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ENTRANCE EXAMINATIONS 2022
Ph.D. (Materials Engineering)

Marks: 70
Time: 2 h Hall Ticket No:

I. Write your Hall Ticket Number on the OMR Answer Sheet given to you. Also write the Hall Ticket Number in the Space provided above.
II. Read the following instructions carefully before answering the questions.
III. This Question paper has TWO parts: PART 'A' AND PART 'B'

1. Part 'A': It consists of 20 objective type questions of **1.75** marks each.
2. Part 'B: It consists of 35 objective questions of one mark each.
3. All questions are to be answered. Answers for these questions are to be entered on the OMR sheet, filling the appropriate circle against each question. For example, if the answer to a question is D, it should be marked as below:

No additional sheets will be provided. Rough work can be done in the question paper itself.

4. Hand over the OMR answer sheet at the end of the examination to the invigilator.

5. Mobile phones, log tables and calculators of any type are NOT permitted inside the Examination Hall.

6. This book contains 11 pages including this cover sheet.

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PART A

1. In a world filled with uncertainty, he was glad to have many good friends. He had always assisted them in times of need and was confident that they would reciprocate. The events of the last week proved him right. Which of the following inference(s) is/are logically valid and can be inferred from the above passage?
   (i) His friends were always asking him to help them.
   (ii) He felt that when in need of help, only his closest friends would care.
   (iii) He was sure that his friends would help him when in need.
   (iv) His friends helped him last week.
   A. (i) and (ii)
   B. (iv) only
   C. (iii) and (iv)
   D. (iii) only

2. Amanda is older than her cousin Mahabba. Mahabba's sister Priya is older than Amanda. When Mahabba and Priya are visiting Amanda, all three like to play chess. Mahabba wins more often than Amanda does.
   Which one of the following statements must be TRUE based on the above?
   A. When Priya plays chess with Amanda and Mahabba, she often loses.
   B. Amanda is the oldest of the three.
   C. Priya is a better chess player than Mahabba.
   D. Mahabba is the youngest of the three.

3. Mithali covers half of her journey by train at 60 km/h, half of the remainder by bus at 30 km/h and the rest by cycle at 10 km/h. The average speed of her during the entire journey in km/h is
   A. 24
   B. 30
   C. 20
   D. 18

4. A cube is built using 64 cubic blocks of side one unit. After it is built, one cubic block is removed from every corner of the cube. The resulting surface area of the body (in square units) after the removal is
   A. 64
   B. 68
   C. 96
   D. 90

5. 5 fully-automatic machines can finish a work in 20 days, 8 semi-automatic machines can finish the work in 25 days; 10 workers can finish the work in 30 days. How long will a combination of 2 fully-automatic, 6 semi-automatic and 5 workers takes to finish the work?
   A. 20
   B. 18
   C. 16
   D. 15

6. Five friends went to a sweet shop. Information regarding the number of sweets they ate is as follows:
   (i) Gimmy ate 8 less than Akshit.
   (ii) Dileep and Raj together ate 37.
   (iii) Jugal ate 8 more than Dileep.
   (iv) Akshit ate 5 more than Dileep.
   (v) Akshit and Gimmy together ate 40.
   How many sweets did Raj eat?

   A. 18
   B. 24
   C. 16
   D. 27

7. Which of the following letters would come next in the series of letters Z, W, R, K,?
   A. (A)
   B. (C)
   C. (B)
   D. (D)

8. Answer the question based on the following information. The city K is 30 km to the east of Z while Y is 50 km to the west of K. Also, H is 38 km to the east of Y. L lies in the direct route between Y and K and its distance from H is 14 km. G also lies on this route and is exactly midway between L and Y. A car starting from K at 9 am and running at a constant speed towards Y reaches H at 9.24 am and then reaches G at
   A. 9.18 am
   B. 10.16 am
   C. 10.36 am
   D. 10.42 am

9. If 'tee see pee' means 'drink fruit juice'; 'see kee lee' means 'juice is sweet' and 'lee ree mee' means 'he is intelligent', which word in that language means 'sweet'?
   A. lee
   B. ree
   C. kee
   D. see

