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2020

TEST BOOKLET

TEST BOOKLET SERIES

B

Time allowed : 2 hours

Full marks : 200

Answer ***all*** the questions.

Questions are of equal value.

Serial No. 05046

Roll No.:

Signature of the Candidate:

INSTRUCTIONS

Candidates should read the following instructions carefully before answering the questions:

SE

1. This booklet consists of 28 pages including this front page, containing 100 questions each for Group 'A' and 'B'. **Verify the Page Nos. and Test Booklet series on each page and bring at once to the Invigilator's notice any discrepancy.**
2. Answers will have to be given in the Special Answer-Sheet supplied for the purpose.
3. Before you proceed to mark in the Answer-Sheet in response to various items in the Test Booklet, you have to fill in some particulars in the Answer-Sheet as per instructions sent to you in the Admit Card. ***Do not fold the Answer-Sheet as this will result in error in your marks.***
4. All questions are of multiple-choice answer-type. You will find ***four*** probable answers **(A)**, **(B)**, **(C)** and **(D)** against each question. Find out which of the four answers appears to be **correct or the best**. Now darken the circle corresponding to the letter of the selected answer in the Answer-Sheet with **Black Ball Point Pen** as per instructions printed on the reverse of the Admit Card and in the Answer-Sheet.
5. One and only one circle is to be fully blackened for answer. Any spot in any other circle (multiple circle) or in wrong circle will be considered as wrong answer.
6. ***There will be negative marking for wrong answer. $\frac{2}{3}$ mark will be deducted for each wrong answer.***
7. ***There are blank pages at the end of this Booklet for Rough Work.***
8. ***The Special Answer-Sheet should be handed over to the Invigilator before leaving the Examination Hall. You are permitted to take away the used Test Booklet after completion of the examination.***

The Questions of **Group – 'A' are meant for the candidates of ELECTRICAL ENGINEERING** and those of **Group – 'B' for the Candidates of MECHANICAL ENGINEERING.**

Group-A
(Electrical Engineering)

1. Which is the most common, famous and adopted method of cooling of a power transformer?

(A) Air blast cooling
(B) Natural air cooling
(C) Oil cooling
(D) Any of the above methods can be used

2. The maximum efficiency of a half-wave rectifier is

(A) 40·60%
(B) 81·30%
(C) 50·50%
(D) 25·25%

3. Transient voltages typically last for

(A) 10 seconds to 1 minute.
(B) 1 to 10 seconds.
(C) few milliseconds to seconds.
(D) a microsecond to several milliseconds.

4. A single-phase, 50 Hz, 40 kVA transformer with a ratio of 2000 V/ 250 V has a primary resistance of 1.15 Ω and the secondary resistance of 0.0155Ω. Calculate total copper loss on half of the full load.

(A) 856.8 W
(B) 214.2 W
(C) 642.6 W
(D) 428.4 W

5. A second-order control system has a damping ratio as 0.6 and natural frequency of oscillation as 11 radian/second. What will be the damped frequency of oscillation?

(A) 2.6 radian/second
(B) 5.6 radian/second
(C) 6.9 radian/second
(D) 8.8 radian/second

6. A three-phase induction motor has a starting torque of 200 N-m when switched on directly to supply. If an Auto-transformer with 50% tapping is used for starting, the starting torque would be

(A) 100 N-m
(B) 400 N-m
(C) 50 N-m
(D) 200 N-m

7. Greenhouse effect is enhanced in the environment by the gas

(A) CO_2
(B) CO
(C) Fluorocarbons
(D) NO_2

8. Poisson's equation relates the potential V at a point to the volume charge density ρ at that point as

(A) $\nabla V = \varepsilon_0 \rho$
(B) $\nabla^2 V = \varepsilon_0 \rho$
(C) $\nabla^2 V = \varepsilon_{0/} \rho$
(D) $\nabla^2 V = -\varepsilon_0 \rho$

9. Solve the given system of equation by Gauss Elimination method:

$$3x+4y-z=-6$$

$$-2y+10z=-8$$

$$4y-2z=-2$$

(A) $(-2,-1,-1)$

(B) $(-1,-2,-1)$

(C) $(-1,-1,-2)$

(D) $(-1,-1,-1)$

10. $\int_0^{\frac{\pi}{2}} \frac{\sin\theta-\cos\theta}{\sqrt{\sin 2\theta}}\, d\theta$ is equal to

(A) 4

(B) 2

(C) 1

(D) 0

11. In a split-phase motor, the running winding should have

(A) high resistance and low inductance.

(B) high resistance and high inductance.

(C) low resistance and high inductance.

(D) low resistance and low inductance.

12. In an alternator, the relay protection is absolutely necessary for

(A) Overcurrent

(B) Field failure

(C) Stator winding fault

(D) None of the above

13. A cumulatively compounded long shunt generator when operating as a motor would be

(A) cumulatively compounded long shunt.

(B) differentially compounded long shunt.

(C) cumulatively compounded short shunt.

(D) differentially compounded short shunt.

14. Study the following program:

```
1. Main()
2. {printf("javatpoint");
3. Main();}
```

What will be the output of this program?

(A) Wrong statement.

(B) Will keep on printing javatpoint.

(C) It will print javatpoint once.

(D) None of the above

15. When a pentavalent impurity is added to a pure semiconductor, it becomes _____.

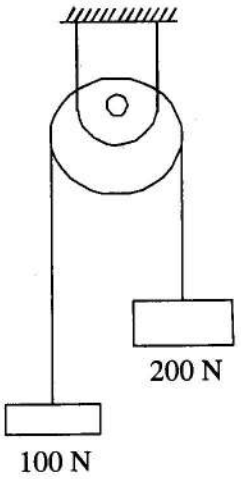
(A) an insulator

(B) an intrinsic semiconductor

(C) *p*-type semiconductor

(D) *n*-type semiconductor

16. An inextensible massless string goes over a frictionless pulley as shown in figure below. Two weights of 100 N and 200 N are attached to the two ends of the string. The weights are released from rest and start moving due to gravity. The tension in the string (in N) is



(A) 133·32 N

(B) 122·22 N

(C) 166·62 N

(D) 144·42 N

AEM

17. Which material has the highest conductivity of all materials?

(A) Silver
(B) Copper
(C) Gold
(D) Tungsten

18. What is the dielectric strength of porcelain?

(A) 55 kV/cm
(B) 60 kV/cm
(C) 75 kV/cm
(D) 80 kV/cm

19. The illumination is directly proportional to the cosine of the angle made by the normal to the illuminated surface with the direction of the incident-flux.

