B

24023 **120 MINUTES**

1. The value of c for which the system

$$x - cy + cz = 0$$
$$cx - y + cz = 0$$
$$cx + cy - z = 0$$

Has a non-trivial solution is:

A) 0 B) ± 1 C) ± 2 D) 3

2. The characteristic equation of the matrix $\begin{bmatrix} 1 & 0 & -2 \\ 2 & 0 & -3 \\ 1 & -1 & 2 \end{bmatrix}$ is:

A) $\lambda^3 - 3\lambda^2 + 3\lambda - 1 = 0$ B) $\lambda^3 - 3\lambda^2 - 3\lambda - 1 = 0$

C) $\lambda^3 - 3\lambda^2 + \lambda - 1 = 0$ D) $\lambda^3 - 3\lambda^2 + 2\lambda - 1 = 0$

3. Which of the following quadratic form is positive semi-definite?

A) $Q(x, y) = xy$ B) $Q(x, y) = x^2 - y^2$

C) $Q(x, y) = x^2 + 2xy + y^2$ D) $Q(x, y) = x^2 + xy$

4. If the eigen values of a 3×3 matrix A are $1, -1$ and 2. Then determinant of A is:

A) 0 B) 1 C) 2 D) -2

5. If $u = sin^{-1}\left(\frac{x}{y}\right) + tan^{-1}\left(\frac{y}{x}\right)$, then $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y}$ is:

A) $\frac{-y}{x^2+y^2}$ B) $\frac{y}{x^2+y^2}$ C) 0 D) 1

6. The value of $\lim_{(x,y)\to(2,0)}\left(\frac{y}{x+y-2}\right)$ is:

A) 0 B) 1 C) -1 D) Does not exist

7. The partial derivative of $f(x, y) = x^2y^3 + x^4y$ with respect to x at the point $(1, 1)$ is:

A) 6 B) 4 C) 3 D) 1

8. The relative maxima of $f(x, y) = x^3y^2(12 - x - y)$ for $x > 0,\ y > 0$ occurs at:

A) $(1, 2)$ B) $(2, 1)$ C) $(4, 6)$ D) $(6, 4)$

9. The series: $\sum_{n=1}^{\infty} \frac{2}{2^n+x}$

A) converges for all $x > 0$
B) converges when $0 < x < 1$ and diverges when $x > 1$
C) diverges when $0 < x < 1$ and converges when $x > 1$
D) diverges for all $x > 0$

10. The series $1 + \frac{1}{3} + \frac{1}{2 \times 9} + \frac{1}{3 \times 27} + \frac{1}{4 \times 81} \ldots$ converges to:

A) $\ln 2 - 1$ B) $\ln \frac{2}{3} - 1$ C) $\ln 3$ D) $\ln \frac{2}{3}$

11. The coefficient of x^2 in the Taylor series expansion of $f(x) = sin^2 x$ about $x = \frac{\pi}{2}$ is:

A) 1 B) -1 C) 2 D) -2

12. If $f(x) = \begin{cases} x, & -\pi < x < 0 \\ 1 - x, & 0 < x < \pi \end{cases}$
has a fourier series expansion, then $f(0)$ is:

A) $-\frac{1}{2}$ B) 0 C) $\frac{1}{2}$ D) -1

13. A particle moves along the curve given by $x = 2t,\ y = 3t^2,\ z = 2t - 5$, where t is the time. The component of its velocity in the direction of $2\vec{\imath} + 2\vec{\jmath} + \vec{k}$ at $t = 1$ is:

A) 6 B) 3 C) 2 D) 1

14. The acceleration of a moving particle is given by $\vec{a}t + \vec{b}$. Then the movement of the particle when both velocity and displacement are zero at time $t = 0$ is given by:

A) $\vec{r} = \vec{a}t^3 + \vec{b}t^2$ B) $\vec{r} = \frac{1}{6}\vec{a}t^3 + \frac{1}{2}\vec{b}t^2$

