GATE -2011 MT

ai25btech11009   Dasu Harshith Kumar

Q.1 – Q.25: One mark each

1. Which one of the following methods is NOT used for numerically solving an ordinary differential equation (ODE)(GATE 2011 MT):

   (a) Euler's method

   (b) Runge-Kutta method

   (c) Adam-Bashforth method

   (d) Newton-Raphson method

2. If two systems P and Q are in thermal equilibrium with a third system M, then P and Q will also be in thermal equilibrium with each other. This is following(GATE 2011 MT):

   (a) First law of Thermodynamics

   (b) Second law of Thermodynamics

   (c) Third law of Thermodynamics

   (d) Zeroeth law of Thermodynamics

3. Humidification of the blast in the iron blast furnace leads to(GATE 2011 MT):

   (a) lowering of the raceway temperature

   (b) increase in raceway temperature

   (c) difficulty in pulverized coal injection (PCI)

   (d) decrease of the oxygen content in the hot metal

4. Which one of the following refractory materials is NOT used in the BOF (LD) working lining(GATE 2011 MT)?

   (a) Tar-bonded dolomite

   (b) Pitch-bonded magnesite

   (c) Fired and pitch-impregnated magnesite

   (d) Graphite-alumina composite

5. In the eutectoid steel, which one of the following structures DOES NOT form during continuous cooling(GATE 2011 MT)?

   (a) Fully pearlitic

   (b) Pearlitic + bainitic

(c) Fully bainitic

(d) Martensitic

6. Which one of the following is a ferrite stabilizer in steels(GATE 2011 MT)?

   (a) Ni

   (b) Cu

   (c) Cr

   (d) Mn

7. The angle between the line vector and the Burgers vector of an edge dislocation is(GATE 2011 MT):

   (a) 0 degree

   (b) 90 degrees

   (c) 120 degrees

   (d) 180 degrees

8. In fracture toughness characterized by K_{IC} or J_{IC}, I in the subscript indicates loading by(GATE 2011 MT):

   (a) crack opening mode

   (b) forward shear mode

   (c) parallel shear mode

   (d) perpendicular shear mode

9. In a brazing process the liquid metal fills the gap by which one of the following means(GATE 2011 MT)?

   (a) Capillary infiltration

   (b) Gravity infiltration

   (c) Pressure infiltration

   (d) Vacuum infiltration

10. Which one of the following expands upon solidification(GATE 2011 MT)?

   (a) Low carbon steel

   (b) High carbon steel

   (c) White cast iron

   (d) Gray cast iron

11. For a simple cubic unit cell with unit vectors i, j, and k, the angle between lattice vectors [100] and in degrees is(GATE 2011 MT):

(a) 35.2

(b) 54.7

(c) 60

(d) 90

12. The inflection point of a nonlinear function $U(r)$ is at(GATE 2011 MT):

    (a) $U = 0$

    (b) $\ln U = 0$

    (c) $\frac{dU}{dr} = 0$

    (d) $\frac{d^2U}{dr^2} = 0$

13. One mole of element P is mixed with one mole of element Q. The entropy of mixing at 0 K is(GATE 2011 MT):

    (a) 0

    (b) $-R \ln 0.5$

    (c) infinity

    (d) $-R \ln 2$

14. Zinc rod is immersed in dilute HCl (pure). If a very small amount of $FeCl_3$ is added to the solution, the corrosion rate of zinc(GATE 2011 MT):

    (a) decreases

    (b) increases

    (c) remains constant

    (d) is zero (passivation)

15. A metal is electrochemically polarized to a potential which is higher than the standard reduction potential of the metal. The overvoltage will be(GATE 2011 MT):

    (a) zero

    (b) negative

    (c) positive

    (d) initially negative, then positive

16. Aluminum is NOT commercially produced by carbo-thermic reduction primarily because(GATE 2011 MT):

    (a) aluminum metal will have excessive dissolved oxygen

    (b) it melts at too low a temperature

    (c) it does not vaporize at reasonable temperatures

(d) Al-Al$_2$O$_3$ line is too low in the Ellingham diagram and needs excessively high temperatures