Above statement is associated with

(A) Planck's law
(B) Macbeth's law of illumination
(C) Bunsen's law of illumination
(D) Lambert's cosine law

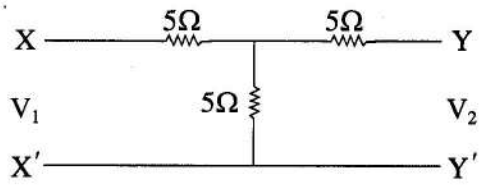
20. In a simple gear train, 1st gear (Driver) has 40 number of teeth, 2nd gear has 20 number of teeth and last gear has 80 number of teeth. The train value of the gear train is

(A) 2·0
(B) 1·2
(C) 1·0
(D) 0·5

21. The centrifugal pump has a _____ flow.

(A) variable
(B) continuous
(C) constant
(D) uniform

22. For the circuit given below, the value of hybrid parameter h_{22} is _____.



(A) 0.2 Ω
(B) 0.5 Ω
(C) 0.1 Ω
(D) 0.3 Ω

23. Maximize the function $x+y-z=1$ w respect to the constraint $xy=36$:

(A) 0
(B) –8
(C) 8
(D) No Maxima exists.

24. Find n for the following data if $f(0.2)$ asked?

x	0	1	2	3	4	5	6
$f(x)$	176	185	194	203	212	220	229

(A) 0.4
(B) 0.2
(C) 1.0
(D) 0.1

25. In an overhead transmission line, wa traps are used for the detection of

(A) the fault current signals.
(B) the fault voltage signals.
(C) carrier signals.
(D) fault power signals.

26. The value of the time constant of a R-L circuit is

(A) L/R
(B) R/L
(C) L
(D) R

27. ∇V is the gradient of V expressed in

(A) $\nabla V=\frac{\delta V}{\delta x}+\frac{\delta V}{\delta y}+\frac{\delta V}{\delta z}$

(B) $\nabla V=\frac{\delta V}{\delta x}i_x+\frac{\delta V}{\delta y}i_y+\frac{\delta V}{\delta z}i_z$

(C) $\nabla V=\frac{\delta V_x}{\delta x}+\frac{\delta V_y}{\delta y}+\frac{\delta V_z}{\delta z}$

(D) $\nabla V=\frac{\delta}{\delta x}i_x+\frac{\delta}{\delta y}i_y+\frac{\delta}{\delta z}i_z$

28. The unit of Kinematic Viscosity is

(A) kg/m^2s
(B) kgs/m^2
(C) m/kgs
(D) m^2/s

29. Find the force between 2C and –1C separated by a distance 1.0 m in air (in Newton).

(A) 18×10^6
(B) -18×10^6
(C) 18×10^{-6}
(D) -18×10^{-6}

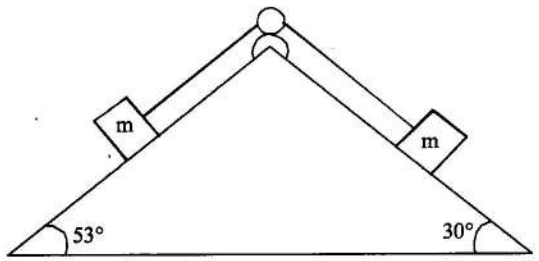
30. For matching a circuit of circuit impedance of 200 Ω with a load of 8 Ω, the turn ratio of the two winding of the transformer should be

(A) 25
(B) 1/25
(C) 5
(D) 1/5

31. According to Kepler, planets move in

(A) circular orbits around the sun.
(B) elliptical orbits around the sun with sun at one of its foci.
(C) straight lines with constant velocity.
(D) elliptical orbits around the sun with sun at exact centre.

32. Consider the figure as shown below. If coefficient of friction is μ then what is the least value of μ so that the system remains in rest?



(A) 0·130
(B) 0·200
(C) 0·203
(D) 0·230

33. A depletion MOSFET differs from a JFET in the sense that it has no

(A) Substrate
(B) Gate
(C) P-N junction
(D) Channel

34. According to Lami's theorem

(A) three forces acting at a point will be in equilibrium.

(B) three forces acting at a point can be represented by a triangle, each side being proportional to force.

(C) if three forces acting upon a particle are represented in magnitude and direction by the side of a triangle, taken in order, they will be in equilibrium.

(D) if three forces acting at a point are in equilibrium, each force is proportional to the sine of the angle between the other two.

35. Why starters are required in a DC motor?

(A) Back emf of these motors is zero initially.

(B) These motors are not self-starting.

(C) These motors have high starting torque.

(D) To restrict armature current as there is no back emf at starting.

36. A material that has zero resistance is called

(A) Insulator

(B) Conductor

(C) Superconductor

(D) Semiconductor

37. The pump, suitable for small discharge and high head, is

(A) Centrifugal pump

(B) Axial flow pump

(C) Mixed flow pump

(D) Reciprocating pump

38. Supplier's fuse, which is provided in domestic wiring system is

(A) after the energy meter.

(B) before the energy meter.

(C) before the distribution board.

(D) after the main switch.

39. $\lim_{x \to 0} x \sin \frac{1}{x}$ is

(A) 1

(B) –1

(C) 0

(D) infinity

40. What will be the radius of gyration of a circular plate of diameter 10 cm?

(A) 1.5 cm

(B) 2.0 cm

(C) 2.5 cm

(D) 3.0 cm

41. The real part of the complex frequency is called

(A) Radian Frequency

(B) Neper Frequency

(C) Sampling Frequency

(D) Angular Frequency

42. In reciprocating pump air vessel is required for

(A) smooth the flow.

(B) increased delivery head.

(C) reduce suction head.

(D) reduce acceleration head.

43. The critical field circuit resistance of a d.c. generator

(A) increases linearly with speed.
(B) decreases linearly with speed.
(C) increases non linearly with speed.
(D) is independent of speed.

44. The energy density of a magnetic field H is

(A) $\frac{\rho H^2}{2}$
(B) $\frac{\rho H}{2}$
(C) $\frac{\mu\sqrt{H}}{2}$
(D) μH

45. In a solid shaft, stress at the centre is

(A) Minimum
(B) Average
(C) Maximum
(D) Zero

46. The usual spans with R.C.C. poles are

(A) 40–50 metres
(B) 60–100 metres
(C) 200–300 metres
(D) 80–150 metres

47. As the thickness of the part to be welded increases, which of the following parameter for ac welding should also increase?

