A

Booklet No. :

VVS1

Electrical & Electronics Engineering

Duration of Test : 2 Hours **Max. Marks : 100**

Hall Ticket No. | | | | | | | | | |

Name of the Candidate : _____

INSTRUCTIONS

1. This Question Booklet consists of **100** multiple choice objective type questions to be answered in **2** hours.
2. Every question in this booklet has 4 choices marked (A), (B), (C) and (D) for its answer.
3. Each question carries **one** mark. There are no negative marks for wrong answers.
4. This Booklet consists of **16** pages. Any discrepancy or any defect is found, the same may be informed to the Invigilator for replacement of Booklet.
5. Answer all the questions on the OMR Answer Sheet using **Blue/Black ball point pen only.**
6. Before answering the questions on the OMR Answer Sheet, please read the instructions printed on the OMR sheet carefully.
7. OMR Answer Sheet should be handed over to the Invigilator before leaving the Examination Hall.
8. Calculators, Pagers, Mobile Phones, etc., are not allowed into the Examination Hall.
9. No part of the Booklet should be detached under any circumstances.
10. The seal of the Booklet should be opened only after signal/bell is given.

ELECTRICAL AND ELECTRONICS ENGINEERING (EE)

PART – A

1. The main purpose of using core in a transformer is to

(A) decrease iron losses

(B) eliminate magnetic hysteresis

(C) reduce reluctance of the common magnetic circuit

(D) prevent eddy current loss

2. A 220 V separately excited dc motor takes 20 A and the armature resistance is 1.0 Ω. If the armature constant $K_a\Phi = 1.5$ rad/sec, the speed of the motor is

(A) 1000 rpm (B) $2000/\pi$ (C) $3000/\pi$ rpm (D) $4000/\pi$ rpm

3. In a 3-phase slip-ring induction motor, the slip at some speed is 0.05. The speed is reduced by inserting an external resistance in the rotor circuit and the slip is 0.15. If the rotor winding resistance per phase is 0.2 Ω, the external resistance is

(A) 0.2 Ω (B) 0.3 Ω (C) 0.4 Ω (D) 0.5 Ω

4. When a V-V three phase transformer system is converted into a Δ-Δ system, increase in capacity of the system is

(A) 86.6% (B) 50% (C) 57.7% (D) 73.2%

5. 3kW load is supplied by an autotransformer with 0.7 transformation ratio. Conductively transferred power from primary to secondary is

(A) 2.1 kW (B) 0.9 kW (C) 4.29 kW (D) 3 kW

6. Number of commutator bars for a 4-pole, 2-layer, DC lap winding with 24 slots and one conductor per layer is

(A) 48 (B) 24 (C) 192 (D) 96

7. The torque developed by any 3-phase induction motor at 0.8 p.u. slip is

(A) Full-load torque (B) unstable torque

(C) starting torque (D) break down

8. The E_b/V ratio of a DC motor is an indication of its _____. (E_b is the back emf and V is the applied voltage across the armature)

(A) Speed regulation (B) Starting torque

(C) Efficiency (D) Running torque.

9. Which of the following test is usually conducted to determine the efficiency of traction motors ?

(A) Field's test (B) Swinburne's test

(C) Hopkinson's test (D) Retardation test.

10. An 8-pole, 50Hz, three-phase induction motor is running at 705rpm and has a rotor copper loss of 5kW. Its rotor input is

(A) 5.06 kW (B) 0.3 kW

(C) 100 kW (D) 83.33 kW

11. A 3-phase, 4-pole, 50Hz induction motor runs at a speed of 1440 rpm. The rotating field produced by the rotor rotates at a speed of _____ rpm with respect to stator field.

