

COLLEGE OF ENGINEERING, PUNE – 5
(An Autonomous Institute of Government of Maharashtra)
End Semester Examination (Spring- Re-examination)
MT 433 – Wire Technology

Programme: **B.Tech. (Metallurgical Engineering)**

Year: **2011-12**

Duration: **Three Hours**

Max. Marks: **100**

Date: **14 May 2012**

Instructions:

- 1) Answer *all* questions.
 - 2) Draw neat figures wherever required.
 - 3) Figures to the right indicate full marks.
 - 4) Assume suitable data if required.
 - 5) Use of non-programmable calculators is allowed.
- Q.1 (a) A wire with diameter 2.63 mm is drawn to a final diameter of 2.54 mm separately. Two dies with approach angles (α) having 0.22 rad and 0.08 rad were used. Calculate percent reduction (%R), contact length (L) in mm, the percent ratio of contact length to final wire diameter, Delta Factor (configurational factor Δ) in the two cases. Also find the respective contact areas. Comment on the effect of approach angle on the contact area.5
- (b) What is the significance of Delta factor and reduction in area in wire drawing? Show with help of suitable graph.5
- (c) "For drawing austenitic stainless steel wires, the dies with intersection of approach and bearing should be *sharp*; whereas for aluminium wire drawing there should be *extreme blending* so that one cannot see where the approach ends and bearing begins." Explain why.5
- Q.2 (a) What is effect of Cobalt, Tantalum and Titanium content on the Tungsten Carbide wire drawing dies?5
- (b) Explain with the help of neat sketches the effect small approach angle and shorter die length on the lubricant take up. What is your recommendation for effective lubricant take-up?5
- (c) State the functions of lubricants used in wire drawing. Which lubricants are used in wire drawing? What is the function of 'precoat'?5
- Q.3 (a) Calculate the temperature increase during the passage of a plain carbon steel wire through the die to give a final diameter 4.87 mm (D_f). The drawing force is 3900N and factor 'k' is 0.8. Given for the steel - density 7.85 g/cm³ and specific heat capacity 0.48 J^oC.g.5
- (b) In case of pearlitic steel, coarse lamellae structure has low ductility and strength; also it fractures at lower strain. Hence fine lamellae pearlite is desired for tire-cord production. State the formula to estimate 'Lamellar Spacing' (S_o) with meaning of each parameter. What measures can be taken to reduce the lamellar spacing?5
- (c) Draw a schematic figure of single block wire drawing machine for two dies. State its limitation and formula for deciding the reduction in this machine.6
- (d) State the Tresca's and von Mises' criteria in mathematical form.4

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End Semester Examination
(MT312)- (POLYMERS AND COMPOSITES)
Semester – II

Year: T. Y. B. Tech
Academic Year: 2011-2012
Duration: 2:00 pm – 5:00 pm

Branch: Metallurgy
Date: 14/05/12
Max. Marks 50

Instructions

- All questions are compulsory. Each carries 10 marks.
 - Mobile phones are strictly not allowed in Examination Halls. Any student found with the same will be debarred from the examinations.
 - Neat diagrams must be drawn wherever necessary
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Q1. State true or false and justify.

- Aluminium-SiC composites have higher coefficient of thermal expansion compared to unreinforced aluminium.
- Creep curves of continuous ceramic fiber reinforced metals are different than that of pure metals.
- The properties of a composite are always given by the rule of mixtures.
- SiC fibers are stiff.
- Longer fibers carry stress more efficiently.
- Boron fibers are produced on a tungsten core and rarely on a carbon core.
- Thermal stresses due to coefficient of expansion differences between the matrix and the reinforcement are important in ceramic matrix composites.
- Glassy polymeric materials such as PMMA are much tougher than inorganic glasses.
- Reinforcing a metal generally degrades both ductility and toughness.
- All the zirconia particles in a zirconia-toughened alumina always exist in the monoclinic crystal form at room temperature

Q.2

- Discuss the main features of the different bonding mechanisms.
- Calculate the tensile modulus of elasticity of a unidirectional carbon-fiber-reinforced – plastic composite material that contains 60 percent by volume of carbon fiber and is stressed under isostress conditions. The carbon fibers have a tensile modulus of elasticity of 54.0×10^6 psi and the epoxy matrix a tensile modulus of elasticity of 0.530×10^6 psi.
- Discuss the production of carbon fibers from PAN precursor.
- Describe the pultrusion process for the manufacture of fiber-reinforced plastics. What are some advantages of this process?
- Write a short note on porous carbon-carbon composites.