(A) Voltage
(B) Current
(C) Frequency
(D) All of the above

48. Which type of lamp holder from the following is fitted directly on the wooden board?

(A) Angle holder
(B) Bracket holder
(C) Batten holder
(D) Pendent holder

49. Complex frequency of $f(t) = 5\cos(500t + 30°)$ is

(A) $-3 + j100$
(B) $-5 + j\theta$
(C) $0 + j500$
(D) $0 + j0$

50. The rotor of a 6-pole, 3-Φ, 50 Hz induction motor has per phase resistance and reactance of 0.1 Ω and 0.5 Ω respectively. The voltage per phase in the rotor at standstill condition is 150 volts. When the motor develops maximum torque, the rotor current per phase will be

(A) 750 A
(B) 150 A
(C) $750\sqrt{2}$ A
(D) $150\sqrt{2}$ A

51. If the supply frequency of a transformer increases, the secondary output voltage of the transformer

(A) decreases.
(B) increases.
(C) remains the same.
(D) Any of the above

52. According to Lambert's law, the illumination on a surface is proportional to

(A) $\cos^2\theta$
(B) $1/\cos^3\theta$
(C) $\cos^3\theta$
(D) $1/\cos^2\theta$

Please Turn Over

53. Which of the following is the fastest switching device?

(A) JFET
(B) BJT
(C) MOSFET
(D) Triode

54. If the angular momentum of a particle of mass m rotating along a circular path of radius r with uniform speed is L, the centripetal force acting on the particle is

(A) $\frac{L^2}{mr^2}$
(B) $\frac{L^2}{mr}$
(C) $\frac{L}{mr}$
(D) $\frac{L^2 m}{r}$

55. Which of the following circuit breakers is preferred for EHT application?

(A) Air blast circuit breakers
(B) Minimum oil circuit breakers
(C) Bulk oil circuit breakers
(D) SF_6 oil circuit breakers

56. A person cannot see the distant objects clearly (though he can see the nearby objects clearly). He is suffering from the defect of vision called

(A) Cataract
(B) Hypermetropia
(C) Myopia
(D) Presbyopia

57. If $v=\left(x^2+y^2+z^2\right)$, then $\frac{\delta^2 v}{\delta x^2}+\frac{\delta^2 v}{\delta y^2}+\frac{\delta^2 v}{\delta z^2}$ is

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

58. Lightwave travel with a velocity of

(A) 3×10^{16} cm/sec
(B) 3×10^{14} cm/sec
(C) 3×10^{12} cm/sec
(D) 3×10^{10} cm/sec

59. What happens when heat is applied to the joined ends of the wires of thermocouple?

(A) The wires contract
(B) The wires start to rotate
(C) A small voltage is generated
(D) The wires separate

60. There are _____ parameters of a transistor.

(A) two
(B) four
(C) three
(D) six

61. A transmission line having length equal to odd multiple of quarter wavelength is short circuited, the input impedance is

(A) Zero
(B) 0.25 pu
(C) Unity
(D) 4 times

62. Given $y = 5e^{3x} + \sin x$, $\frac{dy}{dx}$ is

(A) $5e^{3x} + \cos x$

(B) $15e^{3x} + \cos x$

(C) $15e^{3x} - \cos x$

(D) $2{\cdot}666e^{3x} - \cos x$

63. A 3-phase 440 V, 50 Hz induction motor has 4% slip. The frequency of rotor current will be

(A) 50 Hz

(B) 25 Hz

(C) 5 Hz

(D) 2 Hz

64. An electric motor of 1·5 hp connected for supply of 220 V, then current drawn by electric motor is

(A) 2 A

(B) 3 A

(C) 4 A

(D) 5 A

65. Candela is the unit of

(A) Luminous flux

(B) Luminous intensity

(C) Wavelength

(D) None of the above

66. Find the current carrying capacity of wire from meter to main distribution board having three light/fan circuits of 800 watt each and two 15A power circuits of 1.5 kW each. Take the permissible power factor as 0.8 and safety factor as 1.5.

(A) 50 A

(B) 30 A

(C) 45 A

(D) 65 A

67. What happens if the field winding of the synchronous motor is short-circuited?

(A) First, starts as induction motor then runs as synchronous motor.

(B) Not start

(C) Motor will burn out.

(D) Runs as induction motor.

68. Laplace transform of $e^{at}\cos\omega t$ is

(A) $\frac{(s-a)}{(s-a)^2+\omega^2}$

(B) $\frac{\omega}{(s-a)^2+\omega^2}$

(C) $\frac{a}{(s-a)^2+\omega^2}$

(D) $\frac{s}{(s-a)^2+\omega^2}$

69. Centre of gravity of a solid cone lies on the axis at the height

(A) one-half of the total height above the base.

(B) one-third of the total height above the base.

(C) one-fourth of the total height above the base.

(D) three-eighth of the total height above the base.

70. If all the sequence voltages at the fault point in a power system are equal, then the fault is a

(A) Three-phase fault

(B) Line to ground fault

(C) Line to line fault

(D) Double line to ground fault

71. The Laplacian of a scalar function V is

(A) divergence of V.

(B) divergence of the gradient of V.

(C) gradient of V.

(D) gradient of the gradient of V.

72. d'Alembert's principle is used for

(A) reducing the problem of kinetics to equivalent statics problem.

(B) determining stresses in the truss.

(C) stability of floating bodies.

(D) designing safe structures.

73. Which of the following band is just above the intrinsic Fermi-level for *n*-type semiconductor?

(A) Conduction band

(B) Valence band

(C) Acceptor band

(D) Donor band

74. The domestic refrigerator uses following types of compressors:

(A) Piston type reciprocating

(B) Axial

(C) Miniature sealed unit

(D) Centrifugal

75. Heat from the filament of a lamp is transmitted to the surrounding—mainly through

(A) Conduction

(B) Convection

(C) Radiation

(D) No heat is transferred.

76. The maximum energy that an electron may possess at T = 0 K is

(A) The zero-point energy

(B) Vacuum level energy

(C) Fermi level energy

(D) None of the above

77. Which section of The Electricity Act, 2003 deals with the Captive generation?

(A) Section 12 of The Electricity Act, 2003

(B) Section 9 of The Electricity Act, 2003

(C) Section 14 of The Electricity Act, 2003

(D) Section 20 of The Electricity Act, 2003

78. A two-port device is defined by the following pair of equations:

$$I_1 = 2V_1 + V_2 \text{ and } I_2 = V_1 + V_2$$

Its impedance parameters $\begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix}$ are given by

(A) $\begin{bmatrix} 2 & 1 \\ 1 & 1 \end{bmatrix}$

(B) $\begin{bmatrix} 1 & -1 \\ -1 & 2 \end{bmatrix}$

(C) $\begin{bmatrix} 1 & 1 \\ 1 & 2 \end{bmatrix}$

(D) $\begin{bmatrix} 2 & -1 \\ -1 & 1 \end{bmatrix}$

79. An overcurrent relay having a current setting of 150% is connected through a 400/5 CT. The pick-up value of current is

(A) 2.5 A

(B) 5 A

(C) 7.5 A

(D) 10 A

80. Power transformers are designed to have maximum efficiency at

(A) No load

(B) 50% load

(C) 80% load

(D) Full load

81. The ratio of limiting friction and normal reaction is known as

(A) Angle of Friction
(B) Coefficient of Friction
(C) Angle of Repose
(D) Sliding Friction

