



MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY ORDINARY EXAMINATION

2024/2025 ACADEMIC YEAR

**FOURTH YEAR FIRST SEMESTER EXAMINATION FOR BACHELOR
OF TECHNOLOGY IN MECHANICAL ENGINEERING AND BACHELOR
OF TECHNOLOGY EDUCATION (MECHANICAL ENGINEERING OPTION)**

EMT 405: MANUFACTURING PROCESSES

DURATION: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

1. Answer question ONE and any other two questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

SECTION A – ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION ONE (30 MARKS)

- a) Using a diagram briefly explain the four metal forming processes. (8 marks)
- b) Distinguish the three temperature ranges that are used in metal forming. (6 marks)
- c) With regard to powder metallurgy, differentiate between:
 - i) Mixing and blending. (2 marks)
 - ii) Bulk density and true density. (2 marks)
- d) State four reasons why a controlled furnace is desirable in sintering. (4 marks)
- e) Using a diagram, illustrate arc welding. (4 marks)
- f) Outline any four reasons why most welding operations are inherently dangerous. (4 marks)

SECTION B– ANSWER ANY TWO QUESTIONS IN THIS SECTION

QUESTION TWO (20 MARKS)

- a) A company manufacturing sheets of metal is planning to do rolling on a plate that is 250 mm wide and 25 mm thick and it is to be reduced in a single pass in a two-high rolling mill to a thickness of 20 mm. The roll has a radius of 500 mm and its speed is 30 m/min. The work material has a strength coefficient k of 240 MPa and a strain hardening exponent $n = 0.2$. The coefficient of friction between the rolls and the work is assumed to be 0.11. Determine:
 - i. If the friction is sufficient to permit the rolling operation to be accomplished. (2 marks)
 - ii. Roll force. (3 marks)
 - iii. Roll torque. (2 marks)
 - iv. Horse power required accomplishing the operation. (3 marks)
- b) Based on computational values obtained in (a) above, advise the company on four strategies it can adopt to reduce the large forces used and power consumed during the operation. (4 marks)
- c) Describe any three welding defects. (6 marks)

QUESTION THREE (20 MARKS)

- a) A resistance spot welding operation is used to make a series of spot welds between two pieces of aluminium, each 2.0 mm thick. The unit melting energy for aluminium $U_m = 2.90 \text{ J/mm}^3$, welding current $I = 5,000 \text{ amps}$, time duration $= 0.15 \text{ sec}$. Assume that the resistance $= 75 \text{ micro-ohms}$. The resulting weld nugget measures 5.0 mm in a diameter by 2.5 mm thick. Calculate how much of the total energy generated is used to form the weld nugget. (6 marks)
- b) An oxyacetylene torch supplies 0.3 m^3 of acetylene per hour and an equal volume rate of oxygen for an OAW operation on 4.5 mm thick steel. Heat generated by combustion is transferred to the work surface with a heat transfer factor $f_1 = 0.20$. If 75% of the heat from the flame is concentrated in a circular area on the work surface that is 9.0 mm in diameter, find:
- i) Rate of heat liberated during combustion. (2 marks)
 - ii) Rate of heat transferred to the work surface considering heat transfer factor. (1 mark)
 - iii) Average power density in the circular area. (3 marks)
- c) Discuss any weight rules for the design of powder metallurgy parts. (8 marks)

QUESTION FOUR (20 MARKS)

- a) A solid cube of copper with each side $= 30 \text{ cm}$ is converted into metallic powders of spherical shape by gas atomization. Assuming that all particles are the same size, calculate the percentage increase in total surface area if the diameter of each particle is 100 microns. (10 marks)
- b) A cylindrical work piece is subjected to a cold upset forging operation. The starting piece is 75 mm in height and 50 mm in diameter. It is reduced in the operation to a height of 36 mm. The work material has a flow curve defined by $k = 350 \text{ MPa}$ and $n = 0.17$. Assuming a coefficient of friction of 0.1, determine the force as the process begins at intermediate heights of 62 mm 40 mm and at the final height of 36 mm. (10 marks)