C) $\vec{r} = \frac{1}{4}\vec{a}t^3 + \vec{b}t^2$ D) $\vec{r} = \frac{1}{6}\vec{a}t^3 + \frac{1}{6}\vec{b}t^2$

15. The directional derivative of $\phi\ (x, y, z) = xy^2z^2 + 4xy$ at $(1, 0, 1)$ in the direction of $\vec{\imath} - 2\vec{\jmath} + \vec{k}$ is:

A) $-\frac{8}{3}$ B) $\frac{8}{3}$ C) $\frac{4}{3}$ D) $\frac{7}{3}$

16. Which of the following is **not** true?

A) $div\ (\phi f) = \phi \nabla . f + \nabla \phi . f$
B) $curl\ (\phi f) = \phi \nabla \times f + \nabla \phi \times f$
C) $curl\ curl\ f = grad\ div\ f + \nabla^2 f$
D) $div\ curl\ f = 0$

17. The divergence of $\phi\,(x,y,z) = x^2yz\vec{i} - 2xy\vec{j} + 4z^2\vec{k}$ at (1, -1, 1) is:

A) 0 B) 2 C) -4 D) 4

18. The general solution of $x^2\frac{d^2y}{dx^2} - 4x\frac{dy}{dx} + 4y = 0$ is:

A) $y = (A + Bx)logx$ B) $y = Ax+Bx^4$

C) $y = Ax+Bx^{-4}$ D) $y = Ae^x + Be^{4x}$

19. The Laplace transform of $t \sin 2t$ is:

A) $\frac{4s}{(s^2+4)^2}$ B) $\frac{s}{(s^2+4)^2}$ C) $\frac{4}{(s^2+4)^2}$ D) $\frac{4s}{(s^2+4)}$

20. Which of the following property does **not** hold for Fourier Transforms?

A) If $F(s)$ and $G(s)$ are Fourier transforms of $f(x)$ and $g(x)$ respectively and a, b are constants, then $F\big(af(x) + bg(x)\big) = aF(s) + bG(s)$.

B) If $F(s)$ denote the complex Fourier transform of $f(x)$, then $F\big(af(x)\big) = \frac{1}{a}\,F\left(\frac{s}{a}\right), a \neq 0$.

C) If $F(s)$ denote the complex Fourier transform of $f(x)$, then $F\big(f(x-a)\big) = e^{isa}F(s)$.

D) If $F(s)$ denote the complex Fourier transform of $f(x)$, then $F(f(x)\cos ax) = F(s+a) + F(s-a)$.

Questions **21-25**. Read the passage and choose the most appropriate answer from the options provided.

Caterpillars have a sixth sense that most land-based animals do not. They can sense electric fields around them with small bristles called setae on its body — a feat called electroreception. British researchers have discovered this in laboratory experiments and their findings were published recently in the Proceedings of the National Academy of Sciences. They studied four species of caterpillars: cinnabar moth, scarce vapourer moth, European peacock butterfly, and common wasp.

21. The 'sixth sense' of caterpillars relates to the ------- of electric fields:

A) purpose B) pursuit C) prevalence D) perception

22. 'Electroreception; is considered a 'feat' because:

A) The setae function like feet
B) The bristles resemble nails
C) It is a significant achievement
D) It was discovered only recently

23. The mismatched pronouns in the second sentence of the passage:

A) Feet/feat B) Feat/fete C) They/its D) Around/on

24. The team of researchers belonged to:
A) The United Kingdom B) The United States
C) The United Emirates D) The United Scientists

25. The European peacock butterfly is a/an:
A) Mineral B) Insect C) Bird D) Primate

26. The adjective/qualifying word in the sentence, 'The provisional title of the novel is No Time to Live.'
A) Provisional B) Title C) Time D) Live

27. "I am off to visit the Browns." The speaker mentions a visit to:
A) A household whose members share the family name 'Brown'.
B) A family whose members have a brownish complexion
C) A family whose members have brown eyes
D) A family whose members have brown hair

28. The scholarship was made possible ------of an endowment by a generous donor. (Fill in the blanks, using the correct option)
A) instead B) because C) in spite D) bespoke