82. For which of the following protection from negative sequence currents are provided?

(A) Generators
(B) Motors
(C) Transmission line
(D) Transformers

83. Maxwell's curl equation for static magnetic field is given by

(A) $\nabla \cdot B = 0$
(B) $\nabla \cdot \bar{B} = \mu_0 J$
(C) $\nabla \times \bar{B} = \mu_0 J$
(D) $\nabla \cdot B = \mu_0 J$

84. Carrier current protection scheme is normally used for protection of

(A) HV cable only.
(B) HV transmission line only.
(C) Both (A) and (B)
(D) None of the above

85. CRO gives the visual representation of time varying signals. The display of the signal is

(A) One-dimensional
(B) Two-dimensional
(C) Three-dimensional
(D) Four-dimensional

86. A pair of linear equations $a_1x + b_1y + c_1 = 0$; $a_2x + b_2y + c_2 = 0$ is said to be inconsistent, if

(A) $\frac{a_1}{a_2} \neq \frac{b_1}{b_2}$
(B) $\frac{a_1}{a_2} = \frac{b_1}{b_2} \neq \frac{c_1}{c_2}$
(C) $\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$
(D) $\frac{a_1}{a_2} \neq \frac{c_1}{c_2}$

87. At what temperature the donor states are completely ionized?

(A) 0 K
(B) Room
(C) 300 K
(D) 900 K

88. Which of the following generators are used in arc welding?

(A) Shunt generators
(B) Series generators
(C) Cumulative compound generators
(D) Differential compound generators

89. Newton's universal law of gravitation

(A) applies to small bodies only.
(B) applies to planets only.
(C) is only valid for solar system.
(D) applies to both small and big bodies.

90. The standard voltage of 3 ft. fluorescent tube is

(A) 10 W
(B) 40 W
(C) 65 W
(D) 100 W

91. The magnetic quantum number specifies
(A) Size of Orbitals
(B) Shape of Orbitals
(C) Orientation of Orbitals
(D) Nuclear Stability

92. A piece of paper lies on a table 2m away from a point directly below a bulb of 100 cd and is 4 m above the table. Calculate the illumination on the centre of the paper in lux.
(A) 5.2
(B) 5.7
(C) 4.5
(D) 3.4

93. If brushes of a d.c. generator are moved in order to bring these brushes in magnetic neutral axis, there will be
(A) demagnetization only.
(B) cross-magnetization as well as magnetization.
(C) cross-magnetization as well as demagnetization.
(D) cross-magnetization only.

94. Which section of The Electricity Act, 2003 deals with National policy on electrification and local distribution in rural areas?
(A) Section 7 of The Electricity Act, 2003
(B) Section 4 of The Electricity Act, 2003
(C) Section 5 of The Electricity Act, 2003
(D) Section 9 of The Electricity Act, 2003

95. The secondary winding of which of the following transformers is always kept closed?
(A) Current transformer
(B) Voltage transformer
(C) Power transformer
(D) Step-down transformer

96. Poise is the unit of
(A) Kinematic Viscosity
(B) Mass Density
(C) Dynamic Viscosity
(D) None of the above

97. The matrix which do have an inversion by solving, it is classified as
(A) Non-singular matrix
(B) Singular matrix
(C) Unidentified matrix
(D) Linear matrix

98. If A_I, A_V and A_P are the current, voltage and power gains of a transistor amplifier, then
(A) $A_V = A_P / A_I$
(B) $A_V = A_P A_I$
(C) $A_V = A_P + A_I$
(D) $A_V = A_P - A_I$

99. Laplace Transform of Unit Impulse function is
(A) 1/s
(B) s
(C) 1
(D) 2s

100. Domestic electrical wiring is basically a
(A) series connection.
(B) parallel connection.
(C) combination of series and parallel connections.
(D) series connection within each room and parallel connection elsewhere.

Group-B
(Mechanical Engineering)

1. The mechanical efficiency of single cylinder four stroke engine is 90%. If the frictional power is estimated to be 25 kW, the indicated power will be

(A) 100 kW
(B) 125 kW
(C) 200 kW
(D) 250 kW

2. The heat treatment process, which is used to softening the martensitic steel:

(A) nitriding
(B) annealing
(C) normalising
(D) tempering

3. The moment of inertia of a thin uniform rod of mass M and length L about an axis perpendicular to the rod, through its centre is I, the moment of inertia of the rod about an axis perpendicular to the rod through its endpoint is

(A) $\frac{I}{4}$
(B) $\frac{I}{2}$
(C) 2I
(D) 4I

4. A thin cylinder with both ends closed is subjected to internal pressure p. The longitudinal stress at the surface has been calculated as σ_0. Maximum shear stress at the surface will be

(A) $2\,\sigma_0$
(B) $1.5\,\sigma_0$
(C) σ_0
(D) None of the above

5. A person standing on the bank of a canal drops a stone on the water surface. He notices that the disturbance on the water surface is not travelling up-stream. This is because the flow in the canal is

(A) sub-critical
(B) super-critical
(C) steady
(D) uniform

6. Which of the following voltmeters would be selected for most accurate readings?

(A) 100 V, 1A
(B) 100 V, 100 ohms/volt
(C) 100 V, 1 mA
(D) 100 V, 10 mA

7. The bore and stroke of the cylinder of a 4-cylinder engine working on Otto cycle are 17 cm and 30 cm respectively, total clearance volume is 10000 cm^3, then what is the compression ratio?

(A) 3·72
(B) 2·72
(C) 4·72
(D) 5·42

8. For given value of maximum pressure, temperature and heat rejection, efficiency of Otto cycle compared to Diesel cycle is

(A) same
(B) less
(C) more
(D) None of the above

9. For the function $f(x) = x^2 e^{-x}$ the maximum occurs when x equal to

(A) 2

(B) 1

(C) 0

(D) -1

10. For an underdamped harmonic oscillator, resonance

(A) occurs when excitation frequency is greater than undamped natural frequency.

(B) occurs when excitation frequency is less than undamped natural frequency.

(C) occurs when excitation frequency is equal to undamped natural frequency.

(D) never occurs.

11. What is the value of the definite integral

$$\int_0^{2\pi} |\cos x| \, dx \, ?$$

(A) 0

(B) 4

(C) $\frac{3\pi}{8}$

(D) $\frac{\pi}{8}$

12. Monel metal is an alloy of

(A) copper and nickel

(B) iron and carbon

(C) aluminium and copper

(D) copper and zinc

13. A thin ring of mass 5 kg and diameter 20 cm is rotating about its axis at 4200 rpm. Find its angular momentum (in kgm^2/s).