Q.3

- What are some advantages and disadvantages of the injection-molding process for molding thermoplastics?
- What are two of the most important matrix plastics for fiber-reinforced plastics? What are some advantages of each type?
- What is an aramid fiber? What are two types of commercially available aramid fibers? What type of chemical bonding takes place within and between the aramid fibers?

- d. What are plasticizers? Why are they used in some polymeric materials? How do plasticizers usually affect the strength and flexibility of polymeric materials? What types of plasticizers are commonly used for PVC?
- e. An ABS copolymer consists of 25wt% polyacrylonitrile, 30wt% polybutadiene and 45wt % polystyrene. Calculate the mole fraction of each component in this material

Q.4 Write short notes on following (any two)

- a. Zirconia-toughened alumina
- b. Hand lay-up and spray-up process
- c. Toughening mechanisms (any 3)

Q.5

- a. Describe in detail, what are the fiber and matrix factors which contribute to the mechanical performance of composites? Other than the fiber and the matrix, what other factors influence mechanical performance of a composite?
- b. What are metal matrix composites? What are the advantages and drawbacks of MMCs over PMCs? Are there any properties which degrade when metals are reinforced with fibers? Draw the schematic diagram of the production of multifilament superconducting composite by the bronze route

COLLEGE OF ENGINEERING, PUNE – 5
(An Autonomous Institute of Government of Maharashtra)

End Semester Examination

MT-315: Steel Making

Programme: **B.Tech. (Metallurgy & Materials Science)**
Duration: **180 Minutes**
Max. Marks: **100**
Weightage: **50%**

Year: **2011-12**
Date: **May 13, 2012**

Instructions:

1. *All questions are compulsory.*
2. *Draw neat figures wherever necessary with proper labeling.*
3. *Figures to the right indicate full marks.*
4. *See Page-3 & 4 for the Given Data. Assume suitable data if further required.*

Q.1: Draw the detailed *flow charts* showing the various routes of steel-making. (10)

Q.2: Write in brief about the historical developments in steel making technology till the year-1950. (04)

Q.3: Triplex steel making practice – Explain in detail. (12)

Q.4: Write a note on the following topics: (12)

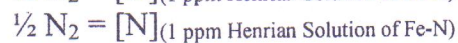
(a) Desulfurization in Steel Making Practice. (12)

(b) Open-hearth Steel Making Practice. (12)

Q.5: The quantity of dissolved nitrogen and hydrogen in steel-melt after secondary steel-making is generally very low (in ppm). Therefore, it is convenient to express the free energy of mixing of each element at 1 ppm standard state in liquid iron (i.e. 1 ppm Henrian solution) as a function of temperature: i.e. $\bar{G}_i^m = A + BT$, where A & B are constants and T is temperature.

Now,

(i) Determine the equation for \bar{G}_i^m in terms of temperature for the following reactions: (08)



(ii) Calculate the solubility of each gas, mentioned above, in liquid iron at 1600 °C at 10^{-3} atm pressure of the corresponding gas. (07)

Q.6: Consider a semi-killed steel with the following composition (in wt.%) produced after secondary steel making: C = 0.1%, Mn = 1%, Si = 0.1%, O = 0.0045%, N = 0.016% & H = 7 ppm. Such steel was subjected to ingot casting at 1 atm pressure. Consider the isothermal solidification of liquid steel at 1495 °C. Now, answer the following by using *appropriate calculations*: (08)

- (i) Will the SiO₂ inclusions form in the liquid steel after 1% solidification ? (08)
- (ii) Will the gas-bubbles form in the liquid steel after 30% solidification ? Here, *neglect* the ferrostatic pressure of liquid steel and the formation of inclusions in the melt during solidification. (12)

Q.7: In vacuum degassing process, MgO is being used as crucible/ladle lining and the temperature is about 1577 °C. Molten steel in the crucible contains very low carbon content and 0.001 wt.% oxygen before degassing begins. Due to the turbulent interaction between melt and crucible lining, some MgO particles entered in the steel-melt. The pressure of the degassing chamber is adjusted to 10⁻² atm in one occasion and 10⁻⁶ atm in another occasion. By using the *appropriate calculations*, comment about the stability of MgO particles/lining in contact with the melt. Will there any change in the oxygen content of the melt during any occasion ? If so, what is the modified oxygen content of the melt ? On the basis of your calculations, what is your major conclusion ? (15)

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Given Data:

Note: You may use the following information if you require.

