MID-SEMESTER EXAMINATION : SEP 2015

INDIAN INSTITUTE OF TECHNOLOY KHARAGPUR

TIME: 2 HOURS, FULL MARKS: 100, No of Students: 186

Autumn Semester: September 2015, Dept: MECHANICAL ENGG, **Sub No: ME31007**

3rd Yr BTech (H), **Sub Name: Casting Forming Welding**

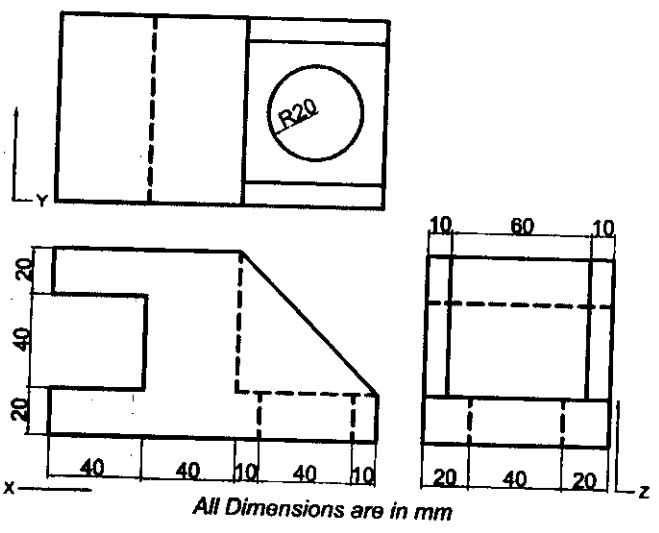
N.B: Assume any data which is required but not mentioned in the question

PART A: Casting [33 Marks]

C1 [10+5]

(a) The schematic of the bracket casting is shown in Fig. 1. Show the core and pattern for sand casting of this bracket with isometric view (draw a neat sketch without worrying about dimensions). Identify the parting line and draw direction in the same sketch.

(b) The tensile true stress-strain response of material close to the outer surface and the middle of casting was found to follow $\sigma = 300\varepsilon^{0.32}$ and $\sigma = 200\varepsilon^{0.11}$ respectively (stresses are in MPa). Which portion of the cast component will show more ductility (i.e. uniform elongation)? What will be the difference in the ultimate tensile strength (in terms of true stress) of the material present in the surface and middle of the casting?

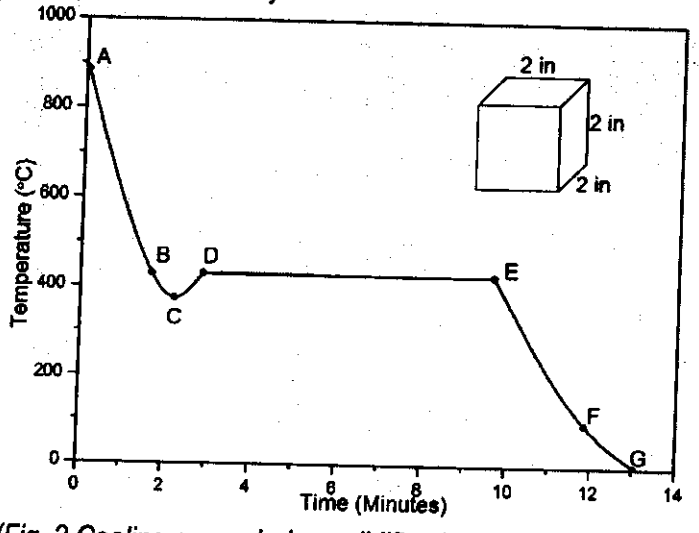


(Fig. 1 Schematic of the bracket casting)

C2 [10]

A cooling curve during sand casting of a binary alloy was obtained at the center of the cube (all sides of 2 inches) component as shown in Fig. 2. The corresponding data is also shown in Table. 1 Determine the followings:

(a)the pouring temperature, (b)the solidification temperature, (c)the superheat, (d)the cooling rate before solidification, (e)the local solidification time, (f)the total solidification time, (g)the undercooling, (h)the mold constant and (i)whether the alloy is an eutectic , hypoeutectic or hypereutectic alloy.



(Fig. 2 Cooling curve during solidification of a cube)

Table-1 Time-temperature data during solidification from Fig. 2

	Time (min)	Temp (°C)
A	0	884.70
B	1.67	430.77
C	2.22	375.54
D	2.87	430.56
E	9.67	429.34
F	11.85	95.62
G	13.05	32.67

C3	What do you mean by constitutional under-cooling (or supercooling) during the solidification of a binary alloy during casting? It may be noted that the constitutional under-cooling favours the formation of dendrite microstructure in casting, which may be detrimental in the context of mechanical properties of the component. Hence, mention all the favorable conditions in order to avoid constitutional under-cooling.	[8]

PART B: Forming [34 Marks]

F1	Draw a unit cell of HCP showing all atoms in it, and calculate its packing factor.	[2+2]
F2	Draw the true stress strain diagram for the following cases: *(i) Rigid and perfectly plastic, (ii) Elastic and perfectly plastic, (iii) Rigid and linearly work hardened, (iv) Elastic and linearly work hardened.*	[4]
F3	(a) Derive the location of the neutral point in a single pass rolling process having no front and back tensions. Graphically show how does the location of the neutral point changes when front tension is applied. (b) A 6 mm-thick aluminum alloy strip is rolled to a thickness of 3 mm, using steel rollers of radius 120 mm. The tensile yield stress of aluminum is 0.3 kN/mm^2. Determine (i) minimum coefficient of friction (μ_{min}) between the work-piece and the rolls for an unaided bite to be possible, (iii) the location of the neutral point with $\mu = \mu_{min}$. (Note- No front and back tensions are applied). (c) What are the defects generally observed in a rolled product?	[6+2] [3+3] [2]
F4	(a) Derive the expression for the drawing power, in terms of drawing ratio, when a material is drawn through a single stage conical die at a constant speed. (Note- No back tension is applied). (b) How does drawing power differ, from the above mentioned situation, if the coefficient of friction between die and the work-piece is negligible.	[6] [4]

PART C: Welding [33 Marks]

W1	Differentiate between the micro-structural features of the respective welded zones of *fusion welding* and *solid state welding* processes.	[8]
W2	Explain, with the help of neat sketches, the salient features and advantages of metal transfer in the "*pulsed current*" mode of an arc welding process.	[8]
W3	Differential rates of thermal expansion/contraction in welding leads to thermally induced stresses and possibly distortion. Explain with the help of Time-Temperature curves.	[9]
W4	In the context of an arc welding process, define the following terms and its influence on the weld quality. (a) Arc blow (b) Electromagnetic pinch effect (c) Explosive evaporation (d) Repelled transfer	[8]