(A) 44

(B) 11

(C) 22

(D) 33

14. Starting friction is low in

(A) Hydrostatic lubrication

(B) Hydrodynamic lubrication

(C) Semi-fluid lubrication

(D) Boundary lubrication

15. A horizontal jet of water with its cross-sectional area of 0·0028 m^2 hits a fixed vertical plate with a velocity of 5 m/s. After impact the jet splits symmetrically in a plane parallel to the plane of the plate. The force of impact (in N) of the jet on the plate is

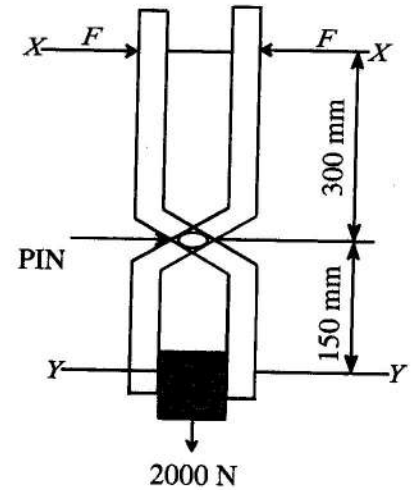
(A) 90

(B) 80

(C) 70

(D) 60

16. The below figure shows a pair of pin-joined gripper-tongs holding an object weighing 2000N. The coefficient of friction at the gripping surface is 0·1. *XX* is the line of action of the input force and *YY* is the line of application of gripping force. If the pin-joint is assumed to be frictionless, the magnitude of force *F* required to hold the weight is



(A) 1000N

(B) 2000N

(C) 2500N

(D) 5000N

17. What is the speed of sound in Neon gas at a temperature of 500 K (gas constant of neon is 0.4210 kJ/kg-K)?

(A) 492 m/s
(B) 460 m/s
(C) 592 m/s
(D) 543 m/s

18. Internal gears can be made by

(A) hobbing.
(B) gear shaping with rack cutter.
(C) gear shaping with pinion cutter.
(D) gang milling.

19. The pollutant of automobile exhaust gas which is a major cause of photochemical smog—

(A) SO_x
(B) HC
(C) NO_x
(D) CO

20. Morse test is used to determine the _____ power of multi-cylinder engine.

(A) brake power
(B) indicated power
(C) friction power
(D) All of the above

21. A balloon containing an ideal gas is initially kept in an evacuated and insulated room. The balloon ruptures and the gas fills up the entire room. Which one of the following statement is true at the end of the above process?

(A) The internal energy of the gas decreases from its initial value, but the enthalpy remains constant.
(B) The internal energy of the gas increases from its initial value, but the enthalpy remains constant.
(C) Both internal energy and enthalpy of the gas remains constant.
(D) Both internal energy and the enthalpy of the gas increase.

22. A venturimeter having a throat diameter of 0·1 m is used to estimate the flow rate of a horizontal pipe having a diameter of 0·2 m. For an observed pressure difference of 2 m of water head and coefficient of discharge equal to unity, assuming that the energy losses are negligible, the flow rate (in m^3/s) through the pipe is approximately equal to

(A) 0·500
(B) 0·150
(C) 0·050
(D) 0·015

23. A forged steel link with uniform diameter of 30 mm at the centre is subjected to an axial force that varies from 40 kN in compression to 160 kN in tension. The ultimate tensile strength, yield strength and corrected endurance limit of the steel material are 600 MPa, 420 MPa and 240 MPa respectively. The factor of safety against fatigue endurance as per Soderberg's criterion is

(A) 1·26
(B) 1·37
(C) 1·45
(D) 2·00

24. A solid shaft can resist a bending moment of 3.0 kNm and a twisting moment of 4.0 kNm together, then the maximum torque that can be applied is

(A) 7.0 kNm
(B) 3.5 kNm
(C) 4.5 kNm
(D) 5.0 kNm

Please Turn Over

25. Group-I contains dimensionless parameters and Group-II contains the ratios.

Group I	Group II
P. Match Number	1. Ratio of inertial force and gravitational force
Q. Reynolds Number	2. Ratio of fluid velocity and velocity of sound
R. Weber Number	3. Ratio of inertial force and viscous force
S. Froude Number	4. Ratio of inertial force and surface tension force

The correct match of dimensionless parameters in Group-I with ratios in Group-II is:

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

26. A 19-tooth pinion paired with a 33-tooth gear has a 2 mm module and 20 degree pressure angle. Tooth forms are standard AGMA full depth involutes. If centre distance during assembly, is increased by 3%, then estimate the new value of pressure angle (in degrees).

(A) 24·17
(B) 20
(C) 14·5
(D) 30

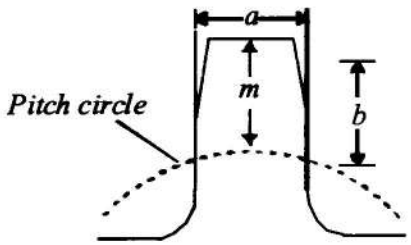
27. What is the dimensions of $\frac{d\phi_B}{dt}$, where ϕ_B is magnetic flux through a coil?

(A) $ML^2A^{-1}T^{-3}$
(B) $ML^3A^{-1}T^{-3}$
(C) $ML^2A^{-2}T^{-3}$
(D) None of the above

28. Microstructure of eutectoid steel contains

(A) 100% pearlite phase
(B) 100% ferrite phase
(C) 100% cementite phase
(D) combination of pearlite and ferrite phase

29. One tooth of a gear having 4 module and 32 teeth is shown in the figure. Assume that the gear tooth and the corresponding tooth space make equal intercepts on the pitch circumference. The dimensions *a* and *b*, respectively, are closest to



(A) 6·08 mm, 4 mm
(B) 6·48 mm, 4·2 mm
(C) 6·28 mm, 4·3 mm
(D) 6·28 mm, 4·1 mm

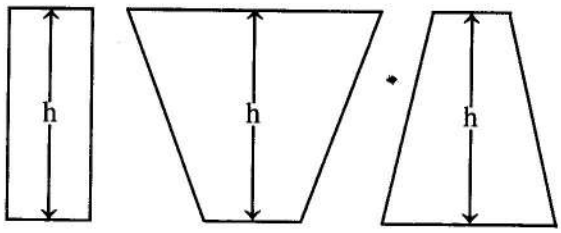
30. The insulation resistance of cables, transformers, etc. is measured by following instrument:

(A) Wheatstone bridge
(B) Meggar
(C) Kelvin bridge
(D) Decade box

31. A hydraulic coupling belongs to the category of

(A) Power absorbing machines
(B) Power developing machines
(C) Energy transfer machines
(D) Energy generating machines

32. Three rigid buckets, shown as in the figures (1), (2) and (3), are of identical heights and base areas. Further, assume that each of these buckets have negligible mass and are full of water. The weights of water in these buckets are denoted as W_1, W_2 and W_3 respectively. Also, let the force of water on the base of the bucket be denoted as F_1, F_2 and F_3 respectively. The option given an accurate description of the system physics is