29. Rearrange the words (numbered 1-7) in the logical order of a sentence:
you we were to miss all beginning 2 3 1 4 5 1 6
1 2 3 4 5 6 7
A) 1 3 6 4 5 2 7 B) 7 4 5 1 3 2 6
C) 2 3 6 7 4 5 1 D) 6 3 2 7 4 5 1

30. Pick the correctly spelt word:
A) Impostor B) impertinant C) improudent D) impaltry

31. What is the proportion of SiO_2 present in the manufacturing of cement?
A) 60 - 65% B) 17 - 25% C) 20 - 30% D) 10 - 15%

32. As per the National Building Code of India, educational buildings are categorized into which group based on occupancy criteria?
A) Group A B) Group B C) Group C D) Group D

33. The ratio quotient obtained by dividing the total floor area on all floors by the area of the plot is known as:
A) Floor area ratio B) Covered area ratio
C) Build area ratio D) None of the above

34. What is the BIS recommended Standard size of Modular bricks?
A) (19 cm x 9 cm x 9 cm) B) (20 cm x 10 cm x 10 cm)
C) (16 cm x 10 cm x 5 cm) D) (12 cm x 10 cm x 12 cm)

35. What is the proportion of CaO present in the manufacturing of cement?
A) 60 - 65% B) 17 - 25% C) 20 - 30% D) 10 - 15%

36. According to the Indian standard of cement, what is the permissible maximum limit for the total loss on ignition?
A) > 1% B) > 2% C) > 4% D) > 5%

37. The quality building stone should possess adequate crushing strength to withstand the load of the superstructure. Typically, what minimum value should this crushing strength not fall below?
A) 900 kg /cm^2 B) 1000 kg /cm^2
C) 1200 kg /cm^2 D) 1500 kg /cm^2

38. The portion of brick obtained by cutting off the triangular piece between centre of one end and centre of one side?
A) Bat B) Closer
C) King closer D) Bevelled closer

39. As per Indian standard what is the specific gravity of cement?
A) 2.16 B) 2.56 C) 3.16 D) 4.46

40. What are the complex compounds formed during the burning process that play a crucial role in the setting and hydration of cement?
A) Hydration compounds B) Bogues compounds
C) Calcium compounds D) Silica compounds

41. The common defect found in timber when the timber is stored for a longer time and may have a curve along its length:
A) Cup B) Bow C) Split D) Check

42. What percentage of tri-calcium aluminate (C3A) leads to an increase in resistance against sulphates?
A) Below 5% B) Above 50%
C) Between 50% to 75% D) Above75%

43. The uniformity coefficient of the soil is always:
A) Greater than or equal to 1 B) Zero
C) Equal to 1 D) None of these

44. What word is used to describe the moisture level in soil that marks the boundary between its liquid and plastic states?
A) Plastic limit B) Shrinkage limit
C) Liquid limit D) None of these

45. What is the term used for the ratio of the total volume of voids to the volume of the soil mass?

A) Void ratio
B) Air content
C) Porosity
D) None of these

46. The efficiency of a carnot engine operating with reservoir temperatures of 100^0 C and -23^0 C will be:

A) 33 %
B) 67 %
C) 40 %
D) 80 %

47. Identify the correct statement:

A) Dual cycle is more efficient than otto cycle for a given compression ratio
B) Otto cycle is more efficient than diesel cycle for a given compression ratio
C) For a given compression ratio, both otto and diesel cycle have same Efficiency
D) None of these

48. Which of the following does **not** describe Diesel cycle?

A) Limited maximum temperature
B) High compression ratio
C) Constant volume heat addition
D) No spark plug needed

49. A two stroke cycle engines gives how many power strokes compared to four stroke cycle engine, at the same engine speed:

A) Half
B) Same
C) Double
D) None of these

50. The ratio of brake power to the indicated power is called:

A) Mechanical efficiency
B) Overall efficiency
C) Indicated thermal efficiency
D) Volumetric efficiency

