

ENTRANCE EXAMINATIONS 2018  
Ph.D. (Materials Engineering)

Marks: 80

Time: 2.00 hrs

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 **TWO** marks each.  
There is a negative marking of **0.66** marks for every wrong answer.
2. Part 'B': It consists of 40 objective questions of one mark each with no negative marking.
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:

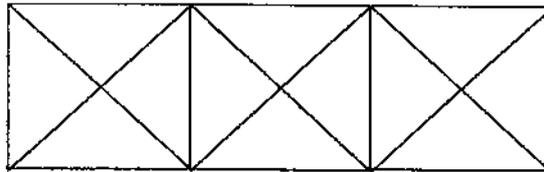


No additional sheets will be provided. Rough work can be done in the question paper itself and rough work sheets provided at the end of the booklet.

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 14 pages including this cover sheet.

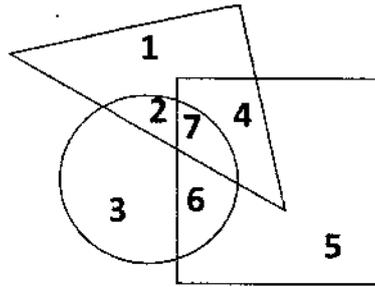
**PART A**

1.  $(x\% \text{ of } y) + (y\% \text{ of } x)$  is equivalent to,  
A. 2% of  $xy$   
B. 2% of  $(xy/100)$   
C.  $xy\%$  of 100  
D. 100% of  $xy$
2. I started walking and after walking 6 kms, I turned right and travelled a distance of 2 kms, then turned left and covered a distance of 10 kms. In the end I was moving towards the north. From which direction did I start my journey?  
A. North  
B. South  
C. South West  
D. North East
3. The total number of all types of triangles in the following figure are



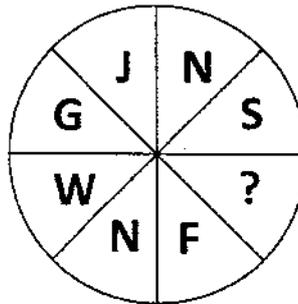
- A. 28  
B. 24  
C. 26  
D. 16
4. The value of "k" that must be added to 7, 16, 43, 79 so that they are in proportion,  
A. 7  
B. 5  
C. 9  
D. 4

5. If "Tall" is equivalent to circle, "Armyman" to triangle and "Strong" to square, which number in the following figure represents "Strong Armyman"?



- A. 3
- B. 5
- C. 6
- D. 4

6. Which letter replaces the question mark (?) in the figure given below?



- A. Z
- B. W
- C. Y
- D. S

7. Surendra is as much older than Kamal as he is younger than Prashant. Navin is as old as Kamal. Which of the following statements is wrong?

- A. Surendra is older than Navin
- B. Kamal is younger than Surendra
- C. Prashant is not the oldest
- D. Navin is younger than Prashant

8. Find the odd one out from the following,

- A. DEHG
- B. RSVU
- C. JKNM
- D. LMQP

9. Indla started walking towards East. After moving a distance of 1 km, he turned southwards and walked 5 kms. Again he turned to east and walked 2 kms. Finally, he turned to the north and walked 9 kms. How far is he from his starting point?

- A. 7 kms
- B. 5 kms
- C. 4 kms
- D. 3 kms

10. A firm is selling its product at Rs 60 per unit. The total cost of production is Rs 100 and the firm is earning a total profit of Rs 500. Later, the total cost increased by 30%. By what percentage should the price be increased to maintain the same profit?

- A. 5%
- B. 10%
- C. 15%
- D. 30%

11. If  $y = 5x^2 + 3$ , then the tangent at  $x = 0, y = 3$

- A. Passes through  $x = 0, y = 0$
- B. Has a slope of +1
- C. Is parallel to x-axis
- D. Has a slope of -1

12. Consider the equation,  $B^3 = JA^{\frac{1}{3}} + C$ . The value of "J" can be determined from

- A. The slope of a graph between "B" on the Y-axis and "A" on the X-axis
- B. The slope of a graph between "B<sup>3</sup>" on the Y-axis and "A<sup>1/3</sup>" on the X-axis
- C. Y-intercept of the graph between "B<sup>3</sup>" on the Y-axis and "A" on the X-axis
- D. X-intercept of the graph between "B" on the Y-axis and "A<sup>1/3</sup>" on the X-axis

