NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR
METALLURGICAL & MATERIALS ENGINEERING DEPARTMENT

End Semester Examination B. Tech VI-Semester (Met & Mats Engg.), 2022

Sib: Engineering Materials, Code: MME 610

Time: 90 minutes Max. Marks: 30

Note: Answer All Questions

1	Give any two applications of HSLA steels	1	CO3
2	Distinguish between steel and cast iron.	1	CO1
3	State the purpose of alloying in steels	1	CO1
4	State the ferrite stabilizer in steels	1	CO1
5	Why heat treatment is required for as cast Hardfield manganese steel	1	CO3
6	Why mild steel shows good weldability?	2	CO3
7	What is the effect of Nickel and Chromium in Steels	2	CO2
8	Explain Mn addition causes anisotropy in properties of rolled steels	2	CO2
9	Why TRIP steels show a good combination of strength and ductility.	2	CO1
10	Duplex stainless steels are stronger than austenitic stainless steels	2	CO2
11	Differentiate between precipitation hardening and dispersion hardening	3	CO1
12	What is sensitization of austenitic stainless steel and how to prevent it.	3	CO1
13	State the important characteristics of austenitic stainless steel.	3	CO2
14	A steel containing overall 0.1% C, how it will produce martensite containing 0.5%C. Explain	3	CO1
15	Explain the effect of alloying elements on 18-4-1 High speed tool steels	3	CO1

National Institute of Technology, Durgapur
B.Tech, End Term, Even semester, 2021-22
Alternative Routes of IronMaking
MME-612

Full Marks: 30 **Time: 1.5 hours**

***Instructions**: Answers of a particular group and a particular question to be written sequentially. State all assumptions clearly. Figure in the margin indicates full marks*

Group A: Answer any six

1.	What are the reaction taking place in reduction shaft of Corex process?	3	CO2
2.	Discuss the classifications of smelting reduction processes?	3	CO2
3.	How HIsmelt process works?	3	CO2
4.	What are the advantages of HIsmelt process?	3	CO3
5.	Discuss the major factors affecting the performance of smelting reduction processes.	3	CO1
6.	What is HPR?	3	CO2
7.	Discuss about the chemical reactions taking place in a smelting reaction vessel.	3	CO2

Group B: Answer any six

8.	How carburizing of DRI occurs in Midrex process	2	CO1
9.	How reforming of natural gas is done in Midrex process?	2	CO3
10.	What is oxy+ technology?	2	CO1
11.	Why coke is necessary for corex process?	2	CO3
12.	What are the major factor affecting the degree of metallization in reduction shaft in corex process?	2	CO1
13.	What are the environmental benefits of Corex process?	2	CO2
14.	Discuss the hot metal quality produced in HIsmelt process.	2	CO2
15.	Discuss the application DRI.	2	CO2

Course Outcome

- CO1: Apply the thermodynamic knowledge to understand the fundamentals of direct reduction and smelting reduction of iron oxides
- CO2: Acquire the knowledge of reaction mechanism and the process technology of alternative routes of iron making
- CO3: Learn to analyze raw materials requirements for different processes

National Institute of Technology, Durgapur
B.Tech, End Term, Even semester, 2021-22
Production of Ferroalloys
MME-613

Full Marks: 30 **Time: 1.5 hours**

***Instructions**: Answers of a particular group and a particular question to be written sequentially. State all assumptions clearly. Figure in the margin indicates full marks*

Group A: Answer any six

1.	What are the reactions taking place in inner zone of SAF during FeSi Production	3	CO2
2.	How aluminium and calcium can be removed from ferrosilicon?	3	CO2
3.	What are the source of oxygen in liquid steel?	3	CO2
4.	Calculate the deoxidation constant at 1650°C. Given $Si + 2[O] = SiO_2$, $\Delta G^o = -142000 + 54.9T, Cal$	3	CO1
5.	Calculate dissolve oxygen content of liquid iron in equilibrium with pure FeO at 1650°C. Given FeO (l) = Fe(l) +$[O]_{\text{in metal}}$ $logK_{Fe} = -\frac{6150}{T} + 2.604$ and $logf_O = -0.17$	3	CO1
6.	How ferroalloy having low melting point compare to liquid steel temperature is dissolved into it.	3	CO2
7.	During ferroalloy addition, what are the precaution one should take?	3	CO2