(A) 1500 (B) 0 (C) 1440 (D) 60

12. Generally, Crawling in squirrel cage induction motors is tendency to run stably at speeds as low as

(A) One-third of their synchronous speed

(B) One-fifth of their synchronous speed

(C) One-seventh of their synchronous speed

(D) One-ninth of their synchronous speed

13. The starting torque of a capacitor-start induction-run motor is directly related to the angle 'θ' between its two winding currents by the relation

(A) $\cos\theta$ (B) $\sin\theta$ (C) $\tan\theta$ (D) $\sin\theta/2$

14. The fractional-pitch used for eliminating 7^{th} harmonic from the emf wave of an alternator is

(A) 2/3 (B) 5/6 (C) 7/8 (D) 6/7

15. A 2-pole, 50 Hz, 3-phase, 100 MVA, 33 kV turbo-alternator connected to an infinite bus has a moment if inertia of 10^7 kg-m^2 in its rotating parts. It has a synchronous reactance of 0.5 p.u. The natural time period of oscillations of the machine is

(A) 7.874 sec (B) 15.748 sec

(C) 23.622 sec (D) 24.9 sec

16. While keeping the excitation constant, if the steam supply of an alternator running in parallel with another identical alternator is increased, then

(A) It would over-run the other alternator

(B) Its rotor will fall back in phase with respect to the other machine

(C) Its portion of share in load will increase

(D) Its power factor would be decreased.

17. The effect of increasing load on a synchronous motor running with normal excitation is

(A) Increase both its I_a and power factor.

(B) Decrease I_a, but increase power factor.

(C) Increase I_a, but decrease power factor

(D) Decrease both I_a and power factor.

18. Transmission lines are transposed to reduce

(A) Ferranti effect and voltage level

(B) Skin effect and efficiency

(C) Proximity effect and current density

(D) Interference with neighboring communication lines

19. If the base current and base voltage of a 345 kV system are 3000 A and 300 kV respectively, per-unit voltage and base impedance of the system respectively are

(A) 1.15 pu, 115 Ω (B) 1.15 pu, 100 Ω

(C) 0.87 pu, 115 Ω (D) 0.87 pu, 100 Ω

20. The surge impedance of a 60 miles long underground cable is 50 Ω. For a 30 miles length it will be

(A) 25 Ω (B) 50 Ω (C) 100 Ω (D) 200 Ω

21. A single core cable is designed to work for a single phase system with a peak voltage of 220 kV. The maximum permissible stress in the dielectric is not to exceed 20 kV/mm. For economical size, the overall core diameter of the cable is

(A) 28.2 mm (B) 26.4 mm

(C) 24.4 mm (D) 22.0 mm

22. Stringing chart is used for

(A) finding the sag in the conductor (B) the design of towers

(C) the design of insulator string (D) finding the distance between towers

23. A suspension type insulator has 2 units with self capacitance C and ground capacitance of 0.2 C. Each unit can withstand for a maximum voltage of 11 kV. Its string efficiency is

(A) 78% (B) 82% (C) 80% (D) 84%

24. If a 5-bus test system contains 6 transmission lines and one transformer, how many non-zero elements are there in the system Y-bus ?

(A) 25 (B) 12 (C) 11 (D) 19

25. The voltages of a generator and an Infinite bus are given as $0.92 \angle 10°$ and $1.0 \angle 0°$ respectively. Which of the following statement is correct ?

(A) Active power flows from generator to Infinite bus and reactive power flows from Infinite bus to generator

(B) Active power and reactive power flows from generator to Infinite bus.

(C) Reactive power flows from generator to Infinite bus and active power flows from Infinite bus to generator

(D) Active power and reactive power flows from Infinite bus to generator.

26. A shunt fault is characterized by

(A) Increase in current, frequency and pf

(B) Increase in current, reduction in frequency and pf

(C) Increase in current and frequency, reduction in pf

(D) Decrease in current and frequency

27. A reactance relay is

(A) Voltage restrained directional relay

(B) Directional restrained over-current relay

(C) Voltage restrained over current relay

(D) Directional restrained over voltage relay

28. In a 132 kV system, the line to ground capacitance is 0.01μF and the inductance is 4 H. What is value of voltage appearing across the CB pole, if the magnetizing current to be interrupted is 5A (instantaneous)?