51. The lowest temperature at which the oil ceases to flow when cooled is known as:

A) Flash point
B) Fire point
C) Cloud point
D) Pour point

52. Which battery is preferred for Electric vehicle?

A) Lead - acid
B) Lithium – ion
C) Sodium –Sulphur
D) Nickel – Cadmium

53. C.O.P can be expressed by which equation?

A) $\frac{Work\ done}{Refrigertion\ effect}$
B) $\frac{Refrigertion\ effect}{Work\ done}$
C) $\frac{Work\ done}{Heat\ transter}$
D) $\frac{Heat\ transfer}{Work\ done}$

54. On a Psychrometric chart, the adiabatic process follows:
A) Constant dry Bulb temperature lines
B) Constant relative humidity lines
C) Constant dew point temperature lines
D) Constant enthalpy lines

55. A pump is to deliver 1000 lit/ m^3 of water at a head of 120 m. If the pump efficiency is 50 %, what is the brake power of motor required to drive the pump?
A) 2 Kw B) 4 Kw C) 6 Kw D) 8 Kw

56. Which device is the driven member of a clutch?
A) Driver gear B) Driven gear
C) Pressure plate D) Flywheel

57. In a four high rolling mill, there are four rolls out of which:
A) One is working roll and three are backing roll
B) Two are working roll and two are backing up roll
C) Three are working roll and one backing up roll
D) All the four are working rolls

58. Soft solder consist of:
A) Copper and Tin B) Lead and Zinc
C) Lead and Tin D) Lead and Aluminium

59. The cutting tool in a milling machine is mounted on:
A) Spindle B) Column C) Knee D) Arbor

60. The full form of STL in roped prototyping:
A) Straight – lithography B) Streto – lithography
C) Stereo – lithography D) Straight - liprography

61. Nodal analysis is primarily based on:
A) Kirchhoff's Voltage Law B) Faraday's Law
C) Kirchhoff's Current Law D) Ohm's Law

62. The law which explains the principle of electromagnetic induction:
A) Ohm's Law B) Faraday's Law
C) Kirchhoff's Law D) Coulomb's Law

63. What is the unit of inductance?
A) Farad B) Henry C) Ohm D) Tesla

64. In a parallel circuit with resistors of equal value, the current through each resistor is?
A) Equal B) Different C) Zero D) Infinite

65. In an AC circuit containing only a capacitor, the current:
A) Leads the voltage by 90 degrees
B) Lags the voltage by 90 degrees
C) Is in phase with the voltage
D) None of these

66. The component which opposes changes in current in an electric circuit:
A) Resistor
B) Capacitor
C) Transformer
D) Inductor

67. If the RMS value of a sinusoidal current is 5A, its peak value is:
A) 3.54 A B) 5 A C) 7.07 A D) 10 A

68. The entire magnetic flux of one coil links the other coil the coefficient of coupling is:
A) Zero B) 0.5 C) 1 D) Infinity

69. An example of statically induced EMF is:
A) The voltage induced in the rotor of a generator
B) The EMF induced in a DC motor's armature
C) The voltage generated in a moving coil
D) The EMF induced in a transformer

70. The MMF in a magnetic circuit is given by:
A) H l B) N I C) B A D) V I

71. A series A.C. circuit has R = 4 Ω and XL= 5Ω. It will be expressed in the rectangular form as:
A) $(-4-j5)\ \Omega$
B) $(-4+j5)\ \Omega$
C) $(4+j5)\ \Omega$
D) $(4-j5)\ \Omega$

72. Reactive power in an AC circuit is measured in:
A) Volt-amperes reactive (VAR)
B) Volt-amperes (VA)
C) Watts (W)
D) None of the above

73. An alternating voltage is given by v = 200 sin314 t. Its peak value will be:
A) 121.4 V B) 282.8 V C) 141.4 V D) 200 V

74. The algebraic sum of instantaneous phase voltages in a three-phase circuit is equal to:
A) Zero
B) Line voltage
C) Phase voltage
D) None of these