17. VOD process is preferred over AOD process for making extra-low carbon stainless steels because(GATE 2011 MT):

(a) p_{CO} can be lowered to a much lower level in the VOD than in the AOD

(b) AOD does not have adequate stirring

(c) free-board needed for such operation is not available in the AOD

(d) AOD refractory is not stable in contact with extra low carbon steel

18. In froth flotation, collector refers to a reagent which primarily(GATE 2011 MT):

(a) promotes bubble break-up and stabilizes the foam

(b) adsorbs on the surface of the mineral, and makes it hydrophobic

(c) promotes separation of the particles from the froth

(d) absorbs on the unwanted mineral and makes it sink

19. With the increase in the degree of supercooling, the growth rate of a nucleus follows which one of the following trends(GATE 2011 MT)?

(a) First increases and then decreases

(b) First decreases and then increases

(c) Only increases

(d) Only decreases

20. For a fcc unit cell, the ratio of the number of tetrahedral voids to the number of atoms is(GATE 2011 MT):

(a) 2:1

(b) 3:1

(c) 4:1

(d) 5:1

21. The material in which there is conduction primarily by holes is(GATE 2011 MT):

(a) conductor

(b) insulator

(c) p-type semiconductor

(d) n-type semiconductor

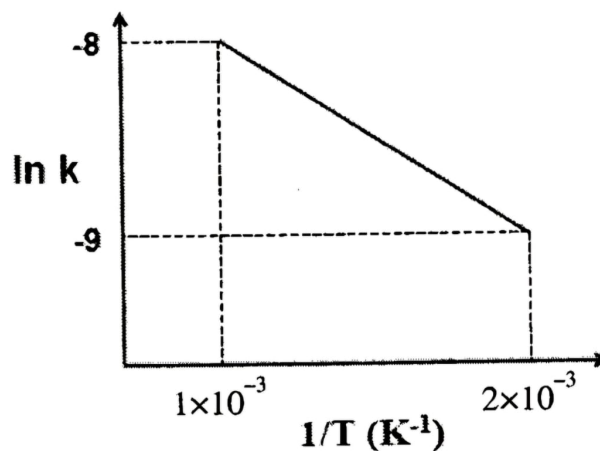22. When load is applied to a material, 'instantaneous' strain develops with(GATE 2011 MT):

(a) the speed of light

(b) half the speed of light

(c) the speed of sound

(d) infinite speed

23. For a given ductile material, which one of the following tensile properties obtained with non-standard specimen is NOT comparable to that obtained with standard specimen(GATE 2011 MT)?

(a) Elongation to fracture

(b) Tensile strength

(c) Uniform elongation

(d) Yield strength

24. The nature of submerged arc welding flux with basicity index of 0.5 is(GATE 2011 MT):

(a) neutral

(b) basic

(c) semi-basic

(d) acidic

25. Which one of the following carbon equivalent in steel is considered good for weldability(GATE 2011 MT)?

(a) 1.0

(b) 0.8

(c) 0.6

(d) 0.4

26. A box contains 5 white balls and 3 red balls. Two balls are withdrawn from the box randomly, one after another (without replacement). The probability that the two balls withdrawn are of different color is(GATE 2011 MT)

(a) $\frac{15}{64}$

(b) $\frac{25}{64}$

(c) $\frac{25}{56}$

(d) $\frac{30}{56}$

27. For a reaction $A \rightarrow B$, if the rate of change in concentration of A (C_A), can be written as
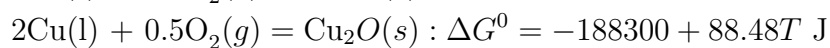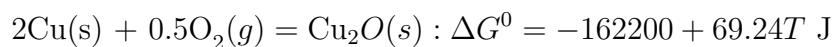
$$\frac{dC_A}{dt} = kC_A^2$$

then the change in concentration with time from initial concentration of A, C_{A0}, is given by(GATE 2011 MT)

