

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

Faculty of Industrial Technology

Department of Industrial and Manufacturing Engineering

MANUFACTURING PROCESSES I -TIE 3113

1st SEMESTER EXAMINATION APRIL 2009

Instructions To Candidates

- 1.Examination length is **3hrs**.
- 2.Each question carries twenty (**20**) marks and there are six (**6**) questions in total.
- 3.Attempt the whole of Section A and any other three questions from Section B.
- 4.Pay attention to the instructions on the cover page of your answer booklet.

Section A

Question 1

- a) What casting process would you use to mass-produce steel camshafts for auto engines? [2]
- b) What casting process would you use to manufacture steel I – shaped beams for building construction? [2]
- c) A casting is found to contain many round smooth holes. What steps would you take to prevent this casting defect? [4]
- d) A casting is found to contain a single, large, hole in its center, with solid dendrites visible, around its edges. What steps would you take to prevent this casting defect? [4]
- e) A grey iron casting took 10 minutes to freeze. Given that $C = 1.5 \text{ s/m}^2$ and the volume of the casting is 600 cm^3 determine the surface area of the casting if it is prismatic in shape. [4]
- f) A critical aerospace component is made by casting. What technique is most suitable for determining the size and location of potential porosity? [4]

Question 2

- a) Discuss how the properties of castings are changed after manufacture. [6]
- b) Design the thickness of an aluminium casting whose length is 300 mm and width is 200 mm in order to produce a tensile strength of 276 MPa. The mould constant for aluminium alloys cast in a sand mould is 4.2 s/mm^2 . Freezing time for this particular casting is 5 minutes. [8]
- c) Design a cylindrical riser with a height to diameter ratio of 2 that will compensate for shrinkage in a 2 cm x 8 cm x 16 cm aluminium casting of the same alloy as in 2(a) above. [6]

Section B

Question 3

- a) What are the various elements that comprise the gating system? [6]
- b) Explain the parameters, which cause the mould fill time of a given casting to vary. [4]
- c) Differentiate between pressurised and unpressurised gating systems using suitable examples to give weight to your answer. [4]
- d) State the two essential conditions that are to be kept in mind while designing risers. [2]
- e) How is the surface of a casting cleaned? [4]

Question 4

- a) What are the typical situations in which the following casting processes are used?
 - (i) Investment casting [2]
 - (ii) Shell moulding [2]
 - (iii) High pressure die casting [2]
- b) With the aid of neat, well-labelled sketches describe shell moulding. [8]
- c) A brass melt is poured into a sand mould. The metal level in the pouring basin is 200 mm above the centreline of the runner, which is taken as the zero level. The cross section of the runner is 10 mm x 10 mm. Calculate from Bernoulli's theorem, the velocity and flow rate at the gate, ignoring friction losses (the pouring basin is so large that the velocity in it can be taken as zero). [6]

Question 5

- a) Define castability. [2]
- b) Why are steels more difficult to cast than cast irons? [2]
- c) What are the differences in the properties of castings made by permanent mould compared to sand casting methods? Explain. [6]
- d) State the most important factors in casting processes. [4]
- e) Turbulence is undesirable in melt flow in gating systems. Explain why and how it can be minimised. [6]

Question 6

- a) Explain the difference in the importance of drafts in green sand casting versus permanent mould casting. [4]
- b) Is it possible to obtain a sound casting of a solid bar by centrifugal casting? Support your answer with reasons. [6]
- c) Describe the pattern colour code normally used in foundries. [5]
- d) A 1000 mm wide, 400 mm thick, and 2000 mm long ingot is cast into a permanent mould. Sketch the 400 mm x 2000 mm cross-section showing the structure expected in casting a pure metal, free of gases. Show the shape and location of piping and microporosity, if any. [5]

End of Examination