Group B: Answer any six

8.	If deoxidation of liquid steel is not done before casting, what will happen?	2	CO2
9.	What are the basis of choosing a ferroalloy for deoxidation?	2	CO2
10.	To prepare 1ton of high silicon (3%Si) steel, how much ferrosilicon (65%Si) has to be added? Recovery of silicon is 80%.	2	CO1
11.	Why iron ore is rarely used for ferrosilicon production?	2	CO1
12.	Why ferrosilicon is normally cast into large flat slabs?	2	CO2
13.	What is the reaction mechanism of ferrosilicon production?	2	CO2
14.	How Calcium-Silicon production is affected by carbon in the burden?	2	CO2
15.	What are the use of Calcium-Silicon in liquid steel?	2	CO2

Course Outcome

- CO1: Apply thermodynamic knowledge to understand the fundamentals of Ferro alloys production and their use
- CO2: Acquire the knowledge of reaction mechanism and the process technology of production of different ferroalloys
- CO3: Learn to analyze the different design aspects of submerged arc furnace

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Even Semester End-term Examination, 2021-22

Course Code: MME615 Full Marks: 30

Course Name: Ceramic Technology Time: 90 Minutes

Question Paper No.: NITDGP/ MME615/1 Date of Exam: 22/04/2022

Instructions: Answer any three questions.
Materials to be supplied: Graph paper shall be supplied, if required.

Question No.	Body of the Question	Marks	Mapped CO
1	A piece of silicon carbide is loaded in three-point bend configuration. The dimensions are as follows: width= 0.8cm, specimen thickness= 0.6 cm, distance between supports= 10cm. the flexural strength of the silicon carbide sample is 896MPa. Calculate the force required to break the test block in newton.	3	
2	Compute the thermal shock resistance of borosilicate glass. borosilicate glass, $E= 70\ GPa$, $\alpha= 3.3 \times 10^{-6}/K$, $\sigma= 69\ MPa$, $\kappa= 1.4\ W/mK$	3	CO2
3	Show that the minimum cation to anion radius ratio for a coordinate number of 3 is 0.155.	3	CO1
4	A circular specimen of a ceramic is loaded using a three-point bending mode. Compute the minimum possible radius of the specimen without fracture, given that the applied load is 425 N, the flexural strength is 105 MPa, and the separation between load points is 50 mm.	3	CO3
5	The modulus of elasticity for silicon carbide (SiC) having 5 vol% porosity is 437 GPa. (i) Compute the modulus of elasticity for the nonporous material. (ii) Compute the modulus of elasticity for 10 vol% porosity.	3	CO3
6	The minimum cation-to-anion radius ratio for the coordination number 4 is (a) 0.155 (b) 0.225 (c) 1 (d) 0.414	1	CO1
7	The coordination number for both cations and anions in NaCl crystal structure is (a) 5 (b) 6 (c) 4 (d) 8	1	CO1
8	What is the crystal structure of Barium titanate ($BaTiO_3$)? a) Rock salt structure b) Zinc blende structure c) Spinel structure d) Perovskite structure	1	CO1

Course Outcomes
CO1: Describes generic classification of ceramics and their specific engineering applications. Emphasis is put on such engineering ceramics, which are traditionally and commercially important as well as new advanced ceramics.
CO2: Learn various techno-economic aspects of ceramics
CO3: : Learn structure-property relationships, and solve problems of fabrication of high performance ceramic parts

9	Why ceramic materials are, in general, harder yet more brittle than metals (a) Because ceramics have more slip systems, and, therefore, dislocation motion is easy. (b) Because ceramics have high melting temperature. (c) Because ceramics have low thermal conductivity. (d) Because ceramics have fewer slip systems, and, therefore, dislocation motion is highly restricted.	1	CO1
10	The stress–strain behavior of brittle ceramics is measure by a) transverse bending test b) tensile test c) impact test d) Knoop hardness measurement	1	CO2
11	What is ceramic? Give some examples of different ceramics.	2	CO1
12	Draw and describe CsCl crystal structure.	2	CO1
13	For a ceramic compound, what are the two characteristics of the component ions that determine the crystal structure?	2	CO1
14	The flexural strength and associated volume fraction porosity for two specimens of the same ceramic material are as follows: σ_f= 100 MPa at P= 0.05 and σ_f= 50 MPa at P= 0.2 Compute the flexural strength for a completely nonporous specimen of this material.	2	CO2
15	On the basis of ionic radii and ionic charge, predict crystal structures for the following materials: (a) CsI, r_{Cs^+}= 0.170 nm, r_{I^-} =0.220 nm	2	CO1

