



MACHAKOS UNIVERSITY

University Examinations for 2019/2020 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

THIRD YEAR SECOND SEMESTER EXAMINATION FOR
BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING
EMM 315: MATERIAL FORMING PROCESSES I

DATE: 1/12/2020

TIME: 8:30 – 10:30 AM

INSTRUCTIONS

- i. This paper contains three sections with a total of five questions.
- ii. Question 1 is compulsory
- iii. Question 1 carries 30 Marks while the rest carry 20 Marks each
- iv. Answer QUESTION 1 and any other TWO questions from each of the remaining sections.

SECTION A: (COMPULSORY)

QUESTION ONE (30 MARKS)

- a) Using appropriate illustrations, explain the major sheet metal forming processes. (9 marks)
- b) The strength coefficient is 550 MPa and strain-hardening exponent is 0.22 for a certain metal. During a forming operation, the final true strain that the metal experiences is 0.85. Determine the flow stress at this strain and the average flow stress that the metal experiences during the operation.
(6 marks)
- c) What are the advantages and disadvantages of shape casting? (5 marks)
- d) In casting experiments performed using a certain alloy and type of sand mold, it took 155 sec for a cube-shaped casting to solidify. The cube was 50 mm on each side. Determine:
 - i. The value of the mold constant in Chvorinov's rule.

- ii. The total solidification time for a cylindrical casting in which the diameter is 30 mm and length is 50 mm if the same alloy and mold type were used. (10 marks)

SECTION B: ANSWER ANY ONE QUESTION

QUESTION TWO (20 MARKS)

- a) Identify some of the characteristic properties of composite materials and the common forms of the reinforcing phase in composites. (3 marks)
- b) Explain the rule of mixtures. (2 marks)
- c) A fiberglass composite is composed of a matrix of vinyl ester and reinforcing fibers of E-glass. The volume fraction of E-glass is 35%. The remainder is vinyl ester. The density of the vinyl ester is 0.882 g/cm^3 , and its modulus of elasticity is 3.60 GPa. The density of E-glass is 2.60 g/cm^3 , and its modulus of elasticity is 76.0 GPa. A section of composite 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, Determine;
- i. the mass of vinyl ester in the section, (5 marks)
- ii. mass of E-glass fibers in the section, (5 marks)
- iii. the density of the composite. (5 marks)

QUESTION THREE (20 MARKS)

- a) The housing for a certain machinery product is made of two components, both aluminum castings. 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. Sand casting is used to produce the two castings, both of which are plagued by defects in the form of misruns and cold shuts. The foreman complains that the parts are too thin, and that is the reason for the defects. However, it is known that the same components are cast successfully in other foundries. What other explanation can be given for the defects?
(3 marks)
- b) A large steel sand casting shows the characteristic signs of penetration defect: a surface consisting of a mixture of sand and metal.
- i. What steps can be taken to correct the defect? (3 marks)

- ii. What other possible defects might result from taking each of these steps? (3 marks)
- c) True centrifugal casting is performed horizontally to make large diameter copper tube sections. The tubes have a length of 1.0 m, diameter of 0.25 m, and wall thickness of 15 mm.
- i. If the rotational speed of the pipe is 700 rev/min, determine the G-factor on the molten metal.
- ii. Is the rotational speed sufficient to avoid "rain?"
- iii. What volume of molten metal must be poured into the mold to make the casting if solidification shrinkage and contraction after solidification are considered?

Take solidification shrinkage for copper as 4.5%, and solid thermal contraction as 7.5%.

(11 marks)

SECTION C: ANSWER ANY ONE QUESTION

QUESTION FOUR (20 MARKS)

- a) Glass is classified as a ceramic material; yet glass is different from the traditional and new ceramics. What is the difference? (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 to produce tempered glass. (3 marks)
- d) What are some of the design recommendations for glass parts? (6 marks)

QUESTION FIVE (20 MARKS)

- a) Discuss the several reasons why plastic-shaping processes are important. (6 marks)
- b) Using appropriate illustrations, explain the process and equipment used in the extrusion of polymers. (14 marks)