(A) 132 kV (B) 10 kV (C) 220 kV (D) 100 kV

29. The inertia constants of two groups of machines, which swing together are M_1 and M_2. The inertia constant of the system is,

(A) $\frac{M_1 M_2}{M_1+M_2}$ (B) $M_1 - M_2, M_1 > M_2$

(C) $M_1 + M_2$ (D) $\frac{M_1 + M_2}{M_1 M_2}$

30. The per unit synchronous reactance of a machine is 1.6pu. Its Short Circuit Ratio is

(A) 1.6 (B) 3.2

(C) 0.8 (D) 0.625

31. Precise control of reactive current flow entering the transmission and distribution systems can be minimized by using

(A) synchronous condenser

(B) static VAR capacitor

(C) capacitor bank

(D) thyristor switched reactor in parallel with capacitor

32. The sending end and receiving end voltages of a three-phase transmission line are 10 kV/ph and 9.5 kV/ph, respectively. If the resistance drop is 150 V/ph and receiving end power factor is 0.8, the sending end power factor is

(A) 0.745 lagging (B) 0.775 lagging

(C) 0.8 lagging (D) 0.85 lagging

33. A dc distributor of length, l m and resistance r ohms/m, fed at both ends with equal voltages, is uniformly loaded with i A/m run. The power loss in the distributor is

(A) $\frac{i^2rl^3}{3}$ (B) $\frac{i^2rl^3}{4}$

(C) $\frac{i^2rl^3}{8}$ (D) $\frac{i^2rl^3}{12}$

34. Corona loss in transmission lines can be reduced by

(A) using small diameter conductors
(B) using bundled conductors
(C) using less spacing between conductors
(D) increasing the transmission line voltage

35. A 4000 kVA, 11 kV/132 kV delta-star connected 3-phase transformer has reactance, x_1 = 0.12 p.u. The actual value of x_1 referred to the low voltage side is

(A) 0.85 Ω (B) 3.63 Ω (C) 36.3 Ω (D) 252 Ω

36. The number of comparators required in a 4 bit comparator type ADC is

(A) 16 (B) 15 (C) 17 (D) 12

37. In a 5 bit weighted resistor D/A converters, the resistor value corresponding to LSB is 40 kΩ, and the resistor value corresponding to MSB will be

(A) 0.4 kΩ (B) 3 kΩ (C) 2.8 kΩ (D) 2.5 kΩ

38. A switch tail ring counter is made by using a single D-FF. The resulting circuit is

(A) T-FF (B) D-FF (C) SR-FF (D) JK-FF

39. The ALE line of an 8085 microprocessor is used to

(A) latch the output of an I/O instruction into an external latch.
(B) deactivate the chip-select signal from memory devices.
(C) find the interrupt enable states of the TRAP interrupt.
(D) latch the 8 bits of address lines AD7-AD0 into an external latch.

40. Which diode exhibits negative resistance characteristic?

(A) LED (B) Zener
(C) Tunnel diode (D) PN diode

41. A closed –loop transfer function of a unity feed back system is given by $\frac{Y(s)}{R(s)} = \frac{\omega_n^{\ 2}}{s^2 + 2\varsigma\omega_n s + \omega_n^{\ 2}}$. The System K_v is given by

(A) $\frac{\omega_n}{2\varsigma}$ (B) 1 (C) ∞ (D) $\frac{2\varsigma}{\omega_n}$

42. A unity feedback system has open loop transfer function $G(s) = \frac{K(s+1.1)(s+2.2)}{s(s+3.3)(s+4.4)}$. For K = 0 the closed-loop poles are

(A) All real and distinct
(B) One real and two complex conjugate
(C) All real and repeated
(D) Complex and non repeated