Table-1

Standard free energy of formation ($J \cdot mol^{-1}$) of some compounds as a function of temperature (at the indicated temperature range)

$$\Delta G_f^\circ = A + BT$$

Reaction	Temperature, K	A, $J \cdot mol^{-1}$	B, $J \cdot mol^{-1} \cdot K^{-1}$
$2Al(l) + (3/2)O_2(g) = Al_2O_3(s)$	1500-2000	-1679876	321.79
$Ba(l) + (1/2)O_2(g) = BaO(s)$	1500-1910	-552288	92.47
$Ca(l) + (1/2)O_2(g) = CaO(s)$	1500-1765	-6395242	107.86
$Ca(g) + (1/2)O_2(g) = CaO(s)$	1765-2090	-786173	191.21
$C(gr) + (1/2)O_2(g) = CO(g)$	1500-2000	-111700	-87.65
$C(gr) + O_2(g) = CO_2(g)$	1500-2000	-394100	-0.84
$2Ce(l) + (3/2)O_2(g) = Ce_2O_3(s)$	1500-2000	-1826316	336.65
$Ce(l) + O_2(g) = CeO_2(s)$	1500-2000	-1029264	214.22
$2Cr(s) + (3/2)O_2(g) = Cr_2O_3(s)$	1500-2000	-1131981	256.69
$H_2(g) + (1/2)O_2(g) = H_2O(g)$	1500-2000	-251877	58.33
$Fe(l) + (1/2)O_2(g) = FeO(l)$	1809-2000	-238070	49.45
$Fe(s) + (1/2)O_2(g) = FeO(s)$	298-1642	-259600	62.55
$3Fe(s) + 2O_2(g) = Fe_3O_4(s)$	298-1642	-1102720	307.5
$2Fe(s) + (3/2)O_2(g) = Fe_2O_3(s)$	298-1800	-814512	250.7
$Mg(l) + (1/2)O_2(g) = MgO(s)$	1500-2000	-731154	205.40
$Mn(l) + (1/2)O_2(g) = MnO(s)$	1500-2000	-408149	88.78
$2P_2(g) + 5O_2(g) = P_4O_{10}(g)$	1500-2000	-3140929	964.83
$Si(l) + O_2(g) = SiO_2(l)$	1883-2000	-936379	192.90
$Si(l) + O_2(g) = SiO_2(\beta\text{-crst})$	1696-1986	-947676	198.74
$Ti(s) + O_2(g) = TiO_2(s)$	1500-1940	-935124	173.85
$Zr(s) + O_2(g) = ZrO_2(s)$	1500-2000	-1079472	177.82

Table-2

Free energy of mixing of some elements at 1 wt. % standard state in liquid iron (\bar{G}_i^m) as function of temperature ($\bar{G}_i^m = C + DT$)

Element, i	C, $J \cdot mol^{-1}$	D, $J \cdot mol^{-1} \cdot K^{-1}$
Al(l)	63180	27.91
B(s)	65270	21.55
C(graphite)	22590	42.26
Ca(g)	-39460	49.37
Co(l)	1000	-38.74
Cr(s)	19250	-46.86
Cu(l)	33470	-39.37
$(1/2)H_2(g)$	36480	30.46
Mn(l)	4080	-38.16
Mo(s)	27610	-52.38
$(1/2)N_2(g)$	3600	23.89
Nb(s)	23010	-52.30
Ni(l)	-20920	-31.05
$(1/2)O_2(g)$	-117150	-2.89
$(1/2)P_2(g)$	-122170	-19.25
Pb(l)	212550	-106.27
$(1/2)S_2(g)$	-135060	23.43
Si(l)	-131500	-17.24
Sn(l)	15980	-14.43
Ti(l)	-46020	-37.03
Ti(s)	31130	-44.98
V(s)	-20710	-45.61
W(s)	-31380	-63.60
Zr(l)	-51050	-42.38
Zr(s)	-34730	-50.00

Table-3

Interaction coefficients (e_i^j) of some common elements in liquid iron at or near 1600°C (1873 K)

$i \backslash j$	Al	B	C	Cr	Mn	Mo	N	Si
Al	0.043	-	0.091	-	-	-	-0.015	0.056
C	0.043	0.24	0.243	-0.023	-0.012	-0.008	0.11	0.08
Cr	-	-	-0.114	-0.0003	0.004	0.002	-0.182	-0.004
H	0.013	0.058	0.06	-0.0024	-0.002	0.003	-	0.027
Mn	-	-0.024	-0.054	0.004	0	0.005	-0.091	-0.033
Mo	-	-	-0.14	0	0.005	0.0121	0	0.048
N	0.1	0.094	0.130	-0.046	-0.020	-0.011	0	0.048
Ni	-	-	0.032	0	-0.008	-	0.015	0
O	-1.17	-0.31	-0.421	-0.055	-0.021	0.005	-0.14	-0.056
P	0.037	0.015	0.13	-0.018	-0.032	0.001	0.13	0.099
S	0.041	0.134	0.111	0.010	-0.026	0.003	0.01	0.075
Si	0.058	0.20	0.18	-0.0003	-0.015	2.36	0.052	0.103
Ti	-	-	-	-0.055	-0.043	-	-2.06	2.1
V	-	-	-0.14	0.012	0.006	-	-0.4	0.042

• If e_i^j is not given for any system, assume it as zero.

