Ref: Ex/Met/PC/B/T/324/2025

B.E Metallurgical Engineering, Third Year Second Semester Examination 2025
Subject: Extraction of Non-Ferrous Metals

Time: Three Hours **Full marks:** 100

(Question No. 1 is Compulsory; Answer Q2 or Q3; Q4 or Q5; Q6 or Q7; Q8 or Q9)

Q1. (a) What is an Ellingham diagram? What is the basis of drawing an Ellingham diagram? What are the salient features of this diagram? What is its usefulness? Justify whether the Ellingham diagram can always be directly used for feasibility study of a chemical reaction. **[CO1]** 2+2+2+2+3 = 11

(b) Give an account for aluminothermic reduction process. **[CO1]** 5

(c) Justify wehether you would you recommend for carrying reduction of Al_2O_3 by carbon for extaction of Aluminium? **[CO1]** 4

Q2. (a) What is known as a roasting process? What are different kinds of roasting processes? What is a calcination process? How does calcination process differ from roasting process? **[CO3]** 2+2+2 = 6

(b) What is known as decomposition temperature of any carbonate? With an example justify the use of differential calcination process. **[CO3]** 2+2 = 4

(c) What is a 'predominance area diagram?' In what respect study of this diagram is useful? How this diagram is drawn? Discuss with an example. **[CO3]** 2+2+6 = 10

Q3. (a) What is known as "smelting" process? Give the very general reaction that occurs during smelting. **[CO3]** 3+2 = 5

(b) Give an account for 'reduction smelting" process using carbon. **[CO3]** 7

(c) What is "matte?" Give an account for "matte smelting" process. **[CO3]** 2+6 = 8

Q4. (a) List the steps involved in the leaching process of an ore where insoluble residue is formed. **[CO4]** 3

(b) How would you be able to determine the rate controlling step of the leaching process of (a)? Discuss. **[CO4]** 7

(c) Discuss the thermodynamic principles and the relevant factors involved in gaseous reduction of metals from aqueous solutions. **[CO4]** 10

Q5. (a) Discuss the general principles for extraction of metals following ion exchange process. By ion exchange process how will you separate acid and alkali from NaCl solution? **[CO4]** 4+6 = 10

(b) Explain with an example the role of an ion exchanger in separating nonelectrolytes from electrolytes. **[CO4]** 4

c) Discuss the selectivity property of an ion exchanger. **[CO4]** 6

Q6. (a) Name the ores for with its chemical formulae used for extraction of magnesium. Is it possible to recover magnesium by electrolysis of aqueous solution? Justify your answer. **[CO6]** 2+3 = 5

(b) Justify whether MgO can be reduced by silicon at 1000° C? Discuss the techniques used to promote MgO reduction by Silicon? **[CO6]** 3+6 = 9

(c) Discuss the reaction mechanisms involved in the suggested technique in 6(b). **[CO6]** 6

Q7. (a) What is known as 'Dead roasting'? By giving examples justify when we opt for dead roasting and when we do not go for dead roasting. **[CO3]** 2+4 = 6

(b) By giving necessary reactions describe all the stages for production of lead bullion. **[CO6]** 10

(c) Write a short note on "Fire Refining" of blister copper. **[CO6]** 4

Q8. (a) What is bauxite? Why the Bauxite ores of Kashmir are not used for extraction of metal value? **[CO6]** 2+2 = 4

(b) Discuss the physical chemistry involved in the electrolytic production of aluminium. **[CO6]** 6

(c) Using the following data, calculate the power efficiency of the electrolytic process. **[CO6]** 10

The voltage of the cell at an operating temperature of 950° C is 5.29 V. the activity of alumina is 0.1, and the anode gas contains 85 per cent CO_2. The relevant reactions are

$\frac{4}{3}Al + O_2 = \frac{2}{3}Al_2C_3$, ΔG^o at 950° C = - 203.3 kcal

$C + O_2 = CO_2$ ΔG^o at 950° C = - 94.45 kcal

Q9. (a) On thermodynamic consideration discuss the role of carbon on the chlorination process of TiO_2 at 1000° C by using the following data **[CO6]** 10

i) Free energy of formation of solid TiO_2 = -162 kcal per mole at 1000°C

ii) Free energy of formation of gaseous TiCl4 = - 132 kcal per mole at 1000°C

iii) Free energy of formation of CO = - 106 kcal per mole at 1000°C

(b) After giving the necessary reaction and the relevant flow sheet discuss the Kroll's process for production of Titanium sponge from its ore. **[CO6]** 10