43. A unit impulse input to a linear network has a response R(t) and a unit Step input to the same network has response S(t). The response R(t)

(A) equals to $\frac{dS(t)}{dt}$
(B) equals the integral of S(t)
(C) is the reciprocal of S(t)
(D) has no relation with S(t)

44. Phantom loading for testing of energy meter is used

(A) to isolate the current and potential circuits
(B) to increase power loss during testing
(C) for meters having low current ratings
(D) to test meters having a large current rating for which loads may not be available

45. Ratio of the rotor reactance X to the rotor resistance R for a two-phase servo motor

(A) is equal to that of a normal induction motor
(B) is less than that of a normal induction motor
(C) is greater than that of a normal induction motor
(D) may be less or greater than that of a normal induction motor

46. A TRIAC in a single-phase circuit taking V volts and operating at a firing delay angle, α is supplying a resistive load, R. The power loss in the load is

(A) $\frac{2V^2}{\pi R}\frac{\sin 2\alpha}{2}$
(B) $\frac{V^2}{\pi R}\left[\frac{\cos 2\alpha}{2}\right]$
(C) $\frac{V^2}{\pi R}\left[\pi - \alpha + \frac{\sin 2\alpha}{2}\right]$
(D) $\frac{V^2}{\pi R}\left[\pi + \alpha - \frac{\sin 2\alpha}{2}\right]$

47. In a boost chopper circuit if V_s, V_0, L are input voltage, output voltage and inductance, respectively, and when the conducting switch is opened, the rate of change of inductive current is

(A) $\frac{V_s}{L}$
(B) $\frac{V_0}{L}$
(C) $\frac{V_s - V_0}{L}$
(D) $\frac{V_s + V_0}{L}$

48. In a 3-phase converter circuit during commutation when one SCR in one phase is turned on to turn-off an SCR in another phase, results in

(A) voltage notching
(B) harmonic distortion
(C) voltage sag
(D) voltage swell

49. A snubber circuit is connected to the power semiconductor device to reduce the

(A) turn-on time (B) turn-off time

(C) electrical stresses (D) thermal resistance

50. Which phenomenon is present in thyristors but absent in BJT, MOSFET and IGBT ?

(A) forward conduction (B) latching

(C) forward blocking (D) reverse breakdown

51. The 5^{th} harmonic component of induced voltage in a 3-phase alternator can be completely eliminated by using a winding pitch of

(A) $\frac{2}{3}$ (B) $\frac{4}{5}$

(C) $\frac{5}{6}$ (D) $\frac{6}{7}$

52. In an adjustable speed ac drive which quantity gets reduced above rated speed ?

(A) developed torque (B) stator frequency

(C) reduced starting torque (D) stator current

53. RC triggering is preferred over resistance triggering because

(A) it provides triggering at a precise instant

(B) it gives a longer duration gate pulse

(C) it enables triggering at a larger value of firing angle

(D) it protects the SCR against high dv/dt

54. A moving coil meter has a resistance of 3 Ω and gives full scale deflection with 30 mA. To measure voltage up to 300 V, the external resistance to be connected in series with the instrument is

(A) 9997 Ω (B) 10000 Ω (C) 997 Ω (D) 10003 Ω

55. A PMMC instrument has FSD of 100 μA and a coil resistance of 1 kΩ. To convert the instrument into an ammeter with full scale deflection of 100 mA, the required shunt resistance is

(A) 1 Ω (B) 1.001 Ω (C) 0.5 Ω (D) 10 Ω

56. When measuring insulation resistance of cables using d.c. source, the galvanometer used should be initially short circuited because

(A) Cables have a low value of capacitance which draws a high value of charging current

(B) Cables have a low value of initial resistance

(C) Cables have a high value of capacitance which draws a high value of charging current

