

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR**Even Semester End-term Examination, 2021-22****Course Code:** MMC 401

Full Marks: 30

Course Name: Transport Phenomena in Metallurgical Process

Time: 90 Minutes

Question Paper No.: NITDGP/ MMC 401/ 76

Date of Exam: 25/04/2022

Instructions: Answer all the questions. Write down all assumptions clearly. For questions 1 to 10, write the correct answer/answers. No need to copy the question.

Question No.	Body of the Question	Marks	Mapped CO
1	Diffusion coefficient is (a) increases with decreasing temperature (b) increases with increasing temperature (c) initially increases with decreasing temperature then decreases (d) initially increases with increasing temperature then decreases	1	CO2
2	The heat diffusivity is (a) a measure of the ability of the mold to release heat. (b) a measure of the ability of the liquid metal to release heat. (c) a measure of the ability of the liquid metal to absorb heat. (d) a measure of the ability of the mold to absorb heat.	1	CO2
3	The dimension of mass transfer coefficient in term of mass (M), length (L), time (t) and temperature (T) (a) $ML^2t^{-3}T^{-1}$ (b) $MLt^{-3}T^{-1}$ (c) Lt^{-1} (d) L^2t^{-1}	1	CO2
4	Carburized case Depth is (a) Dt (b) D^2t (c) $D^{1/2}t$ (d) $D^{1/2}t^{1/2}$ where D is diffusivity or diffusion coefficient and t is the time.	1	CO2
5	The assumption for the surface renewal model (or penetration theory) is (a) a short contact time between the surface and the fluid element. (b) a long contact time between the surface and the fluid element. (c) no contact between the surface and the fluid element. (d) none of the above.	1	CO2
6	For a converging - diverging nozzle, the velocity at any point is less than $M=1$ in the converging section then the velocity of the jet : (a) increases (b) no change (c) increases if viscosity of the gas does not change (d) decreases	1	CO1
7	Viscosity depends upon shearing stress for: (a) Dilatant Fluids (b) Bingham Plastics (c) Thixotropic Fluids (d) Newtonian Fluids	1	CO1
8	Viscosity decreases with an increase in shear stress: (a) Pseudoplastics (b) Bingham Plastics (c) Thixotropic Fluids (d) Newtonian Fluids	1	CO1
9	For a packed Bed which of the statement is correct? (a) Void fraction is not related to bulk density (b) Superficial velocity is related to actual velocity by void fraction	1	CO1

Course Outcomes

CO1: Understand the fundamentals of fluid flow and momentum transfer.

CO2: Understand different modes of heat transfer and mass transfer.

CO3: Ability to solve metallurgical industry oriented problems involving heat, mass, and momentum transfer.

	(c) Equivalent diameter of a particle is related to diameter of the particle by hydraulic radius (d) shape factor is considered for regular shape particle		
10	Which of the relationship for flow meter is correct ? (a) Venturimeter can be used for measuring pressure (b) Vena contracta is present in Rotameter (c) The coefficient of discharge is always greater than 1 (d) the flow meters can be used for non -Newtonian fluids.	1	CO1
11	Define Hydraulic Radius with respect to Packed Bed .Deduce the relationship with Void Fraction.	2	CO1
12	Consider the casting of slabs thickness 0.1m of aluminium at their melting temperature in sand molds at 25°C. For sand $C_p = 800 \text{ J/kg.K}$, $\rho = 1500 \text{ kg/m}^3$, $k = 0.3 \text{ W/m.K}$ and $\alpha = 2.5 \times 10^{-7} \text{ m}^2/\text{s}$. For aluminium $T_M = 660^\circ\text{C}$, $\Delta H_S = 400.1 \text{ kJ/kg}$ at 660°C and $\rho = 2390 \text{ kg/m}^3$ at 660°C . Calculate the complete solidification time.	2	CO3
13	With the help of Bernoulli's theorem and equation of continuity show the relationship between change in velocity with change in the area and Mach Number.	2	CO1
14	A steel tank contains hydrogen at a constant pressure of 10 atm with a vacuum outside. The hydrogen concentration at the inner surface of the tank is equal to 10 kgm^{-3} . The diffusion coefficient of the hydrogen in steel at room temperature is $10^{-9} \text{ m}^2/\text{s}$. Calculate the rate at which the hydrogen escapes through the wall of the tank which has a thickness of 5 mm.	2	CO2
15	What are the factors affecting the rate of solidification? What is the Chvorinov's rule?	2	CO2
16	Derive the relationship for the derivation of viscosity of a fluid when a spherical ball of radius R and density ρ_s is in a streamline motion inside a fluid of density ρ_l . The terminal velocity of a solid sphere is found to be 2.2 cm/sec. Calculate the viscosity of the fluid with the help of the following data: Density of the solid - 7800 kg/m^3 Density of the liquid - 2450 kg/m^3 Diameter of the sphere - $1.5 \times 10^{-3} \text{ m}$	5	CO1
17	Hydrogen gas diffuses at the rate of $22 \text{ cm}^3\text{s}^{-1}$ (volume specified at NTP) from a pressure at 16 atm through an iron foil of thickness 0.01 cm and cross-sectional area 25 cm^2 to a pressure of 1 atm. Calculate the permeability of the foil for the gas and also its diffusion coefficient in iron when Sievert's law constant is $8.9 \times 10^{-4} \text{ atm}^{-1/2}$. The density of iron may be taken as 7.8 g cm^{-3} .	5	CO3