75. In a delta connection, the line current is:
A) Equal to the phase current
B) $\sqrt{3}$ times the phase current
C) Half of the phase current
D) $\frac{1}{\sqrt{3}}$ times the phase current

76. Major portion of the current in an intrinsic semiconductor is caused by:
A) Valence band electrons B) Conduction band electrons
C) Holes in the valence band D) Thermally-generated electron

77. The most commonly used semiconducting material in electronic devices is:
A) silicon B) germanium C) copper D) carbon

78. For a silicon diode, the value of the forward bias voltage typically:
A) Must be greater than 0.3 V
B) Must be greater than 0.7 V
C) Depends on the width of the depletion region
D) Depends on the concentration of majority carriers

79. The width of depletion layer of a P-N junction:
A) Decreases with light doping
B) Increases with heavy doping
C) Increases under reverse bias
D) Is independent of applied voltage

80. The emitter of a transistor is generally doped heavily because it:
A) Must possess low resistance
B) Has to supply the charge carriers
C) Is the first region of the transistor
D) Has to dissipate maximum power

81. For a properly biased NPN transistor, most of the electrons from the emitter:
A) Recombines with holes in the base
B) Recombines in the emitter itself
C) pass through the base to the collector
D) Are stopped by the junction barrier

82. Avalanche breakdown is primarily dependent on the phenomenon of:
A) Collision B) Doping
C) Recombination D) Ionization

83. Silicon is preferred for the manufacturing of Zener diodes because it:
A) is relatively cheap B) has higher temperature and current capacity
C) needs lower doping level D) has lower break-down voltage

84. Zener diodes are used primarily as:
A) voltage regulators B) rectifiers
C) oscillators D) amplifiers

85. The basic reason for a Full Wave rectifier having twice the efficiency of a Half Wave rectifier is that:
A) It makes use of a transformer
B) Its ripple factor is much less
C) It utilizes both half cycle of the input
D) Its output frequency is double the line frequency

86. When a BJT is used in an amplifier circuit, it works:
A) in cut-off B) in saturation
C) well into saturation D) over the active region

87. The main reason for the variation of amplifier gain with frequency is:
A) The presence of both external and internal capacitances.
B) Due to interstage transformers
C) The logarithmic increase in its output power
D) The Miller effect

88. 100% modulation happens in Amplitude Modulation when carrier signal:
A) Frequency equals modulating signal frequency
B) Frequency exceeds modulating signal frequency
C) Amplitude is same as modulating signal amplitude
D) Amplitude exceeds modulating signal amplitude

89. The main disadvantage of Frequency Modulated transmission is its:
A) High static noise B) Limited line of sight range
C) Expensive equipment D) Adjacent channel interference

90. In an Amplitude Modulated wave with 100 percent modulation, each sideband carries how much amount of the total transmitted power.
A) one-half B) one-sixth C) one-third D) two-third

91. What is the correct syntax to declare a variable in C?
A) int a; B) var int a; C) int a: D) int a = 10;

92. Which of the following is a valid C variable name?
A) int B) 123variable C) variable_1 D) variable-1

93. What is the output of the following code?

```
int a = 5, b = 10;
printf("%d", a + b);
```

A) 5 B) 10 C) 15 D) None of these

94. Which of the following operators is used to get the address of a variable in C?
A) * B) & C) @ D) #

95. What is the output of the following code?

```
#include <stdio.h>
int main() {
    printf("%d", 5+10*3);
    return 0;
}
```

A) 45 B) 35 C) 15 D) 30

96. What is the size of an *int* data type in C?
A) 2 Bytes B) 4 Bytes
C) 8 Bytes D) It depends on the compiler

97. What is the output of the following code?

```
#include <stdio.h>
  int main() {
  int x = 10, y = 5;
  printf("%d", x | y);
 return 0;
}
```

