



MACHAKOS UNIVERSITY

University Examinations for 2022/2023 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

THIRD YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

EMM 315: MATERIAL FORMING PROCESSES I

DATE: 20/4/2023

TIME: 11:00 - 1:00 PM

INSTRUCTIONS:

- ✓ You should have the following for this exam
 - Answer Booklet
 - Non-programmable scientific calculator
- ✓ The examination consists of **FIVE QUESTIONS**.
- ✓ **Start each question you attempt on a fresh page**
- ✓ **Question 1 is COMPULSORY and Carries 30 Marks**
- ✓ **ANSWER QUESTION 1 and ANY other TWO QUESTIONS**
- ✓ Maximum marks for each part of a question are as indicated.
- ✓ Use of mobile phones in the exam room is **strictly prohibited**.
- ✓ If need be, supplementary materials shall be provided

QUESTION ONE (COMPULSORY) (30 MARKS)

- (a) With the aid of neat illustrations, explain the major processes used to work materials with a high surface area to thickness ratio. **[9 Marks]**
- (b) A piece of metal having the strength coefficient and strain-hardening exponent as 560 MPa and 0.21 respectively was taken through a forming operation. The final true strain that the metal experienced was 0.83. Determine the flow stress at this strain and the average flow stress that the metal experienced during the operation. **[6 Marks]**
- (c) Explain the advantages and disadvantages of manufacturing processes that employ metal in liquid or semi-solid form? **[5 Marks]**
- (d) During a sand-casting exercise, the metal took 155 seconds to solidify into a cube of 50mm by 50mm. Calculate:
- (i) The value of the mold constant in Chvorinov's rule.
 - (ii) The total solidification time for a cylindrical casting in which the diameter = 30 mm and length = 50 mm if the same alloy and mold type were used.

[10 Marks]

QUESTION TWO (20 MARKS)

- (a) What are the major characteristic properties of composite materials and common forms of reinforcing phase(s)? **[3 Marks]**
- (b) A class was tasked with the responsibility of determining the strength of a composite laminates, explain the fundamental rule(s) they may have applied. **[2 Marks]**
- (c) Consider a fiberglass composite composed of vinyl ester matrix and E-glass reinforcing fibers. A section of the composite measuring 1.00 cm by 50.00 cm by 200.00 cm is fabricated with the E-glass fibers running longitudinal along the 200-cm direction. Assuming there are no voids in the composite, and given the following data for the constituent materials:-

Volume fraction of E-glass = 35%,
Density of the vinyl ester = 0.882 g/cm³,
Modulus of elasticity of vinyl ester = 3.60 GPa.
Density of E-glass = 2.60 g/cm³,
Modulus of elasticity of E glass = 76.0 GPa.

Determine:

- (i) the mass of vinyl ester in the section,
- (ii) mass of E-glass fibers in the section,
- (iii) the density of the composite.

[15 Marks]

QUESTION THREE (20 MARKS)

- (a) A 2-component aluminium casting is made through the sand-casting process such that the larger component has the shape of a dish sink, and the second component is a flat cover that is attached to the first component to create an enclosed space for the machinery parts. The final product upon inspection is found to have significant defects on both components. If you were in charge of the workshop, write a brief report enumerating the defects and explain what could have caused them. **[3 Marks]**
- (b) A series of cold rolling operations are to be applied to reduce the thickness of a plate from 50 mm down to 25 mm in a reversing two-high mill. Given that the roll diameter is 700 mm, coefficient of friction between rolls and work is 0.15 and assuming that the draft is to be equal on each pass. Determine
- (i) minimum number of passes required, and **[4 Marks]**
 - (ii) draft for each pass? **[2 Marks]**
- (c) A large diameter copper tube section is fabricated using the true horizontal centrifugal casting. Given that the tube has a length, diameter and wall thickness of 1.0 m, 0.25 m and 15 mm respectively, and the solidification shrinkage and solid thermal contraction for copper are 4.5% and 7.5% respectively, for a rotational speed of 700 rev/min, determine:
- (i) the G-factor on the molten metal.
 - (ii) whether the rotational speed is sufficient to avoid defects common in such castings.
 - (iii) The volume of molten metal that must be poured into the mold to make the casting if solidification shrinkage and contraction after solidification are considered. **[11 Marks]**

QUESTION FOUR (20 MARKS)

- (a) Why is glass generally classified as a ceramic material, yet it is different from the traditional and new ceramics? **[1 Mark]**
- (b) Glass possesses special properties that make it desirable in certain applications. Explain. **[10 Marks]**
- (c) Explain how a piece of glass is heat treated and the resulting end-product(s). **[3 Marks]**
- (d) Discuss the design recommendations for glass parts. **[6 Marks]**

QUESTION FIVE (20 MARKS)

- (a) Outline the significance of polymer shaping processes in manufacturing. **[6 Marks]**
- (b) Using appropriate illustrations, explain the process and equipment used in the manufacture of polymer-based window frames and electrical conduit covers. **[14 Marks]**