



ESE 2025

UPSC Engineering Services Examination

Preliminary Examination —— TOPIC WISE ——

Previous Year Questions with Detailed Solution

Volume - I

**ELECTRONICS &
TELECOMMUNICATION ENGINEERING**

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Basic Concept of Network

Charge Current and Voltage

1. The Kirchhoff's current law works on the principle of conservation of [ESE-2018]

1. charge
2. energy
3. power

Which of the above is/are correct?

- (a) 1 only
- (b) 2 only
- (c) 3 only
- (d) 1, 2 and 3

2. Consider the following factors: [ESE-2017]

1. Number of turns of the coil
2. Length of the coil
3. Area of cross-section of the coil
4. Permeability of the core

On which of the above factors does inductance depend?

- (a) 1, 2 and 3 only
- (b) 1, 3 and 4 only
- (c) 1, 2, 3 and 4
- (d) 2 and 4 only

3. A capacitor of $100\mu F$ stores 10 mJ of energy. What is the amount of charge (in Coulomb) stored in it? [ESE-2014]

- (a) 1.414×10^{-6}
- (b) 1.414×10^{-3}
- (c) 2.303×10^{-6}
- (d) 2.303×10^{-3}

4. A 12 V automobile light is rated at 30 W. The total charge that flows through the filament in one minute is [ESE-2014]

- (a) 30 C
- (b) 12 C
- (c) 150 C
- (d) 180 C

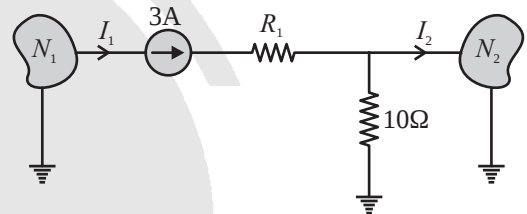
5. If a capacitor is energized by a symmetrical square wave current source, then the steady state voltage across the capacitor will be a [ESE-2013]

- (a) square wave
- (b) triangular wave
- (c) step function
- (d) impulse function

6. A capacitor of capacitance C is charged by connecting it to a battery of emf E . The capacitor is now disconnected and reconnected to the battery with the polarity reversed. The heat developed in the connecting wires is [ESE-2012]

- (a) $0.5 CE^2$
- (b) CE^2
- (c) $2CE^2$
- (d) $3CE^2$

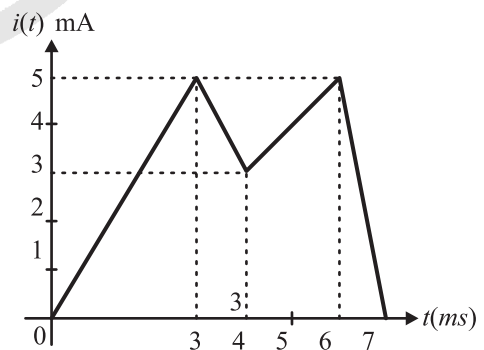
7. Consider the following circuit: [ESE-2004]



In the above circuit, the current I_2 is 2A when the value of R_1 is 20Ω . What will be the value of I_2 , when R_1 is changed to 10Ω ?

- (a) 1A
- (b) 2A
- (c) 3A
- (d) 4A

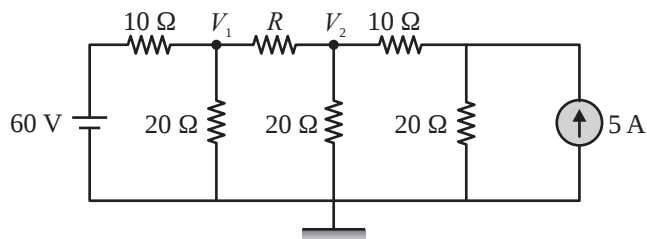
8. A current $i(t)$ as shown in the figure is passed through a capacitor. [ESE-2002]



The charge (in micro-coulomb) acquired by the capacitor after $5\mu s$ is

- (a) 7.5
- (b) 14.5
- (c) 13.5
- (d) 15

9. In the circuit shown below, $V_1 = 40$ V when R is 10Ω . When R is zero, the value of V_2 will be [ESE-2000]



- (a) 40 V (b) 30 V
(c) 20 V (d) 10 V

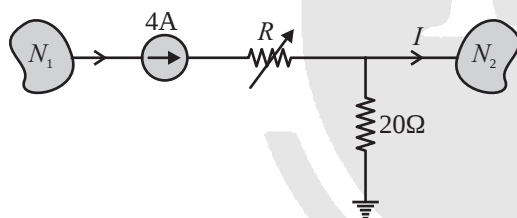
10. A coil would behave as [ESE-2000]

