

Indian Institute of Engineering Science and Technology, Shibpur
B. E. (Mechanical) Part II 4th Semester Final Examination, 2014
Subject: Engineering Materials & Processes (ME-403)

Time: 3 Hours

Full Marks: 70

Answer SIX questions taking THREE from each half

All questions carry equal marks, two marks in both halves is for overall quality

FIRST HALF

- 1 (a) Sketch and label three types of rolling processes.
(b) Discuss the effect of friction force and neutral point in rolling with sketch.
(c) A single pass rolling operation reduces a 25 mm thick plate to 22 mm. Width of the plate = 300 mm. Using a power source of 120 kW at 50 rpm for a single roll, determine the size of the rolls. Take $K= 280 \text{ MPa}$, $n= 0.20$ for the work material and $\mu= 0.15$.

[3+3+5]

- 2 (a) Explain any process by which balls of ball-bearing and currency coins can be manufactured with simple diagrams.
(b) Explain the lubrication system in wire-drawing process for successive reduction with diagram.
(c) A round rod of annealed brass is being drawn from a diameter of 6 mm to 3 mm at a speed of 0.6 m/s. If the semi-die angle is 15° and $\mu= 0.2$ estimate the drawing force and power. Take $K= 750 \text{ MPa}$, $n= 0.4$ for the work material

[3+3+5]

- 3 (a) Explain with sketch(s) exactly how the amount of current and pressure ^{is} precisely controlled over a weld cycle of a resistance spot welding operation.
(b) The unit melting energy for a certain sheet metal to be spot welded is $U_m= 10.0 \text{ J/mm}^3$. The thickness of each ~~the~~ sheets to be welded = 3.0 mm. To achieve required strength, it is desired to form a weld nugget ~~that is~~ ^{of} 5 mm in diameter and 4 mm thick. The weld duration is set at 0.2 sec. It is assumed that the total electrical resistance between the surfaces = 200 micro-ohms and that only 40% of the electrical energy will be utilized to form the nugget. Determine the minimum current level required for the operation.

[4+7]

4. (a) Write the main applications of three types of flames in oxyfuel gas welding.
(b) Explain in what conditions DC welding is necessary.
(c) A shielded metal arc-welding operation is performed on steel with current = 225 A and voltage = 30 V. The heat transfer efficiency, $f_1= 0.85$ and melting efficiency, $f_2= 0.75$. The unit melting energy for steel = 10.2 J/mm^3 . Find: (i) the heat generation at the weld (ii) the volume rate of metal welded (iii) cross-sectional area of the weld bead, if the electrode travel speed = 5 mm/sec

[3+3+5]

5. Write short notes on
(a) Cold chamber die casting
(b) Centrifuge casting
(c) Quality comparison: sand casting vs. centrifugal casting
(d) Casting defect: hot tear & its remedy.

[11]

Second Half

6. a) What is strain hardening? How does strain hardening effect on the true-stress-true-strain diagram? Prove that the true stain at the onset of necking is equal to the strain hardening exponent.
- b) A cable is made of four different materials, all behaving according to the following equation: $\sigma = k \epsilon^n$, where $n = 0.5$. The materials, strength coefficients and cross-sections are as follows:
Material X : $k = 500$ MPa, $A_0 = 7$ mm²
Material Y: $k = 850$ MPa, $A_0 = 2.5$ mm²
Material Y: $k = 430$ MPa, $A_0 = 3.5$ mm²,
Calculate the maximum tensile force that this cable can withstand prior to necking.
7. a) What is phase diagram? Draw the Iron-Carbon Equilibrium diagram, showing all important points.
- b) Hypoeutectoid plain-carbon steel ^{is} ~~was~~ slow-cooled from the austenitic region to room temperature containing 9.6% (wt) eutectoid ferrite. Assuming no change in structure on cooling from just below the eutectoid temperature to room temperature, what is the carbon content of the steel?
8. a) What happens, if austenite steel is allowed to cool below 723⁰C isothermally.
- b) Compare the followings in terms of microstructure and some other characteristics.
Eutectic, Eutectoid, Pearlite and Martensite
- c) Write few applications of ceramic and bronze materials.
9. a) Annealing is essential for a cold-worked material-justify.
- b) Discuss in brief of the following heat treatment processes:
(i) Sub-critical annealing
(ii) Normalizing
(iii) Hardening and tempering
10. Write short notes on the followings:
- a) Stainless steel
b) Surface hardening
c) Composite materials and their applications