(a) $\left(\frac{1}{C_A} - \frac{1}{C_{A0}}\right) = kt$

(b) $(C_{A0} - C_A) = kt$

(c) $(C_{A0} - C_A^2) = kt$

(d) $\ln\left(\frac{C_{A0}}{C_A}\right) = kt$

28. $Y = k_1 - \exp\left(\frac{k_2 AX}{k_3 X}\right)$, where k_1, k_2, k_3 are constants. If $k_2 AX \ll k_3 X$, the value of Y up to first order of approximation would be(GATE 2011 MT)

(a) $Y = k_1 + \frac{k_2 AX}{k_3 X}$

(b) $Y = k_1$

(c) $Y = -k_1$

(d) $Y = k_1 - \frac{k_2 AX}{k_3 X}$

29. A large set of data for a given measurement is normally distributed around a mean μ, with standard deviation σ. Which of the following limits would have about 95

(a) $\mu - 0.5\sigma$ and $\mu + 0.5\sigma$

(b) $\mu - \sigma$ and $\mu + \sigma$

(c) $\mu - 2\sigma$ and $\mu + 2\sigma$

(d) $\mu - 3\sigma$ and $\mu + 3\sigma$

30. During fully developed laminar flow in a circular pipe, the velocity profile is parabolic and symmetric around the axis. The velocity at the tube wall is zero. The ratio of the average velocity to the maximum velocity is(GATE 2011 MT)

(a) $\frac{1}{3}$

(b) $\frac{1}{2}$

(c) $\frac{2}{3}$

(d) $\frac{3}{4}$

31. If k is the rate constant for a reaction and T is the absolute temperature as in the figure, the activation energy for the reaction is(GATE 2011 MT)

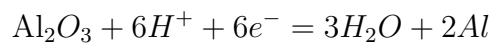(a) 1,000 J/mol

(b) 2,000 J/mol

(c) 4,155 J/mol

(d) 8,314 J/mol

32.

$$2Cu(s) + 0.5O_2(g) = Cu_2O(s) : \Delta G^0 = -162200 + 69.24T \text{ J}$$
$$2Cu(l) + 0.5O_2(g) = Cu_2O(s) : \Delta G^0 = -188300 + 88.48T \text{ J}$$

The molar free energy change at 1300 K for transformation of solid Cu to liquid Cu will be(GATE 2011 MT)

(a) 1,050 J

(b) 960 J

(c) 544 J

(d) 445 J

33.

$$Al_2O_3 + 6H^+ + 6e^- = 3H_2O + 2Al$$
$$\Delta G^0 = 897.3 \text{ kJ}$$

The reduction potential of the above reaction under standard state will be(GATE 2011 MT)

(a) -1.55 V

(b) -1.40 V

(c) 1.65 V

(d) 1.75 V

34. $G = U + PV - TS$. Then which one of the following is CORRECT?(GATE 2011 MT)

   (a) $(\frac{\partial V}{\partial T})_P = (\frac{\partial S}{\partial P})_T$
   (b) $(\frac{\partial V}{\partial T})_P = -(\frac{\partial S}{\partial P})_T$
   (c) $(\frac{\partial V}{\partial T})_P = (\frac{\partial P}{\partial S})_T$
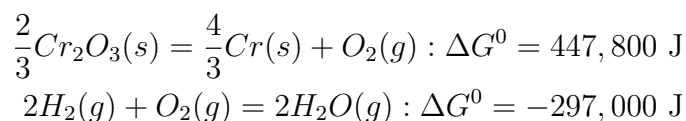   (d) $(\frac{\partial V}{\partial T})_P = -(\frac{\partial P}{\partial S})_T$

35. Match the metals in Group I with the corresponding ores in Group II.

Table 1: Metal-Ore Matching

Group I (Metals)		Group II (Ores)
P. Lead	3	Galena
Q. Zinc	5	Sphalerite
R. Uranium	4	Pitchblende
S. Niobium	1	Columbite