13. In an artificial language,

CLAR means Write

CLARX means Writing

CLARZN means Written

Then the word corresponding to Beating would be

- A. MEAR
- B. MEARN
- C. MEARX
- D. MEARZN

14. The grain size distribution in a material is best represented graphically using a
- A. Pie chart
  - B. Bar chart
  - C. Pert chart
  - D. Histogram
15. From a pack of 52 playing cards 3 cards are drawn at random in sequence. The probability of the cards being a King, a Queen and a Jack is
- A.  $16/5525$
  - B.  $1/52$
  - C.  $1/22100$
  - D.  $52/5525$
16. If  $A = 2$ ,  $B = 5$ ,  $C = 10$ , then value of  $D$  is
- A. 15
  - B. 16
  - C. 17
  - D. 19
17. In the number series: 2, 1, ( $\frac{1}{2}$ ), ( $\frac{1}{4}$ ), ....., what number should come next
- A.  $\frac{1}{3}$
  - B.  $\frac{1}{8}$
  - C.  $\frac{2}{8}$
  - D.  $\frac{1}{16}$
18. If  $(2^{-n}/3) \times (3^{-n}/2) = 1/36$ , what is the value of  $n$
- A. 2
  - B. 3
  - C. 1
  - D. 36
19. If the dimension of matrix  $M$  is  $2 \times 3$  and that of matrix  $N$  is  $3 \times 2$ , what would be the dimension of the product matrix,  $M.N$
- A.  $2 \times 2$
  - B.  $5 \times 5$
  - C.  $4 \times 6$
  - D.  $6 \times 4$

20. Out of the 200 candidates interviewed for a wicket keeper position, 100 had helmets, 70 had gloves 140 had bats. 40 of them had both helmets and gloves, 30 of them had both gloves and bats and 60 of them had both helmets and bats. 10 of them had all the three. How many candidates had none of these?

- A. 0
- B. 20
- C. 10
- D. 25

**PART B**

21. The relationship between Young's modulus (E), Poisson's ratio ( $\nu$ ) and Shear modulus (G) of a material is given by,

A.  $G = \frac{E}{2(1+\nu)}$

B.  $G = \frac{\nu}{2(1+E)}$

C.  $G = 2 \left( \frac{1+\nu}{E} \right)$

D.  $G = \frac{(1+E)}{2\nu}$

22. The linear region of the typical stress-strain curve of a material corresponds to

- A. Inelastic property
- B. Elastic property
- C. Plastic property
- D. Both plastic and elastic properties

23. For a beam fixed at one end and free at the other end how many linear degrees of freedom are there?

- A. 1
- B. 4
- C. 0
- D. 2

24. For an applied load of "F" and displacement of "x", which one of the following define the mechanical spring constant ( $K_m$ )?

A.  $K_m = \frac{F}{x}$

B.  $K_m = F \cdot x$

C.  $K_m = \frac{x}{F}$

D.  $K_m = \frac{1}{2} F \cdot x$

25. The moment of inertia ( $I$ ) of a beam having width "W", thickness "t" and length "L" is defined as,

- A.  $I = \frac{Wt^3}{12}$
- B.  $I = \frac{LW^3}{12}$
- C.  $I = \frac{tW^3}{12}$
- D.  $I = \frac{WL^3}{12}$

26. Polymerization of the monomer is the key step in

- A. Slip casting of ceramics
- B. Tape casting of ceramics
- C. Gel casting of ceramics
- D. Freeze drying of ceramics

27. During sintering of oxide materials densification is NOT due to

- A. Atomic diffusion
- B. Surface diffusion
- C. Bulk diffusion
- D. Grain growth

28. Which of the following have greater impact on longitudinal strength of fibre reinforced composites?

- A. Fibre orientation
- B. Fibre strength
- C. Fibre length
- D. Fibre shape

29. Plastic tubes and pipes are generally made by

- A. Injection moulding
- B. Extrusion moulding
- C. Transfer moulding
- D. Compression moulding