(D) Cables have a low value of capacitance and initial resistance

57. The self inductance of a coil can be measured using

(A) Wien's Bridge (B) Schering Bridge

(C) Anderson's Bridge (D) Wheatstone Bridge

58. A 200 V, 5 A d.c. energy meter is tested at its marked ratings. The resistance of the pressure circuit is 8000 Ω and that of current coil is 0.1 Ω. The power consumed when testing the meter with phantom loading with current circuit excited by a 6 V battery is

(A) 2.5 W (B) 5 W

(C) 32.5 W (D) 35 W

59. A system shows zero steady-state error for step-input, finite steady-state error for Ramp-input and ∞ steady-state error for parabolic-input. Then the system is of

(A) Type - 0 (B) Type – 1

(C) Type - 2 (D) Type – 3

60. After drawing the Root-Locus, the closed-loop poles corresponding to a specified value of gain K can be determined from which of the following criterion ?

(A) Magnitude criterion alone

(B) Angle criterion alone

(C) Both Magnitude and Angle criteria

(D) Angle of departure and angle of arrival.

61. The open-loop transfer function of a unity-feedback system is given by

$$G(s) = \frac{K(s + 13)}{s(s + 3)(s + 7)}$$

The allowable maximum value of K for the closed-loop system to remain stable is

(A) 50 (B) 60

(C) 70 (D) 80

62. The frequencies and voltage used in Dielectric heating are

(A) 10 – 30 MHz, upto 25 kV (B) 50 – 60 Hz, upto 25 kV

(C) 10 – 30 MHz, upto 100 V (D) 50 – 60 Hz, 110 V – 230 V

63. Trapezoidal speed-time curve is

(A) an exact representation of the conditions in Main-line traction service.

(B) an exact representation of the conditions in Suburban traction service.

(C) a close approximation of the conditions in Suburban traction service.

(D) a close approximation of the conditions in Mainline traction service.

64. Pantograph is

(A) a device used to draw Speed-Time characteristics in traction.

(B) used to supply a.c. to transformer in locomotive.

(C) a part of the control devices in locomotives.

(D) used in traction motors for better efficiency.

65. With reference to Fig. 1, which of the following is neither Z_A, nor Z_B, nor Z_C ?

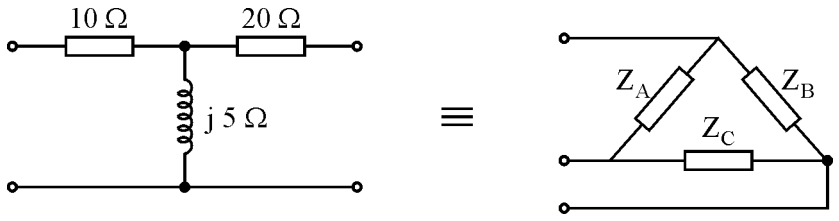


Fig. 1

(A) $10 + j\ 7.5$ (B) $30 - j\ 40$

(C) $20 + j\ 15$ (D) $10 + j\ 15$

66. A network is said to be under resonance when the voltage and the current at the network input terminals are

(A) in phase

(B) out of phase

(C) in phase quadrature

(D) in phase, and have equal magnitudes

67. The internal resistance of an ideal voltage source is

(A) Infinity (B) Zero

(C) Very small approaching zero (D) Very large approaching infinity

68. The time period of third harmonic of power supply frequency, in milli seconds, is

(A) 20 (B) 3.33

(C) 6.66 (D) 60

69. The power consumed by a balanced 3-ph load is measured by two-wattmeter method. The meter readings are 8 kW and 4 kW. The power factor of the load is

(A) zero (B) 0.5

(C) between zero and 0.5 (D) between 0.5 and unity

70. Which of the following statements is incorrect ?

(A) Superposition theorem is useful for Linear and Non-linear circuit analysis when several sources are present in the circuit.

(B) Thevenin's equivalent network consists of one voltage source in series with an impedance.

(C) Norton's equivalent network consists of one current source in parallel with an independence.