10. Refer to the data below and answer the question that follows: In an examination 43% passed in Math, 52% passed in Physics and 52% passed in Chemistry. Only 8% students passed in all the three. 14% passed in Math and Physics and 21% passed in Math and Chemistry and 20% passed in Physics and Chemistry. Number of students who took the exam is 200. Let set P, set C and set M denote the students who passed in Physics, Chemistry and Math, respectively.
    A student is declared pass in the exam only if he/she clears at least two subjects. The number of students who were declared passed in this exam is
    A. 33
    B. 66
    C. 39
    D. 78

11. During blood transfusion the needle is inserted in a vein where the gauge pressure is 2000 Pa. At what height must the blood packet be placed so that blood may just enter the vein? (Density of blood = 1.06×10^3 kgm^{-3}, g = 9.8 m^2s^{-1})
    A. 0.182 m
    B. 0.192 m
    C. 0.162 m
    D. 0.172 m
12. A tank full of water has a small hole at the bottom. Let t_1 be the time taken to empty first one third of the tank, t_2 be the time taken to empty second one third of the tank and t_3 be the time taken to empty the rest of the tank, then
    A. $t_1 = t_2 = t_3$
    B. $t_1 > t_2 > t_3$
    C. $t_1 < t_2 < t_3$
    D. $t_1 < t_2 > t_3$
13. In a 20m deep lake the bottom is at a constant temperature of 4^0C. The air temperature is constant at -10^0C. The thermal conductivity of ice is 4 times that of water. Neglecting the expansion of water on freezing, the maximum thickness of ice will be
    A. 20 m
    B. 10 m
    C. 20/11 m
    D. 200/11 m
14. A refrigerator converts 100g of water at 25^0C into ice at -10^0C in one hour and 50 minutes. The quantity of heat removed per minute is (specific heat of water = 1 cal/g^0C, specific heat of ice = 0.5 cal/g^0C, latent heat of fusion of ice = 80 cal/g)
    A. 200 cal
    B. 102 cal
    C. 50 cal
    D. 75 cal
15. A rope of 1 cm in diameter breaks if the tension in it exceeds 500 N. The maximum tension that may be given to a similar rope of diameter 2 cm is
    A. 250 N
    B. 500 N
    C. 1000 N
    D. 2000 N
16. A wire can sustain the weight of 20 kg before breaking. If the wire is cut into two equal parts, each part can sustain a weight of
    A. 80 kg
    B. 40 kg
    C. 20 kg
    D. 10 kg

17. The correct order of variation in the size of atoms is
    A. Be > C > F > Ne
    B. F > Ne > Be > C
    C. Be > C > F < Ne
    D. Be < C < F < Ne
18. UGC-CARE been setup for promoting quality research, academic integrity and publication ethics. What is the full form of CARE?
    A. Consortium for Academic and Research Ethics
    B. Commission for Academic and Research Ethics
    C. Controller for Academic and Research Ethics
    D. Council for Academic and Research Ethics
19. Plagiarism in research is
    A. creative use of previous data
    B. copying unscrupulously and publish
    C. quoting someone
    D. referring to previous data
20. Ram, Shyam and Hari can do a piece of work in 10, 15 and 30 days, respectively. In how many days can Ram do the work if he is assisted by Shyam and Hari on every third day?
    A. 8 days
    B. 7.5 days
    C. 15 days
    D. 5 days