30. Paint spray gun works on the principle of

- A. Bernoulli's theorem
- B. Boyle's law
- C. Newton's law of viscosity
- D. Combined action of Boyle's law and Newton's law of viscosity

31. Mastication of rubber means
- Its softening
  - A treatment to retard its deterioration due to oxidation
  - Improving its curing rate
  - Depression of its freezing point
32. Which of the following functions of  $x$  can be represented by a Fourier series over the range indicated?
- $\tanh^{-1}(x)$ ,  $-\infty < x < +\infty$
  - $\tan(x)$ ,  $-\infty < x < +\infty$
  - $|\sin(x)|^{-1/2}$ ,  $-\infty < x < +\infty$
  - $\cos^{-1}(\sin(2x))$ ,  $-\infty < x < +\infty$
33. A complex number  $z$  is given by  $z = 3 + 4i$ . What is the value of  $\ln(z)$ ?  
[ $\ln(x)$  is the natural logarithm of  $x$ .]
- $\ln(3) + i \ln(4)$
  - $\ln(3) + \ln(i4)$
  - $\ln(5) + i \tan^{-1}(4/3)$
  - $\ln(5) + i [\tan^{-1}(4/3) + 2n\pi]$  ( $n$  is an integer)
34. Which of the following statements about general vectors  $\mathbf{a}$ ,  $\mathbf{b}$ ,  $\mathbf{c}$  and  $\mathbf{d}$  is true?
- $\mathbf{c} \cdot (\mathbf{a} \times \mathbf{b}) = (\mathbf{b} \times \mathbf{a}) \cdot \mathbf{c}$
  - $\mathbf{a} \times (\mathbf{b} \times \mathbf{c}) = (\mathbf{a} \times \mathbf{b}) \times \mathbf{c}$
  - $\mathbf{d} = \alpha \mathbf{a} + \beta \mathbf{b}$  implies  $(\mathbf{a} \times \mathbf{b}) \cdot \mathbf{d} = 0$  ( $\alpha$  and  $\beta$  are arbitrary constants)
  - $(\mathbf{a} \times \mathbf{b}) \times (\mathbf{c} \times \mathbf{d}) = (\mathbf{c} \times \mathbf{d}) \times (\mathbf{a} \times \mathbf{b})$
35. Which of the following statements about linear vector spaces is **NOT** true?
- Non-singular  $N \times N$  matrices form a vector space of dimension  $N^2$
  - Complex numbers form a vector space of dimension 2
  - Polynomial functions of  $x$  form an infinite-dimensional vector space
  - Absolutely convergent series form an infinite-dimensional vector space

36. The phonon heat capacity (C) dependence on temperature (T) at low and high temperatures is

- A.  $C \sim T^3$  at low T and  $C = \text{constant}$  at high T
- B.  $C \sim T^2$  at low T and  $C \sim T^3$  at high T
- C.  $C = \text{constant}$  at low T and  $C \sim T^3$  at high T
- D.  $C \sim T^3$  at low T and  $C \sim T$  at high T

37. In the Drude model for conductivity of a free electron gas, the relaxation time at room temperature is dominated by,

- A. Electrons
- B. Phonons
- C. Impurities
- D. Holes

38. The total spin quantum number of electrons in the ground state of neutral nitrogen ( $z = 7$ ) is

- A.  $\frac{1}{2}$
- B.  $\frac{3}{2}$
- C.  $\frac{5}{2}$
- D. 1

39. A metallic ring of radius "r" and cross-sectional area "A" is fitted into a wooden circular disc of R ( $R > r$ ). If the Young's modulus of the ring is Y, the force with which the metal expands is

- A.  $\frac{AYR}{r}$
- B.  $\frac{r}{AY(R-r)}$
- C.  $\frac{AYR}{(R-r)}$
- D.  $\frac{AYr}{R}$

40. Three point charges 1C, -2C and -2C are placed at the vertices of an equilateral triangle of side 1meter. The work done by an external force to increase the separation of charges to 2meter in joules, if  $\epsilon_0$  is the permittivity of free space, is

- A.  $\frac{1}{4\pi\epsilon_0}$
- B.  $\frac{1}{8\pi\epsilon_0}$
- C.  $\frac{1}{16\pi\epsilon_0}$
- D. Zero

