



MACHAKOS UNIVERSITY

University Examinations for 2019/2020 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

FIRST YEAR SECOND SEMESTER EXAMINATION FOR

DIPLOMA IN MECHANICAL ENGINEERING (PLANT)

DIPLOMA IN AUTOMOTIVE

2502/102&2503/102: MECHANICAL ENGINEERING SCIENCE

DATE: 15/12/2020

TIME: 8:30 – 11:30 AM

INSTRUCTIONS TO CANDIDATES

This paper consists of FIVE QUESTIONS

Answer ALL Questions.

All questions carry equal marks and maximum marks for each part of a question are shown.

Take $=9.81\text{m/s}^2$ or 9.81N/kg

1 Litre = 1 kg

QUESTION ONE (20MARKS)

- a)
 - i) State the Polygon law of forces. (2 marks)
 - ii) State Two conditions for equilibrium of parallel forces. (2 marks)
- b) Three forces of magnitudes 140N, 160N and 110N act at angles of 70° , 135° and 280° respectively from a reference point. Using the analytical method of resolution of forces determine the magnitude and direction of their resultant force. (8 marks)
- c) A uniform beam AB 120cm long and weighing 1.2N rests on two sharp edged supports C and D placed 10cm from each end of the beam. A 0.2N weight hangs from a loop of a thread 30cm from A and another weight of 0.9N hangs 40cm from B. Determine the reactions from the supports C and D. (8 marks)

QUESTION TWO (20 MARKS)

- a) Define the following terms with reference to motion;
 - i. Linear Velocity (2 marks)
 - ii. Angular Acceleration (2 marks)

- b) State the following laws;
- Newton's second law of motion (2 marks)
 - Law of conservation of momentum (2 marks)
- c) A train travelling between two stations 4km apart completes the journey in 4 minutes. During the first 40 seconds the train moves at a constant acceleration while a uniform retardation brings the train to rest in the last 30seconds. For the second portion of the journey the train moves with uniform speed. Using a speed/Velocity –Time graph, determine
- The uniform speed
 - The acceleration
 - The retardation
 - The distance travelled in the first and the last minute. (7 marks)
- d) A large gear rotating at 50rev/min has an angular retardation of 0.02rad/sec^2 . Calculate;
- Its angular velocity after 40 seconds
 - The number of complete revolutions it makes in 60 seconds
 - Its linear speed at the 40 seconds if its diameter is 0.15m. (5 marks)

QUESTION THREE (20 MARKS)

- a) Define the following terms stating their S.I units
- Energy
 - Power.
 - Specific heat capacity (6 marks)
- b) The velocity of a motor vehicle of mass 1200kg is increased from 5m/s to 15 m/s in 20 seconds. Determine;
- The change in kinetic energy.
 - The power required. (6 marks)
- c) The temperature of a piece of copper of mass 500kg is raised to a temperature of 200°C and is then transferred to an aluminium can of mass 20kg, containing 240kg of methylated spirit at 20°C . Calculate the final steady temperature after the spirit has been well stirred. Neglect the heat capacity of the stirrer and any losses from evaporation and use specific heat capacities of 400J/kgK , 900J/kgK and 2400J/kgK for copper, aluminium and methylated spirit respectively. (8 marks)

QUESTION FOUR (20 MARKS)

- a) Define the following terms with reference to simple lifting machines;
- i. Mechanical Advantage (2 marks)
 - ii. Velocity ratio (2 marks)
 - iii. Efficiency (2 marks)
- b) During a lifting operation on a machine having a velocity ratio of 35, an effort of 150N was found to lift a load of 1150N and an effort of 210N lifted a load of 2540N. Determine,
- i. The effort required to overcome machine friction (2 marks)
 - ii. The law of the machine (2 marks)
 - iii. The limiting Mechanical advantage (2 marks)
 - iv. The efficiency when lifting a load of 1800N (3 marks)
- c) A body having a mass of 500kg is resting on top of a screw jack. The screw jack has a lead of 9 mm and an effort of 40N has been applied tangentially at a radius of 300mm to lift the load. Calculate the;
- i. Velocity ratio. (3 marks)
 - ii. Mechanical advantage (2 marks)

QUESTION FIVE (20 MARKS)

- a) State any three laws of dry friction. (3 marks)
- b) State the following gas laws;
- i. Boyle's law. (2 marks)
 - ii. Charles law (2 marks)
- c) At the start of the first stage of a compression process, the volume of a gas was 450 litres, Absolute pressure 120kPa and at a temperature of 800C. At the end of this stage the volume was 110 litres and the temperature was 140⁰C. The gas was then compressed during the second stage at constant pressure to a volume of 50 litres. Determine the,
- i. Pressure at the end of the first stage. (3 marks)
 - ii. Temperature at the end of the second stage (4 marks)
- d) A casting of mass 400kg is pulled horizontally by a force of 1177.2N along a horizontal floor.
- i. Calculate the coefficient of friction. (2 marks)
 - ii. Determine the force that would move the same casting if it was a push inclined at 30⁰ to the horizontal. (4 marks)