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PART B

21. Consider the 5x5 matrix, $A = \begin{pmatrix} 1 & 2 & 3 & 4 & 5 \\ 5 & 1 & 2 & 3 & 4 \\ 4 & 5 & 1 & 2 & 3 \\ 3 & 4 & 5 & 1 & 2 \\ 2 & 3 & 4 & 5 & 1 \end{pmatrix}$. It has only one real eigenvalue. What is it?
    A. 15
    B. 0
    C. 23
    D. -2.8
22. Divergence of the vector field, $x^2z\hat{\imath} + xy\hat{\jmath} - yz^2\hat{k}$ at (1,-1,1) is
    A. 0
    B. 3
    C. 5
    D. 6
23. Which of the following is the nature of the solution to the Laplace equation, $\nabla^2 f = 0$?
    A. The solutions are not separable in the coordinates
    B. The solutions have neither maxima nor minima anywhere except at the boundaries
    C. The solutions are not continuous
    D. The solutions are not dependent on the boundary conditions
24. A discontinuous real function can be expressed
    A. as Taylor's series and Fourier's series
    B. as Taylor's series and not by Fourier's series
    C. as neither Taylor's series nor Fourier's series
    D. not as Taylor's series but by Fourier's series
25. Internal energy of a material is the sum of all _____ of its constituent particles
    A. kinetic energies
    B. potential energies
    C. kinetic and potential energies
    D. charge
26. Carnot's engine
    A. has equal efficiency to any other engine with all reversible steps
    B. has equal efficiency to any other engine with exactly two reversible steps
    C. involves two isochoric steps
    D. involves only one isothermal step
27. Axes of a H_2O phase diagram are
    A. composition and temperature
    B. composition and volume
    C. composition and pressure
    D. pressure and temperature

28. The pressure of water in a water pipe when tap is open and closed is 3×10^5 Nm^{-2} and 3.5×10^5 Nm^{-2}, respectively. With open tap, the velocity of flowing water is
    A. 10 m/s
    B. 5 m/s
    C. 20 m/s
    D. 15 m/s
29. A vessel contains 14 g of hydrogen and 96 g of oxygen at STP. Chemical reaction is induced by passing electric spark in the vessel till one of the gases is consumed. The temperature is brought back to its starting value. The pressure in the vessel (assuming the gas mixture behave as ideal gas) is
    A. 0.1 atm
    B. 0.4 atm
    C. 0.3 atm
    D. 0.2 atm
30. When water is boiled at 2 atm pressure, the latent heat of vaporization is 2.2×10^6 J/kg and the boiling point is 120^0C. At 2 atm pressure, 1 kg of water has volume of 10^{-3} m^3 and 1 kg of steam has a volume of 0.824 m^3. The increase in internal energy of 1 kg of water when it is converted into steam at 2 atm pressure and 120^0C is (1 atm pressure = 1.013×10^5 N/m^2)
    A. 2.033 J
    B. 0.167×10^6 J
    C. 2.033×10^6 J
    D. 2.267×10^6 J
31. One mole of an ideal gas undergoes a process whose molar heat capacity is 4R. In this process, the work done by the gas for small changes in the temperature is given by the relation, dW = 2RdT, then the ratio C_p/C_v is
    A. 7/5
    B. 5/3
    C. 3/2
    D. 2
32. A gas undergoes an adiabatic process in which pressure becomes $(8/3\sqrt{3})$ times and volume becomes $3/4^{th}$ of the initial volume. If initial absolute temperature was T, the final temperature is
    A. $32T/9\sqrt{3}$
    B. $2T/\sqrt{3}$
    C. $T^{3/2}$
    D. $\sqrt{3}T/2$
33. In a conventional unit cell of a crystal, $a = b \neq c$ and $\alpha = \beta = \gamma = 90^\circ$. This crystal belongs to which of the following systems?
    A. Cubic
    B. Tetragonal
    C. Orthorhombic
    D. Triclinic

34. The respective units for dislocation density and stress intensity factor are
    A. m^2 and MPa.m
    B. m^2 and $MPa.m^{1/2}$
    C. m^{-2} and $MPa.m^{1/2}$
    D. m^{-2} and MPa.m
35. Which one of the following microstructures of a Ni-base super alloy imparts the highest creep resistance?
    A. Fine grained equiaxed
    B. Coarse grained equiaxed
    C. Columnar
    D. Single crystal
36. With which one of the following metal forming processes is the earing defect associated?
    A. Deep drawing
    B. Rolling
    C. Forging
    D. Wire drawing
37. A species can diffuse through the lattice (diffusion coefficient, D_L), along grain boundaries (diffusion coefficient, D_{GB}), and along free surfaces (diffusion coefficient, D_s). Which of the following relations is correct?
    A. $D_L > D_{GB} > D_s$
    B. $D_s > D_L > D_{GB}$
    C. $D_{GB} > D_S > D_L$
    D. $D_S > D_{GB} > D_L$
38. Goldsmith tolerance factor is used to judge the stability of the
    A. spinel structure
    B. perovskite structure
    C. zinc blende structure
    D. rock salt structure
39. Which of the following sintering methods will result in minimal grain growth for the same level of densification?
    A. Conventional solid state sintering
    B. Microwave sintering
    C. Spark plasma sintering
    D. Liquid phase sintering
40. If two springs with spring constants 1/m and 1/n are joined in series, then what is the spring constant of the joined system?
    A. $\frac{m}{n}$
    B. $\frac{n}{m}$
    C. $\frac{1}{m}+\frac{1}{n}$
    D. $m+n$