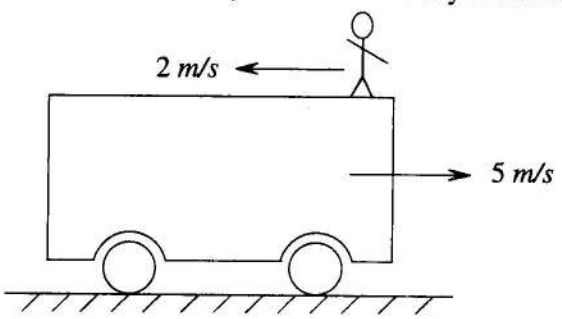
All three buckets have the same base area

(A) $W_2 = W_1 = W_3$ and $F_2 > F_1 > F_3$
(B) $W_2 > W_1 > W_3$ and $F_2 > F_1 > F_3$
(C) $W_2 = W_1 = W_3$ and $F_1 = F_2 = F_3$
(D) $W_2 > W_1 > W_3$ and $F_1 = F_2 = F_3$

33. Cleavage fracture is a form of

(A) ductile fracture
(B) brittle fracture
(C) elastic fracture
(D) None of the above

34. A trolley of 600 kg can move along a horizontal frictionless track, as shown in the figure below. Initially the trolley with a man on it of mass 70 kg is moving towards right at a speed of 5 m/s. If the man starts walking on the trolley with a speed of 2 m/s towards left, what is the velocity of travel?



(A) 4.79 m/s
(B) 5.21 m/s
(C) 5.81 m/s
(D) None of the above

35. Piston compression rings are made of

(A) white metal
(B) bronze
(C) aluminium
(D) cast iron

36. Low pressure angle gears result in

(A) stronger teeth.
(B) weaker teeth.
(C) strength has nothing to do with pressure angle.
(D) could be stronger or weaker depending on module adopted.

Please Turn Over

37. A disc clutch is required to transmit 5 kW at 2000 rpm. The disc has a friction lining with coefficient of friction equal to 0.25. Bore radius of friction lining is equal to 25 mm. Assume uniform contact pressure of 1 MPa. The value of outside radius of the friction lining is

(A) 39.4 mm
(B) 49.5 mm
(C) 97.9 mm
(D) 142.9 mm

38. The joining of shank with the body of a twist drill is done by

(A) friction welding
(B) spot welding
(C) projection welding
(D) TIG welding

39. For a steady incompressible laminar flow between two infinite parallel stationary plates the shear stress variation is

(A) linear with zero value at the plates.
(B) linear with zero value at the centre.
(C) quadratic with zero value at the plates.
(D) quadratic with zero value at the centre.

40. For subcritical flow in an open channel, the control section for gradually varied flow profiles is

(A) at the downstream end.
(B) at the upstream end.
(C) at both upstream and downstream ends.
(D) at any intermediate section.

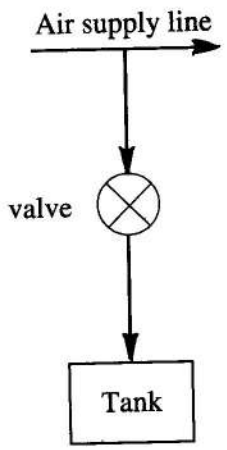
41. The period of satellite in a circular orbit of radius R is T, the period of another satellite in a circular orbit of radius 4R is

(A) 4T
(B) $\frac{T}{4}$
(C) 8T
(D) $\frac{T}{8}$

42. Three-way catalytic converter does not control

(A) CO emission
(B) HC emission
(C) NO_x emission
(D) PM emission

43. A rigid, insulated tank is initially evacuated. The tank is connected with a supply line through which air (assumed to be ideal gas with constant specific heats) passes at 1 MPa, 3500C. A valve connected with the supply line is opened and the tank is charged with air until the final pressure inside the tank reaches 1 MPa. The final temperature inside the tank



(A) is greater than 350°C
(B) is less than 350°C
(C) is equal to 350°C
(D) may be greater than, less than, or equal to 350°C, depending on the volume of the tank

44. In a footstep bearing, if the speed of the shat is doubled, then the torque required to overcome the viscous resistance will be

(A) Double
(B) Four times
(C) Eight times
(D) Sixteen times

45. A reversible thermodynamic cycle containing only three processes and producing work is to be constructed. The constraints are

(i) There must be one isothermal process,

(ii) There must be one isentropic process,

(iii) The maximum and minimum cycle pressure and the clearance volume are fixed,

(iv) Polytropic processes are not allowed.

Then the number of possible cycles are

(A) 1

(B) 2

(C) 3

(D) 4

46. A ball of mass 1 kg moving with a velocity of 2 m/s collides directly with a stationary ball of mass 2 kg. If the first ball comes to rest after impact, what is the velocity of the second ball after impact?

(A) 1.0 m/s

(B) Zero

(C) 2 m/s

(D) 0.5 m/s

47. A cylindrical shaft is subjected to an alternating stress of 100 MPa. Fatigue strength to sustain 1000 cycles is 490 MPa. If the corrected endurance strength is 70 MPa, estimated shaft life will be

(A) 1071 cycles

(B) 15000 cycles

(C) 281914 cycles

(D) 928643 cycles

48. A rail engine accelerates from its stationary position for 8 seconds and travels a distance of 280 m. According to the Mean Value Theorem, the speedometer at a certain time during acceleration must read exactly

(A) 0

(B) 8 kmph

(C) 75 kmph

(D) 126 kmph

49. For same compression ratio, which of the following ideal cycles have equal thermal efficiency?

(A) Joule and Diesel

(B) Otto and Joule

(C) Diesel and Stirling

(D) Otto and Stirling

50. One kg of an ideal gas (gas constant R = 287 J/kg·K) undergoes an irreversible process from state-1 (1 bar, 300 K) to state-2 (2 bar, 300 K). The change in specific entropy (s2 – s1) of the gas (in J/kg·K) in the process is

(A) 199

(B) 300

(C) – 199

(D) – 300

51. A bolt of M 24×2 means that

(A) the pitch of the thread is 24 mm and depth is 2 mm.

(B) cross sectional area of the thread is 24 mm^2.

(C) the nominal diameter of the bolt is 24 mm and pitch is 2 mm.

(D) the effective diameter of the bolt is 24 mm and there are two threads per 2 cm.

52. Spherical roller bearings are normally used

(A) for increased radial load.

(B) for increased thrust load.

(C) when there is less radial load.

(D) to compensate for angular misalignment.