41. Fracture toughness has units of

- A. MPa m<sup>1/2</sup>
- B. MPa m<sup>3/2</sup>
- C. MPa m<sup>5/2</sup>
- D. MPa m

42. Tresca yield criterion is based on

- A. Distortion energy
- B. Maximum shear stress
- C. Maximum principal stress
- D. Maximum hydrostatic stress

43. J-integral in fracture mechanics represents

- A. Temperature
- B. Strain energy release rate
- C. Work function
- D. Impedance

44. Consider the following statements about Dynamic strain ageing

1. Dislocation motion retardation by solute atoms
2. Negative strain rate sensitivity
3. Serrated plastic flow

Which of the above statements is true?

- A. 1 only
- B. 2 only
- C. 3 only
- D. 1, 2 and 3

45. Reduced activation Ferritic-Martensitic steel is used in

- A. Auto bodies
- B. Aero Planes
- C. Nuclear reactors
- D. Bridges

46. A typical Ni-based superalloy will contain

- A.  $\gamma$ - phase only
- B.  $\gamma'$ - phase only
- C.  $\gamma''$ - phase only
- D.  $\gamma$ ,  $\gamma'$  and  $\gamma''$  phases

47. Carbide phases in superalloys will lead to
- A. Better fatigue properties
  - B. Better creep properties
  - C. Better Young's modulus
  - D. Better Poisson's ratio
48. Super alloys are normally produced by
- A. Blast furnace
  - B. L. D. Converter
  - C. Open heart furnace
  - D. Vacuum induction melting followed by vacuum arc re-melting
49. Extrusion is used to make
- A. Ingots
  - B. Tubes
  - C. Plates
  - D. Billets
50. Mineral beneficiation is done to
- A. Add the gauge material
  - B. Make lower grade product
  - C. Increase cost of material
  - D. Remove the gauge material
51. During a cathodic protection the sacrificial anode
- A. Accept electron from protected metal
  - B. Reacts spontaneously with the protected metal
  - C. Oxidizes more readily than the protected metal
  - D. Causes the protected metal to become an anode
52. A plastically deformed metal crystal at low temperature exhibits wavy slip line pattern due to
- A. Dislocation pile up
  - B. Large number of slip systems
  - C. Low stacking fault energy
  - D. Dislocation climb
53. Railway tracks are typically manufactured using
- A. Forging
  - B. Extrusion
  - C. Deep drawing
  - D. Rolling

54. Minimum number of slip systems operative during plastic deformation is
- A. 3
  - B. 4
  - C. 5
  - D. 6
55. Which one of the following does NOT improve fatigue life of a steel component?
- A. Nitriding
  - B. Decarburization
  - C. Improving surface finish
  - D. Shot peening
56. Microstructure of a 0.2% carbon steel would consist of the following
- A. 25% Ferrite and 75% Pearlite
  - B. 75% Ferrite and 25% Pearlite
  - C. 50% Ferrite and 50% Pearlite
  - D. 80% Ferrite and 20% Pearlite
57. Steel contains impurities such as phosphorous and sulphur and they eventually form phosphides and sulphides that are harmful to which one of the following properties?
- A. Toughness
  - B. Yield strength
  - C. Corrosion
  - D. Ductility
58. Slag is traditionally represented by which one of the following mass concentration ratios?
- A. %CaO/%SiO<sub>2</sub>
  - B. %MgO/%Fe<sub>2</sub>O<sub>3</sub>
  - C. %SiO<sub>2</sub>/%CaO
  - D. %Fe<sub>2</sub>O<sub>3</sub>/%MgO
59. Iron oxide dissolves in slag in two valence states of iron, divalent Fe<sup>+2</sup> and trivalent Fe<sup>+3</sup>. The ratio of Fe<sup>+2</sup>/Fe<sup>+3</sup> does not depend on
- A. Temperature of slag
  - B. Oxygen potential of slag
  - C. Slag composition
  - D. Slag viscosity

60. Ceramics are in general,

- A. Strong in tension and weak in compression
- B. Weak in tension and strong in compression
- C. Weak in both tension and compression
- D. Strong in both tension and compression