- (a) an inductor at high frequencies
(b) a capacitor at very low frequencies
(c) a capacitor at very high frequencies
(d) a resistor at high frequencies

11. If a coil has diameter ' d ', number of turns ' N ' and form factor ' F ' then the inductance of the coil is proportional to [ESE-2000]

- (a) $N^2 d F$ (b) $N d^2 F$
(c) $N^2 d^2 / F$ (d) $N^2 d / F$

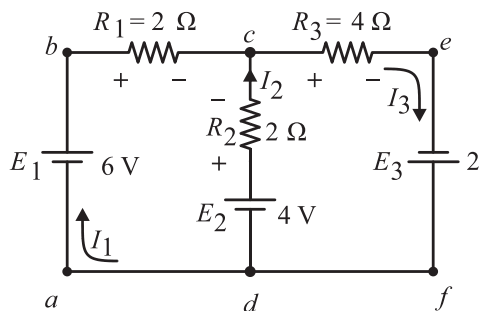
12. In the circuit shown in the figure, for $R = 20\ \Omega$ the current ' I ' is 2A. When R is $10\ \Omega$, the current ' I ' would be [ESE-1999]



- (a) 1A (b) 2A
(c) 2.5A (d) 3A

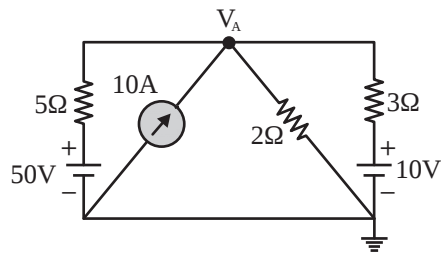
KCL and KVL

13. The current (I_2) of the circuit given below is [ESE-2024]



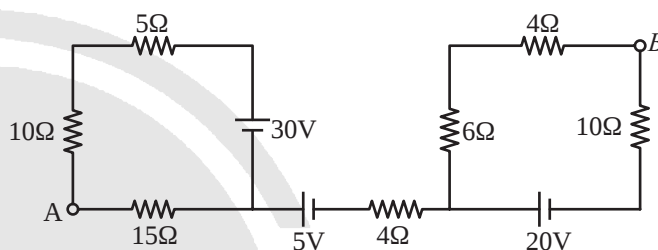
- (a) 2 mA (b) 20 mA
(c) 0.2 A (d) 2 A

14. What is the value of voltage at node V_A shown in the network below? [ESE-2023]



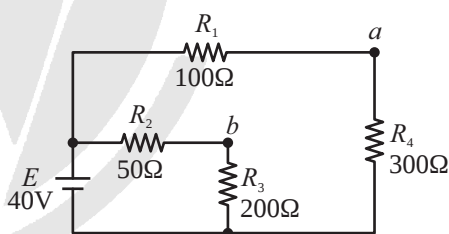
- (a) 21.65 V (b) 22.65 V
(c) -21.65 V (d) -22.65 V