(D) When both the load and source impedances are purely resistive, maximum power transfer is achieved under the condition : Load Resistance = Source Resistance

PART – B

Direction (Q. 71 to 73) : In each of the following questions a statement has been given followed by four inferences A, B, C and D. Find out the inference that definitely follows from the given statement and mark your answer.

71. 'Most of the students are of outstanding merit.'

(A) Some of the students are of outstanding merit.

(B) There are no students who are not of outstanding merit.

(C) There are some students who are below par.

(D) All students are of outstanding merit.

72. 'Most of the pens in that shop are expensive.'

(A) There are no cheap pens in that shop.

(B) Some of the pens in that shop are expensive.

(C) There are some cheap pens in that shop.

(D) Camlin pens in that shop are expensive.

73. 'Ability is poor man's wealth.' This means.

(A) A poor man is always able.

(B) A poor man has the ability to earn wealth.

(C) A wealthy man is always able.

(D) A poor man can earn wealth if he has ability.

74. If PAINT is coded as 74128 and EXCEL is coded as 93596, then how would you encoded ACCEPT ?

(A) 455978 (B) 547978 (C) 554978 (D) 455968

75. Find the missing term in the following series :

240, ___, 120, 40, 10, 2.

(A) 240 (B) 220 (C) 182 (D) 200

76. In the series 2, 6, 18, 54, …., what will be the 8^{th} term ?

(A) 4370 (B) 4374 (C) 7443 (D) 7434

77. If N is the brother of B, M is the sister of N, J is the brother of P and P is the daughter of B. Who is the uncle of J ?

(A) B (B) M (C) P (D) N

78. A group consists of both boys and girls is 100. ₹ 312 is distributed among the boys and girls such that each boy gets ₹ 3.60 and each girl gets ₹ 2.40. The number of girls are

(A) 88 (B) 40 (C) 60 (D) 65

79. The sum of three consecutive odd numbers is always divisible by

(I) 2 (II) 3 (III) 5 (IV) 6

(A) I and II (B) Only II (C) Only I and III (D) Only II and IV

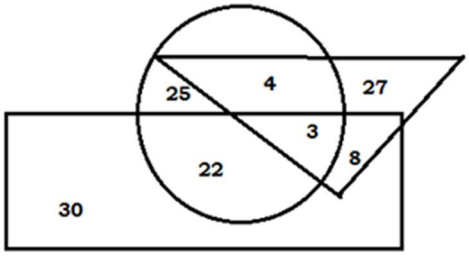
80. If the L.C.M. of two numbers is 48 and the numbers are in ratio 3:4, then the sum of the numbers is

(A) 28 (B) 32 (C) 40 (D) 64

81. Which one is the same as Coal, Ebony and Soot ?

(A) Blush (B) Raven (C) Ash (D) Rust

Direction : Questions **82** & **83** are based on the following diagram :



The triangle represents 'Doctors', the circle represents 'Players' and the rectangle represents 'Artists'.

82. How many artists are players ?

(A) 22 (B) 25 (C) 30 (D) 29

83. How many doctors are players but not artists ?

(A) 7 (B) 27 (C) 4 (D) 15

84. How many numbers from 1 to 100 are such each which is divisible by 8 and whose at least one digit is 8 ?

(A) Four (B) Five (C) Eight (D) Six

85. In the following group of letters, one of them is different from the rest. Find out that group.

(A) BQCR (B) DSEU (C) FVGW (D) HXIY

86. What will be the next term in the series: DCXW, FEVU, HGTS, _____

(A) LKPO (B) ABYZ (C) JIRQ (D) LMRS

Direction (Q. 87 to 89): The problems below contain question and two statements of certain data. You have to decide whether the data given in the statements are sufficient for answering the questions. The correct answer is

(A) If statements (I) alone is sufficient but statement (II) alone is not sufficient to answer.

(B) If statements (II) alone is sufficient but statement (I) alone is not sufficient to answer.

