

**B.E. METALLURGICAL ENGINEERING  
THIRD YEAR, SECOND SEMESTER EXAM 2024**

**Subject: EXTRACTION OF NONFERROUS METALS**

**Time:** Three Hours

**Full marks:** 100

**Answer the following questions (Q1 and Q8 are compulsory, Q2 or Q3, Q4 or Q5, Q6 or Q7)**

1. (a) What is an Ellingham Diagram for formation of metal oxide? What is the basis of drawing this diagram? What do you understand from this diagram? **[CO1]** 4+2+4 = 10
- (b) What difference do we observe when the relevant data is plotted in the Ellingham diagram for the reactions and justify the difference: (i)  $C + O_2 = CO_2$ , and (ii)  $2C + O_2 = 2CO$ . **[CO1]** 5
- (c) Find the oxygen partial pressure in equilibrium with a metal and its oxide at any given temperature and make comment about this metal to metal oxide reaction. **[CO1]** 5
2. (a) What is the difference between roasting and calcination? What are different types of roasting? What is the purpose of roasting in case of hydrometallurgical processes? **[CO3]** 3+2+3 = 8
- (b) What is known as "predominance area diagram" so far as roasting of sulfide ore is concerned? Taking one example discuss the "predominance area diagram" and its importance. **[CO3]** 3+9 = 12
3. (a) State the advantages and disadvantages of hydrometallurgical process of metal extraction. **[CO4]** 5
- (b) Taking an example discuss the contact reduction of metals from aqueous solution and the kinetics of the process. **[CO4]** 7+8 = 15
4. (a) Give a general flow sheet showing various steps for hydrometallurgical extraction of metals. **[CO4]** 6
- (b) With an example discuss the thermodynamic principles for gaseous reduction of metal ions from aqueous solution including the effect of different variables present in such reduction process. **[CO4]** 7+7=14
5. (a) Discuss the steps that are followed for solvent extraction of metals. **[CO4]** 10
- (b) By giving all the necessary reactions discuss the procedure for extraction of uranium by solvent extraction process. **[CO4]** 10
6. (a) Discuss in detail various steps with justification for extraction of aluminium from its ore. **[CO6]** 14
- (b) Discuss the role of cryolite in the aluminium extraction process. **[CO6]** 6
7. Why is "matte smelting process" adopted for extraction of copper from its sulfide ore? Discuss the "matte smelting" process for extraction of copper from sulfide ores with necessary reactions that occur during "matte smelting" process. What is the composition of "copper matte?" **[CO6]** 5+12+3 = 20
8. Write Short Notes on the following **[CO6]**: 6+4+7+3 = 20
- (i) Pidgeon process; (ii) Carbonyl process; (iii) Kroll process; (iv) Parke's process