UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
Online End Semester Examination, December 2020

Course: A Primer on Stainless Steels   **Semester: VII**
Program: B. Tech Mechanical & Mechatronics   **Time 03 hrs**
Course Code: MECH4032   **Max. Marks: 100**

Instructions:

SECTION-A: Total 30 marks
Each question carries 5 marks

S. No.		CO
Q 1	**True or False:** a) Nickel addition makes ferritic stainless steels prone to chloride stress corrosion cracking. _____ b) Corrosion resistance of ferritic stainless steels in sulphuric acid increases with increasing chromium content. _____ c) The addition of noble metals to stainless steels increases their corrosion resistance in acids. _____ d) Corrosion resistance of carbon steels in reducing acids is greater than Type 430 stainless steel. _____ e) In aerated acids the cathodic reaction is hydrogen evolution reaction. _____ **Answer**: a) _____, b) _____, c) _____, d) _____, e) _____	CO2

Q 2	i) Which of the following test gives idea about toughness of a material?
	    a) Bend test b) Tension test c) Non-destructive test d) Impact test
	
	ii) Sigma formation tendency is increased by adding:
	    a) Sulphur b) Carbon c) Nitrogen d) Molybdenum
	
	Answer: i) _____, ii) _____
		CO5

Q 3	i) To qualify as Food Grade stainless steel, the min Cr content should be:
	    a) 20% b) 15% c) 16% d) 12.5%
	
	ii) What is the per capita consumption of Stainless Steel in India?
	    a) 5 kg b) 6 kg c) 1 kg d) 2 kg
	
	Answer: i) _____, ii) _____
		CO1

Q 4	i) For bus body fabrication, globally the SS grade used is:
	      a) EN 1.4003 b) SS 201LN c) SS 316L d) SS 2101
	
	ii) For high corrosive applications, which grade of SS is preferred?
	      a) Ferritic b) Duplex c) Martensitic d) Semi-austenitic
	
	Answer: i) _____ , ii) _____
		CO1

Q 5	i) Depth of mushy zone (solid + liquid) during solidification depends on:
	      a) Solidus T_S b) Liquidus T_L c) Superheat d) $T_L - T_S$
	
	ii) High segregation will result in the following problem during solidification:
	      a) Lower liquidus b) Thin solid shell c) Thick solid shell d) No effect
	
	Answer: i) _____ , ii) _____
		CO3

Q 6	i) Solid fraction f_S during casting increases from 0 to 1. ZDT corresponds to:
	      a) $f_S = 0$ b) $f_S = 0.7$ c) $f_S = 0.9$ d) $f_S = 1$
	
	ii) The following is the approximate brittle temperature zone during solidification:
	      a) $f_S = 0.9 - 1$ b) $f_S = 0.5 - 0.7$ c) $f_S = 0.3 – 0.5$ d) $f_S = 0 - 0.3$
	
	Answer: i) _____ , ii) _____
		CO3

	SECTION-B: Total 50 marks **Each question carries 10 marks**	
Q 7	a) Mention the common exogenous entrapments in steel. (3) b) Explain whether continuously cast slab of AISI 430, 304 and 310 grades will show tendency for sticking, bulging, or depression. (7)	CO3
Q 8	a) How do we calculate the Life Cycle Cost savings of a vehicle? (2) b) What are the cost components for calculating the Life Cycle costing of structures? (2) c) What are the 2 major stainless steel grades used in Architecture, Building and Construction segments? Give 3 reasons for the same. (3) d) What is the grade of stainless steel used for railways and material handling applications? Give 4 reasons for the same. (3)	CO1
Q 9	a) What is the difference between deep-drawing and stretch forming process? (3) b) What is LDR (Limiting draw ratio) and average plastic strain ratio (R-bar)? (5) c) What is the importance of these two parameters on deep draw ability? (2)	CO5

Q 10	a) What is sensitization in stainless steel, explain with schematic diagram. (5)	CO5
	b) What are the suggested precautionary steps to minimize intergranular corrosion. (5)	
Q 11	What are the advantages of using argon in AOD process for decarburization?	CO4

SECTION-C: Total 20 marks

Q 12	Liquid iron, 100 tons, at 1650 K, contains 4% dissolved carbon. Half of the carbon in metal is oxidized to 80 volume % CO and 20 volume % CO_2 by oxygen gas supplied at 298 K; no iron is oxidized. CO and CO_2 gases leave at constant temperature of 1550 K. **Calculate the final temperature of metal with remaining carbon dissolved in it**.	CO4

	Given the following (T is in Kelvin):
	• Enthalpy values:
	    Fe (kJ/kg of Fe): 0.72105*T - 3.86
	    C (kJ/kg of C): 1.996786*T - 1057.5
	    CO_2 (kJ/kg of CO_2): 1.2331*T - 449.49
	    CO (kJ/kg of CO): 1.5884*T - 652.08
	
	• Heat of reaction values:
	    At 25°C: Pure carbon(s) C → CO gas: 3980 kJ/kg of CO exothermic
	    At 25°C: Pure carbon(s) C → CO_2 gas: 8932 kJ/kg of CO_2 exothermic
	
	• Heat of solution of carbon (endothermic) = 2211 kJ/kg of C	