   (A) P-3, Q-5, R-2, S-4
   (B) P-3, Q-2, R-5, S-4
   (C) P-3, Q-5, R-4, S-1
   (D) P-3, Q-4, R-5, S-2

36. For the following reactions, the standard free energy change is given at 1773 K as follows(GATE 2011 MT):

$$\frac{2}{3}Cr_2O_3(s) = \frac{4}{3}Cr(s) + O_2(g) : \Delta G^0 = 447,800 \text{ J}$$
$$2H_2(g) + O_2(g) = 2H_2O(g) : \Delta G^0 = -297,000 \text{ J}$$

If chromium oxide powder has to be reduced by hydrogen in a fluidized bed, the minimum P_{H_2}/P_{H_2O} ratio that has to be maintained at the exit of the reactor is(GATE 2011 MT)

   (a) 8.5
   (b) 10.6
   (c) 100.2
   (d) 166.5

37. The hydrogen content of steel in equilibrium with hydrogen gas at 1 bar pressure is 28 ppm at some temperature. Hydrogen content in the metal at the same temperature gets reduced to 1 ppm, when the equilibrium P_{H_2} changes to(GATE 2011 MT)

   (a) 28 bar
   (b) $\frac{1}{28}$ bar

8

(c) $\left(\frac{1}{28}\right)^{0.5}$ bar

(d) $\left(\frac{1}{28}\right)^{2}$ bar

38. A furnace wall consists of two layers. The inside layer of 450 mm is made of light weight bricks of thermal conductivity 1 W/m.K and the outside layer of 900 mm is made of refractory of thermal conductivity 2 W/m.K. The hot face of the inside layer is at temperature 1300 K and the cold face of the outer layer is at 400 K. The temperature at the interface between the two layers is (GATE 2011 MT)

   (a) 1000 K

   (b) 850 K

   (c) 700 K

   (d) 600 K

39. Match the heat treatment processes in Group I with resultant microstructure of steel in Group II.

Table 2: Heat Treatment-Microstructure Matching

Group I		Group II
P. Martempering	3	Tempered martensite
Q. Normalising	2	Fine Pearlite
R. Subcritical annealing for long time	4	Spheroidised cementite in matrix of ferrite
S. Full annealing	1	Coarse Pearlite

   (A) P-1, Q-4, R-3, S-2

   (B) P-2, Q-3, R-1, S-4

   (C) P-4, Q-1, R-2, S-3

   (D) P-3, Q-2, R-4, S-1

40. In case of homogeneous nucleation, the critical edge length for a cube shaped nucleus is (γ: Energy per unit area of the interface between the product and parent phase; Δg: Gibbs free energy change per unit volume)(GATE 2011 MT)

   (a) $-4\gamma/\Delta g$

   (b) $-2\gamma/\Delta g$

   (c) $\gamma/\Delta g$

   (d) $-3\gamma/\Delta g$

41. For a cubic metal with lattice parameter of 3.92 Å, the first four diffraction peaks from the X-ray powder diffraction pattern taken with CuKα radiation ($\lambda = 1.5405$ Å) occur at 2θ values of 39.7, 46.2, 67.5, and 81.3 degrees. The crystal structure of the metal is (GATE 2011 MT)

9

(a) simple cubic

(b) fcc

(c) bcc

(d) diamond cubic

42. The largest size of immobilized segment of dislocation in a Frank-Read (FR) source in a polycrystalline material is of the order of grain size. In a metal of 10 μm grain size, the shear stress required to operate such a FR source is 100 MPa. If the grain size is reduced to 10 nm, the shear stress required to operate such FR source would be (GATE 2011 MT)

(a) 10^2 MPa

(b) 10^3 MPa

(c) 10^5 MPa

(d) 10^6 MPa

43. Which one of the following reactions in fcc/bcc crystals with lattice parameter a is energetically favorable? (GATE 2011 MT)