Table-4

Some values of Equilibrium segregation coefficients (K_e) for solidification of iron

Element	K_e	
	δ -iron	γ -iron
Al	0.92	-
C	0.13	0.36
Cr	0.95	0.85
H	0.32	0.45
Mn	0.84	0.95
Mo	0.80	(0.60)
Ni	0.80	0.95
N	0.28	0.54
O	(0.02)	(0.02)
P	0.13	0.06
Si	0.66	(0.5)
S	(0.02)	(0.02)
Ti	0.14	0.07
V	0.90	-

Other Data:

- Atomic weight of elements \Rightarrow H: 1, C: 12, N: 14, O: 16, Fe: 55.85, Ca: 40.08, Mg: 24.31, Al: 26.98, Si: 28.09
- Mg \Rightarrow Melting point: 650 °C & Boiling-point: 1107 °C
- R = 8.314 J. mol⁻¹. K⁻¹
- 1 J = 0.239 cal
- 1 ppm = 10⁻⁴ wt.%

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End Semester Examination

MT-314 Structural Metallurgy

Year: T.Y. B. Tech
Academic Year: 2012-13
Duration: 3 Hours.

Branch: Metallurgy
Date : 11th May 2012
Out of 50 Marks

Instructions to candidates:

1. Neat Diagrams must be drawn wherever necessary.
2. Figures to the right indicate full marks.

Put your MIS here, before you start.

All Questions are Compulsory

Question 1

18

- A.** In solidification of pure metals,
- i. What are the two energies involved in the transformation?
 - ii. Write the equation for the total free energy change involved in the transformation of liquid to produce a strain free solid nucleus by homogeneous nucleation.
 - iii. Illustrate graphically the energy changes associated with the formation of a nucleus during solidification. **4**
- B.** Explain heterogeneous nucleation and discuss the cases for which Δf_{het}^* can be derived as a function of Δf_{homo}^* . **4**
- C.** During solidification, how does the degree of under cooling affect the critical nucleus size? Assume homogeneous nucleation. **3**
- D.** Arrange the following carbides in order of their **effectiveness** as heterogeneous nucleating agents for crystallization of aluminium. The percentage misfit for the best matching crystal planes at the interface are given in brackets: **TiC(6%), ZrC(14.5%), VC(1.4%) and NbC(8.6%)**. Give reason for your sequence. **2**
- E.** Calculate the number of atoms in a critically sized nucleus for homogeneous nucleation of pure iron. **5**
- M.P = 1535°C, Heat of fusion (J/cm²) = 2098
Surface energy (J/cm²) = 204 x 10⁻⁷ undercooling = 295°C .
Lattice parameter of solid BCC iron is 2.92 Å

Question 2

15

- F. Explain the transformation of austenite to fine and coarse pearlite with the help of dN/dt , dU/dt and dX/dt curve? 5
- G. Describe the Bain's mechanism for converting FCC cell into BCT martensite cell in steels. Also explain the high hardness of martensite. 5
- H. Explain the effect of aging time and temperature on the hardness of duralumin. 5

Question 3

17

- I. Why diffusion rate in perfect crystal and a polycrystalline solid differ? 2
- J. Write the equation for Fick's first law of diffusion, and define each of the terms in SI units. 2
- K. Explain the term "Kirkendall Effect" and Kirkendall porosity. 4
- L. At 900°C, what is the time required to carburize a steel with an initial composition of 0.2% carbon to 1% carbon at a depth of 0.2 mm? Assume a constant surface concentration of 1.4% carbon due to the carburizing atmosphere. 4
- M. The strength of titanium is found to be 450 MPa when the grain size is 17×10^{-6} m and 570 MPa when the grain size is 0.8×10^{-6} m. Determine, 5
- i) the constants in the Hall-Petch equation and
 - ii) the strength of the titanium when the grain size is reduced to 0.2×10^{-6} m

COLLEGE OF ENGINEERING, PUNE-5
Department of Metallurgy and Material Science

End Semester Examination

(MT 311) - Foundry Technology

Programme: T.Y.B.Tech (Metallurgy)

Year: 2011-12

Duration: 3 Hrs.