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR**Even Semester End-term Examination, 2021-22****Course Code:** MMC 402

Full Marks: 30

Course Name: Phase Transformation and Phase Equilibria

Time: 90 Minutes

Question Paper No.: NITDGP/MMC 402/01

Date of Exam: 26/04/2022

Instructions: Answer all the questions.

Materials to be supplied: Graph paper shall be supplied, if required.

Question No.	Body of the Question	Marks	Mapped CO
1	How do you apply Grube solution to analyze 'Carburization' of steel?	3	CO2
2	How does the concepts of interdiffusion coefficient and intrinsic diffusion coefficients arise?	3	CO2
3	How does the basic mechanism of pearlitic transformation invoke the fundamental categorization of reconstructive transformation involving 'diffusion' coupled with 'interfacial reaction'?	3	CO2
4	"The typical mechanism of bainitic transformation refers to partly diffusional and partly athermal (diffusionless) under the displacive category"-justify.	3	CO2
5	"The complete mechanism of martensitic transformation goes beyond the conceptualization of the 'distortion' model by Bain" – explain.	3	CO2
6	Draw a binary phase diagram containing one eutectic point. Thereafter, draw free energy vs composition diagrams at eutectic temperature.	3+3	CO1
7	Draw free energy change vs embryo/nucleus radius for homogenous and heterogeneous nucleation. Why embryo with radius less than critical radius can not grow and with radius higher than critical radius grows? Discuss with the help of the schematic diagram.	3+3	CO1
8	To initiate homogeneous nucleation higher undercooling is required than heterogeneous nucleation. Why? Effect of ΔT is more on r^* or on ΔG^* ?	2+1	CO1

Course Outcomes

CO1: To correlate atomic structure,periodictable,elementalproperties, chemical bonding and material properties.

CO2: To interpretcrystal structure in view oftranslationalperiodicityandsymmetry and as well as to introspect different kinds of defects in a crystal.

CO3: To study the binary phase diagrams anda brief introduction to different engineering materials.

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR**Even Semester End-term Examination, 2021-22****Course Code:** MMC 403

Full Marks: 30

Course Name: Materials Characterization

Time: 90 Minutes

Question Paper No.: NITDGP/MMC 403/01

Date of Exam: 27/04/2022

Instructions: Answer all the questions.

Materials to be supplied: Graph paper shall be supplied, if required.

Question No.	Body of the Question	Marks	Mapped CO
1	It is impossible to generate $K\alpha$ without accompanying $L\alpha$ - Justify	2	CO1
2	What is an auger electron ?	1	CO3
3	Wavelength of $K\beta$ is shorter than $K\alpha$ but having lower intensity than $K\alpha$ -Justify.	3	CO1
4	Characteristic radiation gives information about the electronic structure of the target material but continuous radiation does not – Justify.	2	CO1
5	The wavelength λ_K of the K absorption edge must be shorter than that of any K characteristic line of the absorber-Justify	2	CO1
6	Precise lattice parameter measurements are generally done with back reflected beams (2θ near 180°)-justify	2	CO2
7	The powder pattern of an element is made with $CuK\alpha$, ($\lambda = 1.54178$ angstrom) radiation contains 06 lines whose $\sin^2\theta$ values are 0.1118, 0.1487, 0.294, 0.403, 0.439, 0.583. Index these lines and determined the crystal system to which the element belongs. Also calculate the lattice parameter.	3	CO2
8	State three different positions of different apertures (Objective aperture and intermediate aperture) to form bright and dark field image and SAD pattern. In these three different modes mention the types (transmitted/diffracted) of electron beam used for.	3+3	CO1
9	Draw representative schematic diagrams to show SAD pattern of coarse grain austenitic steel, nanocrystalline austenitic steel and a steel with glassy structure.	3	CO2
10	Why does camera constant of one transmission electron microscope may vary from another transmission electron microscope?	2	CO1
11	Schematically compare the resolution of EDS and WDS. Narrow or wide, which aperture is suitable for bulk composition analysis?	3+1	CO3

Course Outcomes

CO1: Learn fundamentals of X-ray diffraction, electron microscopy and other characterization techniques.