41. Which one of the following is not an ore of iron?
    A. Wustite
    B. Hematite
    C. Magnetite
    D. Limonite
42. Which one of the following phenomena is not caused by local melting of a constituent of an alloy or impurity in the grain boundary below the melting point?
    A. Hot Shortness
    B. Grain boundary Embrittlement
    C. Temper embrittlement
    D. Grain boundary sliding
43. The roughened surface of large grained metals after metal forming, namely, orange peel or orange skin texture, is related to
    A. Yield point phenomenon
    B. Hardness
    C. Phase transformation
    D. Tempering
44. The shear stress, required to produce slip, continuously increases with increase in shear strain. The phenomenon is due to
    A. polygonization
    B. increase in stacking fault energy
    C. work hardening
    D. work softening
45. Vacancy in pure metal may be caused by
    A. annealing
    B. normalising
    C. rapid quenching
    D. tempering
46. Agglomeration of fine iron ores is done, because
    A. fines have high melting point
    B. fines are not easily reduced
    C. it utilises non-coking coal instead of coke
    D. fines decrease the porosity of the burden and thereby hindering the movement of gases
47. Atomic displacement for twinning is
    A. less than the interatomic distance
    B. more than the interatomic distance
    C. equal to twice the interatomic distance
    D. equal to the interatomic distance
48. A stacking fault is a _____ defect that can occur in crystalline materials
    A. planer defect
    B. point defect
    C. line defect
    D. dislocation defect

49. Twinning occurs when the material has a
    A. low stacking fault Energy
    B. high stacking fault Energy
    C. high Dislocation density
    D. low dislocation density
50. Which one of the following, in general, will not occur during low temperature recovery process?
    A. Reduction in stored energy
    B. Increase in grain size
    C. Increase in electrical conductivity
    D. Increase in thermal conductivity
51. Crack propagation in brittle crystalline materials will happen
    A. along specific crystallographic planes
    B. along a low angle grain boundary
    C. along a high angle grain boundary
    D. along a Twin boundary
52. Which of the following helps in decreasing the lattice strain in a metallic body?
    A. Inducing line defects in the lattice of the metallic body
    B. Inducing dislocations in the lattice of the metallic body
    C. Inducing point defects in the lattice of the metallic body
    D. Heating the metallic body
53. What is the modulus of elasticity in tension of a material with 1% porosity when that without porosity is 1000 GPa?
    A. 500 GPa
    B. 1081 GPa
    C. 1000 GPa
    D. 981 GPa
54. What are the colors of newly cut lead surface and the newly cut lead surface exposed to air?
    A. reddish orange and silver blue metallic grey, respectively
    B. silver blue and metallic grey, respectively
    C. yellowish black and silver blue, respectively
    D. reddish orange and metallic grey, respectively
55. How does the elastic energy stored per unit volume change when the loading in tension is increased?
    A. Remains the same
    B. Increases
    C. First decreases and then drastically increases
    D. Decreases

Key for ME_Oct 2022

Q No	Ans	Q No	Ans	Q No	Ans
1	C	21	A	41	D
2	D	22	C	42	D
3	A	23	B	43	A
4	C	24	D	44	C
5	D	25	C	45	C
6	A	26	A	46	D
7	C	27	D	47	A
8	B	28	A	48	A
9	C	29	A	49	A
10	D	30	C	50	B
11	B	31	C	51	A
12	C	32	B	52	D
13	D	33	B	53	D
14	B	34	C	54	B
15	D	35	D	55	B
16	C	36	A		
17	C	37	D		
18	A	38	B		
19	B	39	C		
20	B	40	D		