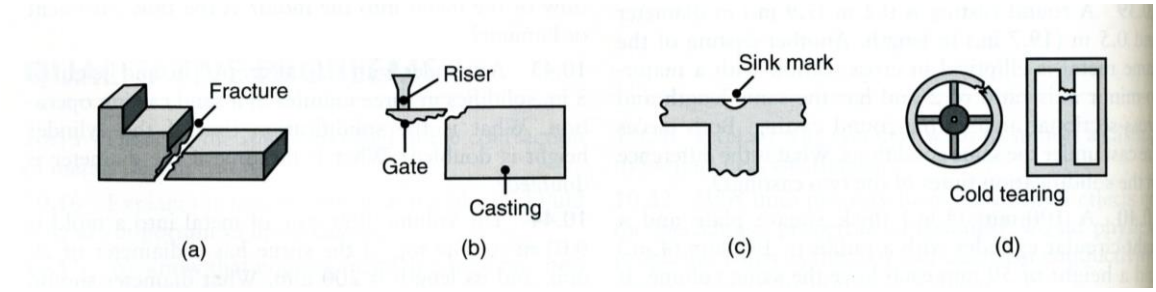
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Mechanical Engineering
2.810 Manufacturing Processes and Systems Fall 2013
Casting Homework

Problem 1

(a) The Figure below indicates various defects and discontinuities in cast products. Review each one and offer solutions to avoid them.



(b) Sketch a graph of specific volume versus temperature for a metal that shrinks as it cools from the liquid state to room temperature. On the graph, mark the area where shrinkage is compensated for by risers.

Problem 2. Sand Casting Shrinkage of 2.810 Chassis
Attached to this homework is a drawing of a chassis pattern (2.810CAR) designed and machined by Gerry Wentworth for an earlier class of 2.810. On the drawing you will find dimensions for the machine pattern and for the green sand cast chassis. Please compare these two cases for all of the dimensions (A) through (E) and the thickness measurements designated F-2 and F-5. Can you comment on how these values compare with typical shrinkage values for aluminum of 0.013 in/in. Please explain any deviations in terms of the design, and the physical phenomena which might be responsible for the deviation.

Problem 3. Cooling Time

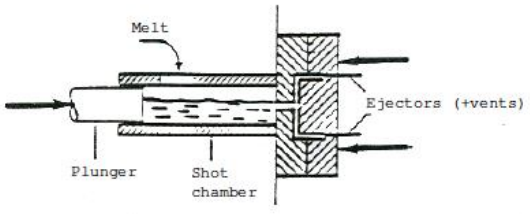


Figure 1: Zinc C-Section Die

(a) Consider the zinc die casting of a "C" section as shown in Figure 2. Calculate the cooling time for two different sets of dimensions

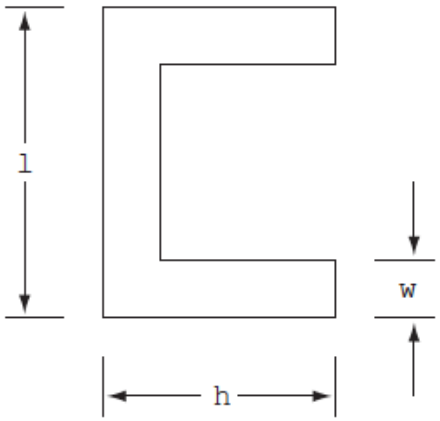


Figure 2: Cast C- Section

1. (1 + 2h = 100mm) x (100mm) x (w = 2.5mm)
2. (1 + 2h = 100mm) x (100mm) x (w = 8mm)

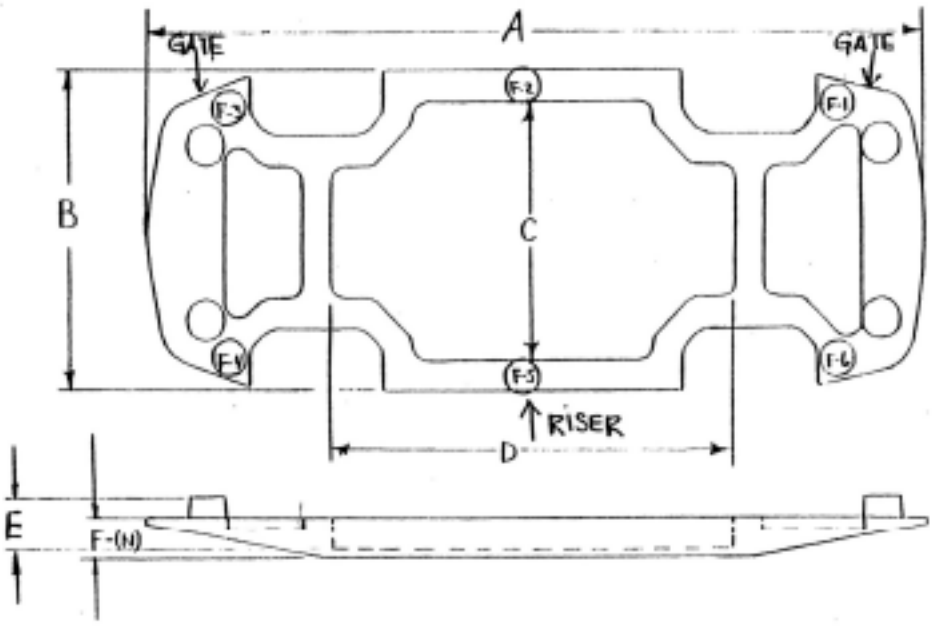
Use the following values:

H_f = 113kJ/kg (enthalpy of fusion)
C = 419J/kg K (heat capacity)
h = 1.58kW/m^2 K (film coef.)
α_t = 40.9mm^2/s (thermal diffusivity)
ρ = 6.6g/cm^3 (density)

T_{inject} = 410^oC
T_{eject} = 240^oC
T_{mold} = 60^oC

(b) Describe how you might go about calculating the cooling time required to cool a sand cast part to below its melt temperature. How would you formulate the problem? What physical quantities would you need to know? What problems might there be in doing this calculation accurately?

2.810 Car Chassis



Legend	Green Sand	No-Bake	Machine Pattern
A	9.935	9.930	10.070
B	3.8300	3.8265	3.8800
C	3.1070	3.0920	3.1320
D	5.1735	5.1600	5.2260
E	.742	.746	.757
F-1	.4940	.4980	.5070
F-2	.5052	.5002	.5075
F-3	.5030	.4980	.5050
F-4	.4940	.4995	.5063
F-5	.5080	.5020	.5100
F-6	.5000	.5020	.5100