Max. Marks: 50

Instruction to candidates:

1. Neat Diagrams must be drawn wherever necessary.
2. Assume suitable data, if necessary.
3. Use of only non-programmable calculator is allowed.

		Marks
Q. 1	With a neat sketch, explain the different sections in a foundry.	5
Q. 2	Explain in detail gooseneck type and submerge type pressure die casting technique.	5
Q. 3	What do you mean by Gating ratio? Describe in brief Top, Bottom and parting line gating system.	5
Q. 4	What is a role of metal flow rate, Reynolds number and velocity calculation at the time of designing a gating system?	5
Q. 5	What are the functions of the riser? How is riser efficiency improved?	5
Q. 6	State the factors that lead to the defects in a casting. For any 3 defects state causes and remedies of the same.	5

Q. 7

A cupola charge weighs 1850 Kg and is made up of the constituents of the following compositions.

10

----- %-----

Proportion constituents	C	Si	Mn	P	S
24% Pig iron No.1	3.1	2.0	0.87	0.17	0.025
32% Pig iron No.2	3.5	2.1	0.72	0.19	0.017
22% New scrap	2.8	1.9	0.59	0.11	0.033
Balance-Returns	3.2	2.1	0.63	0.15	0.018

Given data :

Respective loss and gain of elements during melting :

Si ----- 13 % loss

Mn -----11% loss

Sulphur pick -up ----- 5%.

Coke to Iron ratio -----1:12

Sulphur content in coke----- 0.55%

Ferro-silicon contains..... 60% Si

- (a) Calculate the final analysis for cupola melt.
- (b) Adjust the charge(in the returns only) and calculate the proportions of charge constituents required (in Kg) if the desired silicon content in the melt is 2.4%

Q. 8

Write short note on of the following:

10

- 1. Cast iron foundry practice.
- 2. Coring and segregation phenomena during solidification of castings.
- 3. Squeeze casting technique.
- 4. mold coatings
- 5. Compatibility and friability test of green sand molding

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COLLEGE OF ENGINEERING, PUNE
(An Autonomous Institute of Government of Maharashtra)
END-SEM EXAMINATION
(MT 313) - (MATERIALS CHARACTERIZATION)

Programme: T.Y. B. Tech. (Metallurgical Engineering)
Time Duration: 3 Hours

Year: 2011 – 2012
Max. Marks: 50

Instructions

1. Answer any five questions. Each question has equal marks.
3. Neat diagrams must be drawn wherever necessary
4. Sharing/exchange of calculators is not allowed.

		Marks
Q. 1	Why do you need electron microscope (EM) in Metallurgy? Explain schematically the interaction of the primary electron beam with the sample in EM. Write the important steps of any three sample preparation techniques for transmission electron microscopy (TEM) analysis. What are the applications and limitations of TEM?	10
Q. 2	Why do you need measurement of grain size of metals and alloys? Explain schematically three important techniques of grain size measurement. Also write assumptions of each technique.	10
Q. 3	An x-ray diffractometer recorder chart for an element which has either BCC or FCC crystal structure shows diffraction peaks at the following 2θ angles; 40, 58, 73, 86.8, 100.4, and 114.7° (wavelength of x-ray = 1.54 Å). Determine the crystal structure and the lattice constant of the element. Also identify the element, if the lattice constants of Fe, W, U and Au are 0.2866, 0.316, 0.2858 and 0.407 nm, respectively.	10
Q. 4	A Compare at least five features of the optical microscope and scanning electron microscope. B Explain the principle of electron energy loss spectrometry and its typical EELS spectra. C Write name and probe size of four electron sources used in electron microscope?	5 3 2
Q. 5	Answer any four from the following questions;	4×2½ marks = 10
	A A steel sample is 2 meter long at 30 °C. What will be the length of the sample if it is heated uniformly to 230 °C? [Given: $\alpha_{\text{steel}} = 12 \times 10^{-6} (\text{°C})^{-1}$].	
	B What length of an alloy wire of resistivity $5.0 \times 10^{-7} \Omega \cdot \text{m}$ and diameter 500 μm is required to make a standard 6.0 Ω resistor?	
	C Define and calculate the short wavelength limit for x-rays generated at 30 kV.	
	D What is the main difference between the x-ray radiography and x-ray diffraction?	
	E Optical microscope can gives colored photo-image while electron microscope does not. Why?	
Q. 6	Write short notes on any four from the following; ;	4×2½ marks= 10
	A Vacuum techniques and their importance	
	B Scanning Probe Microscope	
	C Line broadening in XRD pattern	
	D Bright field and dark filed images in TEM	
	E Comparison between wavelength dispersion spectrometry and energy dispersion spectrometry	