear. Find the gyroscopic couple on the aircraft and the state the effect on it **(7 marks)**

(b) The turning moment diagram of a multi-cylinder IC engine is drawn to the following scales 1cm=15° crank angle and 1cm=3000 Nm torque. During one revolution of the crank, the areas above and below the mean torque lines taken in order are: 3.52, 3.77, 3.62, 4.35, 4.40 and 3.42 sq. cm. Design a flywheel to keep the coefficient of fluctuation of speed q within 0.05 when the engine speed is 200 rpm. The radius of gyration of the flywheel may be taken as 1 m.

(13 marks)