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Even Semester End-term Examination, 2021-22

Course Code: MME 616
Course Name: Solidification Phenomena
Question Paper No.: NITDGP/MME616/

Full Marks: 30
Time: 90 Minutes
Date of Exam: 22/04/2022

Instructions: Answer all the questions.

Question No.	Body of the Question	Marks	Mapped CO
1	Compare Rheo and Thixo routes.	3	CO1
2	Explain endogenous inoculation with respect to ingot casting.	4	CO3
3	What are the conditions for the formation of dendritic structure?	4	CO2
4	Explain SEED technique.	4	CO1
5	What are the theories of Liquid Structure?	3	CO1
6	How is critical radius calculated in case of homogeneous nucleation? What is the effect of temperature in the critical radius determination?	3	CO3
7	What are the three mechanisms of the growth of interface? Explain briefly each of them.	3	CO1
8	What are the two approaches of control of grain structure in castings? Give examples of grain refiner with respect to particular alloys.	3	CO2
9	With a neat sketch explain the microstructure of a pipe of 20 mm diameter manufactured by green sand molding and gravity pouring of liquid metal.	3	CO3

Course Outcomes
CO1: Understand solidification theories to industrial processes
CO2: Predict microstructures as a function of process parameters.
CO3: Understand solidification of alloys in different industrial conditions

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Even (6th) Semester End-term Examination, 2021-22

Course Code: MME 617 **Full Marks: 30**

Course Name: Metal Joining Processes (Depth Elective 2) Time: 90 minutes

Question paper No. NITDGP/MME 617 **Date of Exam: 22/04/2022**

Instruction: Answer all the Questions.

Question No.		Marks	Mapped CO
1.	TIG welding is best suited for welding (i) Stainless steel (ii) Carbon steel (iii) Silver (iv) Aluminium	1	CO1
2.	Which of the processes are fusion welding? (i) Arc welding, (ii) Friction welding, (iii) Ultrasonic welding, (iv) Laser beam welding	1	CO1
3.	With an increase in the heat input of arc welding method, how does it affect the welding speed? Why? (i) Increases (ii) Decreases (iii) Remains same (iv) No relation	1	CO2
4.	What is microfissuring?	1	CO3
5.	In an arc welding process, the voltage and current are 25V and 300A respectively. The arc heat transfer efficiency is 0.85 and welding speed is 8 mm/sec. Calculate the net heat input.	2	CO2
6.	What do you mean by Knife-line attack?	2	CO3
7.	What do you mean reflectivity?	2	CO2
8.	It has been suggested that compared to SMAW, the cooling rate is higher in GMAW and it is, therefore, more likely for	2	CO1

	heat-affected zone cracking to occur in hardenable steels. What is the main reason for the cooling rate to be higher in GMAW than SMAW?		
9.	Consider the welding of 25.4-mm-thick steel plates. Do you prefer to apply Rosenthal's two- or three-dimensional heat flow equation for full-penetration electron beam welds? What about bead-on plate gas–tungsten arc welds?	2	CO2
10.	With the help of Fe-Fe_3C phase diagram, explain the microstructural changes occur in HAZ for arc welding of age hardenable alloy.	4	CO2
11.	What is the principle of Resistance SEAM Welding process?	3	CO1
12.	What is the difference between Solidification cracking and liquation cracking?	2	CO1
13.	Classify the various defects formed in welding. Explain with neat sketches the following defects in welding and suggest remedial measures: (i) Lack of penetration (ii) Spatter (iii) Under-cut (iv) Inclusion	5	CO3
14.	Explain hardness profile in heat affected zone.	2	CO3

Course Outcomes:

CO1: Indicate which types of joining processes are suited for production.
CO2: Determine various gas, arc, solid state, thermo chemical welding processes with their process parameters.
CO3: Identify the various Weld Joints & Metallurgy