53. In CI engine knocking takes place at

(A) Ist stage of combustion

(B) IInd stage of combustion

(C) IIIrd stage of combustion

(D) IVth stage of combustion

54. A body is subjected to a direct tensile stress of 300 MPa on one plane accompanied by a simple shear stress of 200 MPa. The maximum normal stress on the plane will be

(A) 100 MPa

(B) 200 MPa

(C) 300 MPa

(D) 400 MPa

55. The dimension for kinematic viscosity is

(A) L/MT

(B) L/T^2

(C) L^2/T

(D) ML/T

56. A small steam whistle (perfectly insulated and doing no shaft work) causes a drop of 0.8 kJ/kg in enthalpy of steam from entry to exit. The kinetic energy of the steam at entry is negligible, the velocity of steam at exit is

(A) 4 m/s

(B) 40 m/s

(C) 80 m/s

(D) 120 m/s

57. Knocking in SI engine is reduced by

(A) increasing the cooling water temperature.

(B) increasing the compression ratio.

(C) increasing the inlet air temperature.

(D) retarding the spark advance.

58. When a cylinder is located in a Vee-block, the number of degrees of freedom which are arrested is

(A) 2

(B) 4

(C) 7

(D) 8

59. A plane flow has velocity components $u = \frac{x}{T_1}, v = -\frac{y}{T_2}$ and $w = 0$ along x, y and z directions respectively, where $T_1 (\neq 0)$ and $T_2 (\neq 0)$ are constants having the dimension of time. The given flow is incompressible if

(A) $T_1 = -T_2$

(B) $T_1 = -T_2/2$

(C) $T_1 = T_2/2$

(D) $T_1 = T_2$

60. A metal bar of 100 mm in diameter is turned at a feed of 0.25 mm/rev with a depth of cut of 4 mm. The rotational speed of the work piece is 160 rpm. The material removal rate in mm^3/s is

(A) 160

(B) 1600

(C) 837.75

(D) 1675.5

61. The rake angle of a single point thread cutting tool should be

(A) zero

(B) positive

(C) negative

(D) Cannot say

62. Air enters an adiabatic nozzle at 300 kPa, 500 K with a velocity of 10 m/s. It leaves the nozzle at 100 kPa with a velocity of 180 m/s. The inlet area is 80 cm^2. The specific heat of air Cp is 1008 J/kg K. The exit temperature of the air is

(A) 516 K

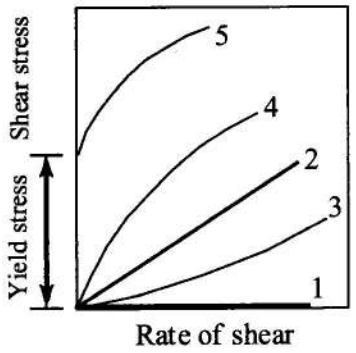
(B) 532 K

(C) 484 K

(D) 468 K

63. *Group I* contains the types of fluids while *Group II* contains the shear stress-rate of shear relationship of different types of fluids, as shown in the figure.

Group I	*Group II*
P. Newtonian fluid	1. Curve 1
Q. Pseudo plastic fluid	2. Curve 2
R. Plastic fluid	3. Curve 3
S. Dilatant fluid	4. Curve 4
	5. Curve 5



The correct match between *Group I* and *Group II* is

(A) P-2, Q-4, R-1, S-5

(B) P-2, Q-5, R-4, S-1

(C) P-2, Q-4, R-5, S-3

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

64. The heat removal rate from a refrigerated space and the power input to the compressor are 7.2 kW and 1.8 kW, respectively. The coefficient of performance (COP) of the refrigerator is

(A) 4
(B) 5
(C) 3
(D) 6

65. Two circular rings *A* and *B* of radii *n*R and R are made from the same wire. The M.I. of A about an axis passing through the centre and perpendicular to the plane of *A* is 27 times that of smaller loop *B*. What is the value of *n*?

(A) 2
(B) 3
(C) 4
(D) 5

66. Due to supercharging of Diesel engine, the tendency of knocking

(A) decreases
(B) increases
(C) remain same
(D) None of the above

67. In orthogonal cutting test, the cutting force and thrust force were observed to be 1500 N and 750 N respectively. If the rake angle of tool is zero, the coefficient of friction in chip-tool interfaces will be

(A) 1
(B) 0.5
(C) 0.707
(D) 1.41

68. For a 4 bar linkage in a toggle position, the value of mechanical advantage is

(A) 0·0
(B) 0·5
(C) 1·0
(D) ∞

69. A planar mechanism has 8 links and 10 rotary joints. The number of degrees of freedom of the mechanism, using Gruebler's criterion, is

(A) 0
(B) 1
(C) 2
(D) 3

70. The number of inversions for a slider crank mechanism is

(A) 6
(B) 5
(C) 4
(D) 3

71. A series motor at no load develops

(A) Zero speed
(B) Average speed
(C) Rated speed
(D) Infinite speed

72. Group I lists a few devices while Group II provides information about their uses.

Match the devices with their corresponding use.

Group I	Group II
P. Anemometer	1. Capillary potential of soil water
Q. Hygrometer	2. Fluid velocity at a specific point in the flow stream
R. Pitot Tube	3. Water vapour content of air
S. Tensiometer	4. Wind speed

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

73. A single cylinder, 4-stroke cycle engine is fitted with a rope brake. The diameter of the brake wheel is 590 mm and the rope diameter is 36 mm. The dead weight on the brake is 300 N and the spring balance reads 50 N. If the engine runs at 400 rpm, what will be the brake power of the engine?

(A) 4.5 kW
(B) 3.27 kW
(C) 2.5 kW
(D) 1.25 kW

74. The approximate ratio of heat distributed among chip, tool and work in metal cutting operation, in the order of

(A) 80:10:10
(B) 10:10:80
(C) 33:33:33
(D) 30:60:10

75. $\int_0^3 \int_0^x (6-x-y)\,dx\,dy$ is

(A) 13.5
(B) 27.0
(C) 40.5
(D) 54.0

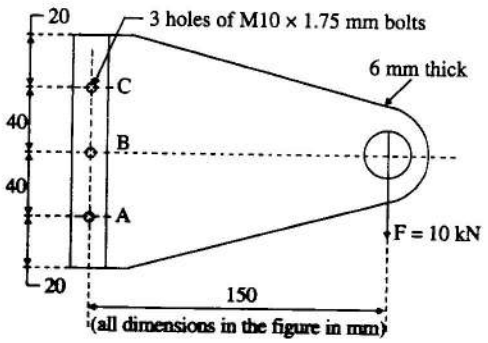
76. The transverse shear stress acting in a beam of rectangular cross-section subjected to a transverse shear load is

(A) variable with maximum at the bottom of the beam.
(B) variable with maximum at the top of the beam.
(C) uniform with maximum at the top of the beam.
(D) variable with maximum on the neutral axis.