15. What is the value of voltage between points A and B of the network shown in the figure? [ESE-2023]



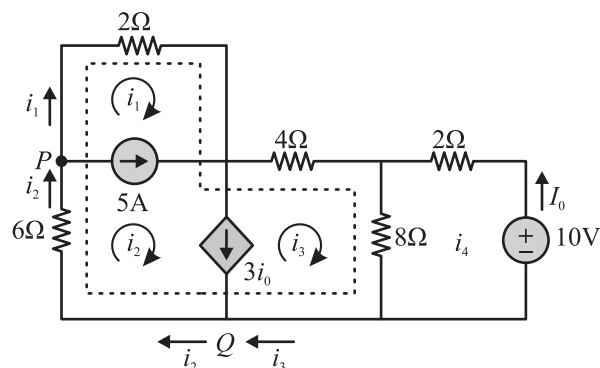
- (a) 15 V (b) 30 V
(c) -30 V (d) -15 V

16. In the figure given below, the value of voltage drop across the resistor R_1 is [ESE-2022]

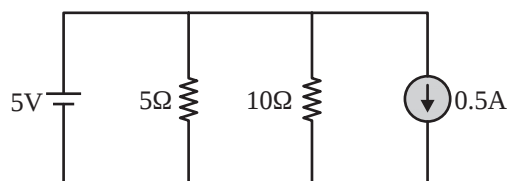


- (a) 100 V (b) 10 V
(c) 1 V (d) 0.1 V

17. For the given circuit, the currents i_1 and i_3 are [ESE-2021]

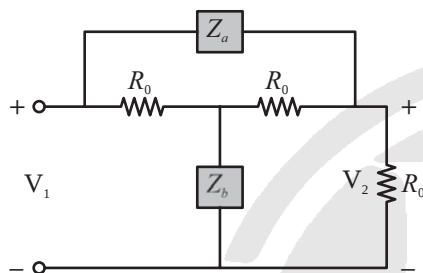


77. The total resistance faced by the voltage source having zero internal resistance in the circuit is [ESE-2012]



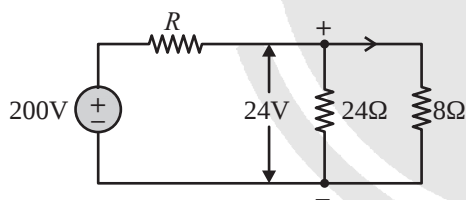
- (a) 10Ω (b) 5Ω
(c) 2.5Ω (d) 1.5Ω

78. The condition under which the input impedance at port 1 for the below network will be equal to R_0 is [ESE-2012]



- (a) $Z_a + Z_b = R_0$ (b) $Z_a Z_b = R_0^2$
(c) $\frac{Z_a}{Z_b} = 1$ (d) $\frac{Z_b}{Z_a} = \frac{1}{2}$

79. The value of R in the below circuit is [ESE-2010]



- (a) 4Ω (b) 40Ω
(c) 44Ω (d) 440Ω

80. The circuit shown in Figure-I is replaced by that in Figure-II. If current ' I ' remains the same, then R_0 then will be [ESE-1999]

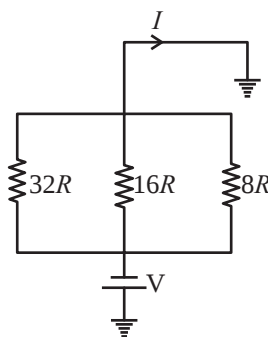


Figure I

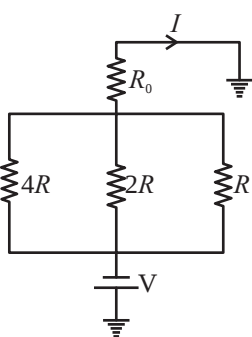


Figure II

- (a) zero (b) R
(c) $2R$ (d) $4R$

Power Calculation

81. A coil consists of 1000 turns of copper wire having a cross-sectional area of 0.8 mm^2 . The mean length per turn is 80 cm and the resistivity of copper is $0.02 \mu\Omega - \text{m}$. What are the values of resistance of the coil and power absorbed by the coil when connected across 100VDC supply respectively? [ESE-2023]

- (a) 20Ω and 250 W (b) 40Ω and 250 W
(c) 20Ω and 500 W (d) 40Ω and 500 W

82. **Statement-I:** Voltage (or potential difference) is the energy required to move a unit charge through an element.

Statement-II: Power is the time rate of expending or absorbing energy. [ESE-2022]

- (a) Both Statement-I and Statement-II are individually true and Statement-II is the correct explanation of Statement-I.
(b) Both Statement-I and Statement-II are individually true, but Statement-II is not the correct explanation of Statement-I.
(c) Statement-I is true, but Statement-II is false.
(d) Statement-I is false, but Statement-II is true.

83. Two resistances, one of 30Ω and another of unknown value, are connected in parallel. The total power dissipated in the circuit is 450 W when the applied voltage is 90 V. The unknown resistance is [ESE-2019]

- (a) 45Ω (b) 35Ω
(c) 30Ω (d) 20Ω

84. A coil of wire of 0.01 mm^2 area of 1000 turns is wound on a core. It is subjected to a flux density of 100 mWb/mm by a 1 A current. The energy stored in the coil is [ESE-2018]

- (a) 2.0 J (b) 1.5 J
(c) 1.0 J (d) 0.5 J

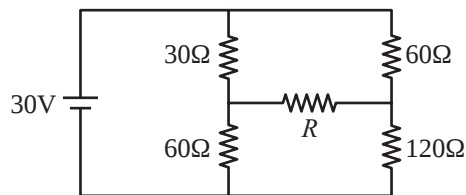
85. Two lamps each of 230 V and 60 W rating are connected in series across a single phase 230 V supply. The total power consumed by the two lamps would be [ESE-2013]

- (a) 120 W (b) 60 W
(c) 30 W (d) 15 W

86. A coil of inductance 2H and resistance 1Ω is connected to a 10 V battery with negligible internal resistance. The amount of energy stored in the magnetic field is [ESE-2013]

- (a) 8 J (b) 50 J
(c) 25 J (d) 100 J

87. Consider the following circuit: [ESE-2004]



What is the power delivered to resistor R in the above circuit?