(C) If both statements (I) and (II) together are sufficient but neither of the statement alone is sufficient to answer the question.

(D) If each statement alone is sufficient to answer the question.

87. Is cone A is similar to cone B ?

(I) The surface area of A is 9 times the surface area of B.

(II) The volume of A is 9 times the volume of B.

88. Is $x > 1$?

(I) $\sqrt{x + \frac{x}{x^2-1}} = x\sqrt{\frac{x}{x^2-1}}$

(II) $x^3 + 1 = 0$

89. The total expenses of two individuals X and Y are ₹ 3,600 and ₹ P respectively. They are represented with the help of a pie-chart. What is P ?

(I) The radius of the circle representing X's total expenditure is 4.2 cm and that of Y's total expenditure is 3.5 cm.

(II) The ratio of the radii of the two circles is 4:1.

90. Three friends A, B and C shared chocolates from a bowl. A took $1/3^{rd}$ of the chocolates, but returned four to the bowl. B took $1/4^{th}$ of what was left but returned three chocolates to the bowl. C took half of the remainder but return two back into the bowl. If the bowl has 17 chocolates left, how many chocolates were originally there in the bowl ?

(A) 32 (B) 48 (C) 64 (D) 52

91. There are nine bags of sugar looking alike, eight of which have equal weight and one is slightly heavier. The weighing balance is of unlimited capacity. Using this balance, the minimum number of weighings required to identify the heavier bag is

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

92. A person starts from a point S, goes South for 4 km and West for 3 km to reach a point T. He then turns to face point S and goes 18 km in that direction. He then goes South for 12 km. How far is he from point S, in which direction should he go to reach point S ?

(A) 5 km, East (B) 5 km, West (C) 7 km, East (D) 7 km, West

93. The number of 3-digit numbers such that the digit 2 is never to the immediate left of 1 is

(A) 881 (B) 880 (C) 891 (D) 890

94. 4 men can finish a work in 6 days, 8 women can finish the same work in 15 days, 10 children can finish the same work in 24 days. How long a team of 1 man, 2 women and 2 children will take to finish the same work ?

(A) 12 (B) 14 (C) 15 (D) 16

95. How many two-digit odd numbers can be composed from the nine digits 1, 2, 3, …,9

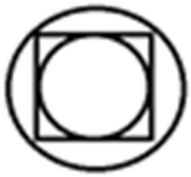
(A) 36 (B) 40 (C) 42 (D) 45

96. If the sum of the next two numbers in the following series is 'x', then the value of $log_2 x$ is is

2, – 4, 8, – 16, 32, – 64, 128, …

(A) 7 (B) 8 (C) 9 (D) 12

97. There is an inner circle and an outer circle around a square as shown in the figure. What is the ratio of area of the outer circle to that of the inner circle ?



(A) $\sqrt{2}$ (B) 2 (C) $2\sqrt{2}$ (D) $\sqrt{3/2}$

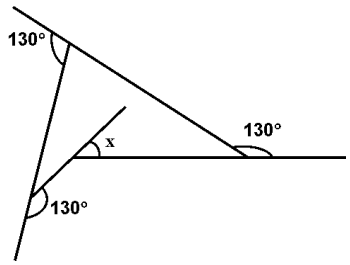
98. In what ratio must rice at ₹ 9.30 per kg be mixed with rice at ₹ 10.80 per kg so that the mixture is worth ₹ 10 per kg ?

(A) 8/7 (B) 7/8 (C) 5/6 (D) 6/5

99. A person bought a shirt at 10% discount and sold it to his friend at a loss of 10%. If his friend paid him ₹ 729 for the shirt, what was the undiscounted price of the shirt ?

(A) ₹ 800 (B) ₹ 911 (C) ₹ 900 (D) ₹ 911.25

100. What is the angle 'x' in the schematic diagram given below ?



(A) 50° (B) 60° (C) 70° (D) 30°

SPACE FOR ROUGH WORK