77. Air injection in diesel engine refers to injection of

(A) air only
(B) liquid fuel only
(C) liquid fuel and air
(D) supercharging air

78. A bolted joint is shown below. The maximum shear stress, in MPa, in the bolts at A and B, respectively are



(A) 242.6, 42.5
(B) 42.5, 242.6
(C) 42.5, 42.5
(D) 60.15, 343.64

79. The Jominy end-quench test is used to find

(A) hardness
(B) yield strength
(C) hardenability
(D) toughness

80. The contents of a well-insulated tank are heated by a resistor of 23 Ω in which 10 A current is flowing. Consider the tank with its contents as a thermodynamic system. The work done by the system and the heat transfer to the system are positive. The rates of heat (Q), work (W) and change in ΔU during the process in KW are

(A) Q = 0, W = – 2.3, ΔU = + 2.3
(B) Q = + 2.3, W = 0, ΔU = + 2.3
(C) Q = – 2.3, W = 0, ΔU = – 2.3
(D) Q = 0, W = 2.3, ΔU = – 2.3

81. To make worm drive reversible, it is necessary to increase

(A) centre distance

(B) worm diameter factor

(C) number of starts

(D) reduction ratio

82. Octane number of Indian petrol is

(A) 40-50

(B) 60-70

(C) 70-80

(D) 90-100

83. In spur gears, the circle on which the involute is generated is called the

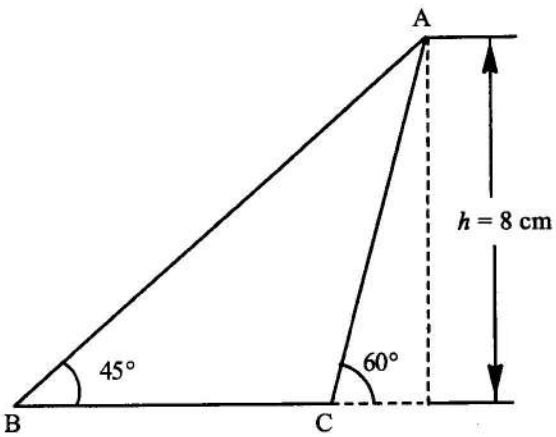
(A) pitch circle

(B) clearance angle

(C) base circle

(D) addendum circle

84. What is moment of inertia of triangle ABC as shown in the figure below, about base BC?



(A) 48.13 cm^4

(B) 144.26 cm^4

(C) 341.3 cm^4

(D) None of the above

85. Two spheres of masses m and M are situated in air and the gravitational force between them is F. The space around the masses is now filled with a liquid of specific gravity 3. The gravitational force will now be

(A) 3F

(B) F

(C) $\frac{F}{3}$

(D) $\frac{F}{9}$

86. What should be the value of λ such that the function defined below is continuous at $x = \frac{\pi}{2}$?

$$f(x) = \begin{cases} \dfrac{\lambda \cos x}{\frac{\pi}{2} - x} & \text{if } x \neq \dfrac{\pi}{2} \\ 1 & \text{if } x = \dfrac{\pi}{2} \end{cases}$$

(A) 0

(B) $\frac{2}{\pi}$

(C) 1

(D) $\frac{\pi}{2}$

87. Bernoulli's equation is applicable for

(A) viscous and compressible fluid flow.

(B) inviscid and compressible fluid flow.

(C) inviscid and incompressible fluid flow.

(D) viscous and incompressible fluid flow.

88. The pressure, temperature and velocity of air flowing in a pipe are 5 bar, 500K and 50 m/s, respectively. The specific heats of air at constant pressure and at constant volume are 1.005 kJ/kg K and 0.718 kJ/kg K respectively. Neglect potential energy. If the pressure and temperature of the surrounding are 1 bar, 300 K respectively, the available energy in kJ/kg of the air steam is

(A) 170
(B) 191
(C) 187
(D) 213

89. Air enters an adiabatic nozzle at 300 kPa, 500 K with a velocity of 10 m/s. It leaves the nozzle at 100 kPa with a velocity of 180 m/s. The inlet area is 80 cm^2. The specific heat of air Cp is 1008 J/kg K. The exit area of the nozzle in cm^2 is

(A) 90.1
(B) 56.3
(C) 4.4
(D) 12.9

90. A band brake having band width of 80 mm, drum diameter of 250 mm, coefficient of friction of 0.25 and angle of wrap of 270 degrees is required to exert a friction torque of 1000 Nm. The maximum tension (in kN) developed in the band is

(A) 1.88
(B) 3.56
(C) 6.12
(D) 11.56

91. For a simply supported beam on two end supports (carrying loads), the bending moment is maximum

(A) usually at the supports.
(B) always at the mid span.
(C) where there is no shear force.
(D) where the deflection is maximum.

92. For a certain engine having an average speed of 1200 rpm, a flywheel approximated as a solid disc, is required for keeping the fluctuation of speed within 2% about the average speed. The fluctuation of kinetic energy per cycle is found to be 2 kJ. What is the least possible mass of the flywheel if its diameter is not to exceed 1 m?

(A) 40 kg
(B) 51 kg
(C) 62 kg
(D) 73 kg

93. Steam enters an adiabatic turbine operating at steady state with an enthalpy of 3251.0 k.J/kg respectively. The mass flow rate of steam is 10kg/s. Kinetic and potential energy changes are negligible. The power output of the turbine in MW is

(A) 6.5
(B) 8.9
(C) 9.1
(D) 27.0

94. If C_f is the coefficient of speed fluctuation of a flywheel then the ratio of $\frac{\omega_{max}}{\omega_{min}}$ will be

(A) $\frac{1-2C_f}{1+2C_f}$
(B) $\frac{2-C_f}{2+C_f}$
(C) $\frac{1+2C_f}{1-2C_f}$
(D) $\frac{2+C_f}{2-C_f}$

95. Which one of the following statements is correct?

(A) The strain produced per unit volume is resilience.

(B) The maximum strain produced per unit volume is called proof resilience.

(C) The least strain energy stored in a unit volume is called proof resilience.

(D) The greatest strain energy stored in a unit volume of a material without permanent deformation is called proof resilience.

96. A cylinder contains 5 m^3 of an ideal gas at a pressure of 1 bar. This gas is compressed in a reversible isothermal process till its pressure increases to 5 bar. The work in kJ required for this process is

(A) 804·7

(B) 953·2

(C) 981·7

(D) 1012·2

97. In a band brake the ratio of tight side band tension to the tension on the slack side is 3. If the angle of overlap of band on the drum is 180°, the coefficient of friction required between drum and band is

(A) 0·20

(B) 0·25

(C) 0·30

(D) 0·35

98. A vibrating machine is isolated from the floor using springs. If the ratio of excitation frequency of vibration of machine to the natural frequency of the isolation system is equal to 0·5, the transmissibility of ratio of isolation is

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

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

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

(D) 2

99. Range of compression ratio in CI engine is

(A) 6-12

(B) 12-24

(C) 24-36

(D) None of the above

100. Which of the following motors has high starting torque?

(A) A.C. Motor

(B) D.C. Shunt Motor

(C) Synchronous Motor

(D) D.C. Series Motor