(a) $a/2[110] + a/2 \rightarrow a/2$

(b) $a/2 + a/2 \rightarrow a$

(c) $a/2 + a/2 \rightarrow a$

(d) $a/2 + a/2 \rightarrow a/2$

44. Match the hardness test methods in Group I with the indenter used in Group II. (GATE 2011 MT)

Table 3: Hardness Test-Indenter Matching

Group I		Group II
P. Brinell hardness	3	10 mm diameter steel ball
Q. Vickers hardness	2	Square base diamond pyramid
R. Rockwell C hardness	1	Brale indenter
S. Rockwell B hardness	4	1.6 mm diameter steel ball

(A) P-1, Q-2, R-3, S-4

(B) P-3, Q-2, R-1, S-4

(C) P-1, Q-4, R-3, S-2

(D) P-1, Q-2, R-4, S-3

45. Assertion 'a': During casting of aluminium, grain refinement can be achieved by addition of certain alloying elements.
Reason 'r': The addition of the alloying element may result in the formation of deoxidation products or intermetallic compounds which may act as nucleation sites for grain refinement.

    (a) Both 'a' and 'r' are true but 'r' is not the reason for 'a'

    (b) Both 'a' and 'r' are true and 'r' is the reason for 'a'

    (c) 'a' is true but 'r' is false

    (d) 'a' is false but 'r' is true

46. Match those listed in Group I with the NDT methods listed in Group II.(GATE 2011 MT)

Table 4: NDT Method Matching

Group I		Group II
P. Penetrameter	3	X-Ray radiography
Q. Differential coil probe	4	Acoustic emission test
R. Piezo-electric probe	1	Ultrasonic test
S. Developer	2	Dye-penetrant test

    (A) P-3, Q-4, R-1, S-2

    (B) P-2, Q-1, R-3, S-4

    (C) P-1, Q-2, R-4, S-3

    (D) P-4, Q-3, R-2, S-1

47. Match the manufacturing process of Group I to be used for producing the product in Group II. (GATE 2011 MT)

Table 5: Process-Product Matching

Group I		Group II
P. Drawing	2	Tube
Q. Forging	3	Crank shaft
R. Rolling	4	Plate
S. Stretch forming	1	Large curved disc

    (A) P-2, Q-3, R-4, S-1

    (B) P-1, Q-4, R-3, S-2

    (C) P-3, Q-2, R-1, S-4

    (D) P-4, Q-1, R-2, S-3

48. An aluminium billet of 300 mm diameter is extruded with an extrusion ratio of 16. What is the diameter of the final product? (GATE 2011 MT)

   (a) 150 mm

   (b) 75 mm

   (c) 59 mm

   (d) 19 mm

49. What is the ideal extrusion pressure if the effective flow stress in compression is 250 MPa? (GATE 2011 MT)

   (a) 693 MPa

   (b) 346 MPa

   (c) -346 MPa

   (d) -703 MPa

50. At the eutectoid point, the alloy has α and β in the weight ratio 1:1. The eutectoid point occurs at composition (GATE 2011 MT)

   (a) 46 wt% Q

   (b) 47.5 wt% Q

   (c) 50 wt% Q

   (d) 52.5 wt% Q

51. At the eutectoid temperature, the ratio of α and β phases in the specimen observed under microscope is (GATE 2011 MT)

   (a) 0.50

   (b) 0.40

   (c) 0.25

   (d) 0.20

52. The amount of oxygen in CO and CO_2 leaving with the top gas is (GATE 2011 MT)

   (a) 293 kg

   (b) 407 kg

   (c) 700 kg

   (d) 1050 kg

53. The CO/CO_2 molar ratio in the top gas is (GATE 2011 MT)

   (a) 0.9

   (b) 1.0

12

(c) 1.1

(d) 1.5

54. The magnitude of Burgers vector in copper is (GATE 2011 MT)

(a) 2.54 Å

(b) 2.39 Å

(c) 2.20 Å

(d) 2.18 Å

55. The elastic strain energy per unit length of dislocation line in copper is (GATE 2011 MT)

(a) 34.8 $\times 10^{-10}$ N

(b) 28.8 $\times 10^{-10}$ N

(c) 24.8 $\times 10^{-10}$ N

(d) 14.5 $\times 10^{-10}$ N

56. Choose the word from the options given below that is most nearly opposite in meaning to the given word: Frequency (GATE 2011 MT)