CO2: Identify the crystal structure and index the diffraction patterns of different phases to meet contemporary needs (including tutorials).

CO3: Learn different applications and developments in characterization techniques.

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Even Semester End-term Examination, 2021-22

Course Code: MMC 601

Course Name: Steel Making

Question Paper No.: NITDGP/MMC 601/

Full Marks: 30

Time: 90 Minutes

Date of Exam: 18/04/2022

Instructions: Answer all the questions.

Question No.	Body of the Question	Marks	Mapped CO
1	What is SIP process and what is the reason behind its use?	4	CO2
2	Explain lance profile for the production of 0.06% C steel?	4	CO2
3	Explain the oxygen jet and surroundings interaction in the following condition – a) Density of jet is high than density of surroundings. b) Density of surrounding is high than density of jet.	2.5 2.5	CO1
4	Explain the importance of bottom blowing.	2	CO2
5	Explain Rhomboidity and Oscillation Marks with respect to Continuous casting. How can they be avoided?	3	CO3
6	How does heat transfer take place in ingot steel making?	3	CO1
7	How does inclusions found in steel making ingots?	3	CO2
8	What is the Principle of Continuous Casting and its applicability with the running of C- Type machine?	3	CO3
9	How is Vacuum generated in Secondary Steel Making reactors? Give examples of 3 Secondary Steel Making reactors. (Abbreviations not allowed)	3	CO2

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR**Even Semester End-term Examination, 2021-22****Course Code:** MMC602

Full Marks: 30

Course Name: Mechanical Working of Materials

Time: 90 Minutes

Question Paper No.: NITDGP/MMC602/1

Date of Exam: 19/04/2022

Instructions: Answer all the questions.

Materials to be supplied: Graph paper shall be supplied, if required.

Question No.	Body of the Question	Marks	Mapped CO
1	With the help of relevant equations of Bland and Ford theory of cold rolling, explain the effects of back and front tensions on the friction hill.	3	CO1
2	Derive the equation for maximum allowable back tension in cold rolling.	4	CO1
3	With the help of Ekelund's equation and Hitchcock's formula, explain how you can estimate the cold rolling load considering roll flattening into account.	2	CO1
4	List out the variables controlling rolling process and rolling load.	1	CO3
5	From among the following mills, which one can be used for producing foils? a) 2-high reversing mill b) 3-high mill c) Sendzimir planetary mill d) Z-mill	1	CO2
6	Threads can be produced by: a) Longitudinal rolling b) Cross rolling c) None of the above d) Either by longitudinal rolling or by cross rolling	1	CO2
7	In the situation of skidding, the no slip angle is: a) Equal to angle of contact b) Equal to 0° c) Equal to 90° d) Greater than 0° but less than the angle of contact	1	CO3
8	Crowned rolls are used to eliminate: a) Roll flattening effect b) Roll bending effect c) Alligatoring of rolled products d) Scales from the surface of the rolled products	1	CO2
9	In cogging mill, rolls with ragged surface are used to: a) Decrease the rolling load b) Increase the angle of bite c) Decrease the angle of bite d) Decrease the no-slip angle	1	CO3

Course Outcomes

CO1: To understand the mechanics of metal forming processes

CO2: To know about tools and techniques of different metal forming processes

CO3: To understand the parameters which are needed to be controlled for increasing quality and productivity of different metal forming operations

10	Which of the following operations are closely related to open-die forging: (a) Cogging, (b) flashless forging, (c) Impression-die forging, (d) Mannesmann process	1	CO2
11	Which of the following are classified as forging operation: (a) Impact extrusion, (b) Roll piercing, (c) Swaging, (d) Thread rolling	1	CO2
12	Which of the following is bulk deformation process: (a) Bending, (b) Deep drawing, (c) Forging, and (d) Shearing?	1	CO2
13	Hot forging of metals refers to which one of the following temperature regions relative to the melting point of the given metal on an absolute temperature scale: (a) Room temperature, (b) $0.2T_m$, (c) $0.4T_m$, or (d) $0.6T_m$?	1	CO3
14	The sides of the upset cylinder becomes barreled because (a) Temperature distribution is nonuniform (b) Metal will flow most easily toward the nearest free surface that has lowest frictional path (c) Deformation load is nonuniform (d) None of the above	1	CO3
15	What is the function of flash?	2	CO2
16	What is fullering?	2	CO2
17	Describe some advantages of close die forging operations.	2	CO2
18	Describe some forging defects.	2	CO2
19	Describe some forging equipment.	2	CO2