A) 2 B) 5 C) 10 D) 15

98. Which of the following is used to input a string in C?
A) gets() B) scanf() C) printf() D) putchar()

99. What will be the output of the following code?

```
#include <stdio.h>
int main() {
    int a = 10;
    if (a < 20) {
      printf("a is less than 20\n");
    }
 return 0;
}
```

A) No output B) a is less than 20
C) Error D) None of these

100. Which of the following is **not** a valid storage class in C?
A) auto B) static C) register D) private

101. Which of the following functions is used to compare two strings in C?
A) strcmp() B) strcpy() C) strcat() D) strlen()

102. Which of the following statements about functions is true in C?
A) A function can have more than one return statement
B) A function cannot return a value
C) A function cannot call another function
D) Functions can only return integer values

103. Which of the following is the correct syntax to declare a constant in C?
A) const int a; B) int const a;
C) Both A and B D) None of these

104. What is the output of the following code?

```
#include <stdio.h>
int main() {
    int var = 10;
    int *ptr;
    ptr = &var;
    printf("%d", *ptr);
    return 0;
}
```

A) Address of var B) 10
C) Value of ptr D) Error

105. What will be the output of the following code?

```
#include <stdio.h>
int main() {
    int x = 5;
    int *ptr = &x;
    *ptr = 10;
    printf("%d", x);
    return 0;
}
```

A) 5 B) 10
C) Address of x D) Garbage value

106. If two equal forces of magnitude P act at a point with an included angle 180°, their resultant will be:
A) P/2 B) P sin 90 C) Zero D) 2P

107. The forces, which do not meet at one point, but their lines of action lie on the same plane, are known as:
A) Coplanar non-concurrent forces
B) Coplanar concurrent forces
C) Concurrent forces
D) on-concurrent forces.

108. Find the magnitude of the two forces, such that if they act at right angles, their resultant is 10 N . But if they Act at 60°, their resultant is 13 N. Two resolved parts in two directions at right angles are equal:
A) 1N, 3N B) 1N, 2N C) 2N, 3N D) 2N, 2N

109. The process of splitting up the given force into a number of components, without changing its effect on the body is called:
A) Splitting of forces B) Resolution of a force
C) Force couple D) Balancing of couple

110. In which type of lever, the effort and load act on the opposite sides of the fulcrum:
A) Lever of first order B) Lever of second order
C) Lever of third order D) Lever of forth order

111. A framed structure is perfect if it contains members equal to:
(where n = number of joints in a frame)
A) n-1 B) 2n-1 C) 2n-2 D) 2n-3

112. The unit of moment of inertia of an area is:
A) kgm^2 B) m^3 C) kg/m^2 D) m^4

113. The unit of mass moment of inertia is:
A) Kg/m^2 B) Kgm^4 C) kgm^2 D) kg/m^3

114. The ratio of limiting friction to the normal reaction is defined as:
A) Angle of friction B) Angle of repose
C) Cone of friction D) Coefficient of friction

115. Which one of the following statements is **not** correct?
A) The algebraic sum of the forces, constituting the couple, is zero.
B) The algebraic sum of the moments of the forces, constituting the couple, about any point is the same, and equal to the moment of the couple itself.
C) A couple can be balanced by a single force.
D) A couple can be balanced only by a couple of opposite sense.

116. The Centre of gravity of right circular solid cone with height "h" is measured along the vertical axis from its base is:
A) h B) h/3 C) h/2 D) h/4

117. The distance through which a screw thread advances axially in one turn is:
A) Pitch
B) Lead
C) Helix
D) Depth of thread

118. The larger and smaller diameters of a differential wheel and axle are 80 mm and 70 mm respectively. The effort is applied to the wheel of diameter 250 mm. What is the velocity ratio?
A) 28
B) 48
C) 2
D) 3

119. The efficieney of a lifting machine entail in terms of the ratio of:
A) Its the mechanical advantage to its velocity ratio
B) Work done by it to the work done on it
C) It's output to input
D) All of the above

120. The efficieney of a lifting machine is kept constant, its velocity ratio is directly proportional to its:
A) Mechanical advantage
B) Effort applied
C) Machine friction
D) All of these