(a) periodicity

(b) rarity

(c) gradualness

(d) persistency

57. Choose the most appropriate word from the options below to complete the sentence: It was her view that the country's problems had been by foreign technocrats, so that to invite them to come back would be counter-productive.(GATE 2011 MT)

(a) identified

(b) ascertained

(c) exacerbated

(d) analysed

58. There are two candidates P and Q in an election. During the campaign, 40% of the voters promised to vote for P, and rest for Q. However, on the day of election 15% of the voters went back on their promise to vote for P and voted for Q. 25% of the voters went back on their promise to vote for Q and voted for P. Suppose, P lost by 2 votes, then what was the total number of voters? (GATE 2011 MT)

(a) 100

(b) 110

(c) 90

(d) 95

59. Gladiator: Arena

   (a) dancer: stage

   (b) commuter: train

   (c) teacher: classroom

   (d) lawyer: courtroom

60. Under ethical guidelines recently adopted by the Indian Medical Association, human genes are to be manipulated only to correct diseases for which treatments are unsatisfactory. (GATE 2011 MT)

   (a) similar

   (b) most

   (c) uncommon

   (d) available

61. Given that $f(y) = \frac{|y|}{y}$, and q is any non-zero real number, the value of $|f(q) - f(-q)|$ is (GATE 2011 MT)

   (a) 0

   (b) -1

   (c) 1

   (d) 2

62. Three friends, R, S and T shared toffee from a bowl. R took 1/3rd of the toffees, but returned four to the bowl. S took 1/4th of what was left but returned three toffees to the bowl. T took half of the remainder but returned two back into the bowl. If the bowl had 17 toffees left, how many toffees were originally there in the bowl? (GATE 2011 MT)

   (a) 38

   (b) 31

   (c) 48

   (d) 41

63. The fuel consumed by a motorcycle during a journey at various speeds is indicated in the graph below. (GATE 2011 MT)
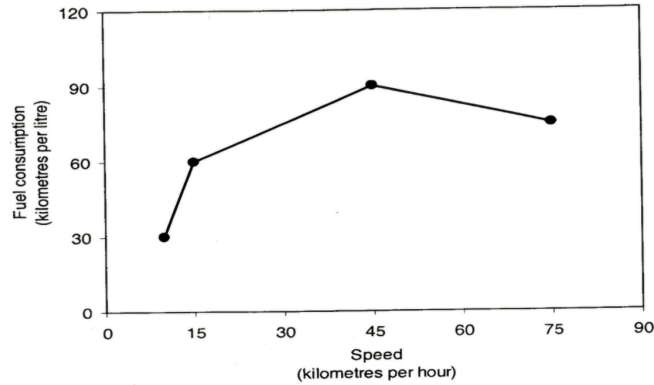
The distances covered during four laps of the journey are listed in the table below.

Lap	Distance (kilometres)	Average speed (kilometres per hour)
P	15	15
Q	75	45
R	40	75
S	10	10

From the given data, we can conclude that the fuel consumed per kilometre was least during the lap

(a) P

(b) Q

(c) R

(d) S

64. The horse has played a little known but very important role in the field of medicine. Horses were injected with toxins of diseases until their blood built up immunities. Then a serum was made from their blood. Serums to fight with diphtheria and tetanus were developed this way. It can be inferred from the passage, that horses were (GATE 2011 MT)

(a) given immunity to diseases

(b) generally quite immune to diseases

(c) given medicines to fight toxins

(d) given diphtheria and tetanus serums

65. The sum of n terms of the series $4 + 44 + 444 + \ldots$ is

(a) $\frac{4}{81}[10^{n+1} - 9n - 1]$

15

(b) $\frac{4}{81}[10^{n-1} - 9n - 1]$

(c) $\frac{4}{81}[10^{n+1} - 9n - 10]$

(d) $\frac{4}{81}[10^{n} - 9n - 10]$