- (a) -15 W
(b) 0 W
(c) 15 W
(d) Cannot be determined unless the value of R is known

88. Consider the following: [ESE-2002]

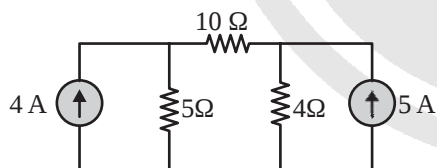
Energy storage capability of basic passive elements is due to the fact that

1. resistance dissipates energy
2. capacitance stores energy
3. inductance dissipates energy

Which of the above is/are correct?

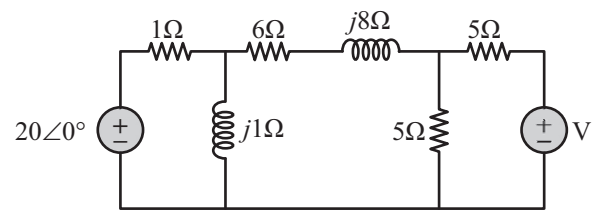
- (a) 1, 2 and 3 (b) 1 and 3
(c) 3 alone (d) 1 and 2

89. In the circuit shown in the given figure, power dissipated in the 5Ω resistor is [ESE-2001]



- (a) Zero (b) 80 W
(c) 125 W (d) 405 W

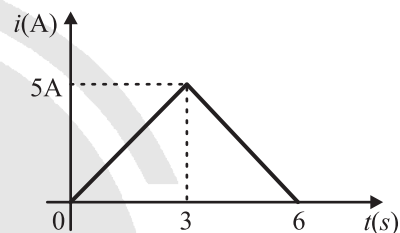
90. In the circuit shown below, if the power dissipated in the 6Ω resistor is zero then V is [ESE-2000]



- (a) $20\sqrt{2} \angle 45^\circ$ (b) $20 \angle 30^\circ$
(c) $20 \angle 45^\circ$ (d) $20\sqrt{2} \angle 30^\circ$

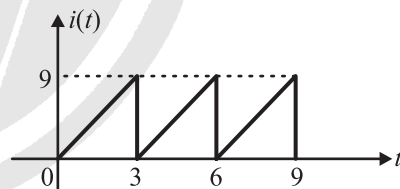
Average and Root Mean Square

91. A waveform shown in the figure is applied to a resistor of 20Ω . The power dissipated in the resistor is [ESE-2018]



- (a) 100 W (b) 600 W
(c) 900 W (d) 1000 W

92. The current waveform $i(t)$ in a pure resistor of 20Ω is shown in the figure. [ESE-2014]



The power dissipated in the resistor is

- (a) 135 W
(b) 270 W
(c) 540 W
(d) 14.58 W



ANSWER KEY

1. (a)	2. (c)	3. (b)	4. (c)	5. (b)	6. (c)	7. (b)	8. (d)	9. (a)	10. (a)
11. (c)	12. (b)	13. (c)	14. (b)	15. (a)	16. (b)	17. (d)	18. (d)	19. (c)	20. (a)
21. (d)	22. (c)	23. (a)	24. (d)	25. (b)	26. (c)	27. (b)	28. (b)	29. (a)	30. (b)
31. (a)	32. (d)	33. (a)	34. (d)	35. (c)	36. (b)	37. (d)	38. (a)	39. (a)	40. (c)
41. (a)	42. (a)	43. (a)	44. (a)	45. (c)	46. (b)	47. (d)	48. (d)	49. (d)	50. (a)
51. (a)	52. (d)	53. (d)	54. (a)	55. (b)	56. (c)	57. (a)	58. (b)	59. (d)	60. (b)
61. (a)	62. (c)	63. (b)	64. (c)	65. (d)	66. (b)	67. (c)	68. (c)	69. (b)	70. (b)
71. (c)	72. (d)	73. (c)	74. (d)	75. (c)	76. (d)	77. (c)	78. (b)	79. (c)	80. (d)
81. (c)	82. (b)	83. (a)	84. (d)	85. (c)	86. (d)	87. (b)	88. (d)	89. (b)	90. (a)
91. (N/A)	92. (c)								



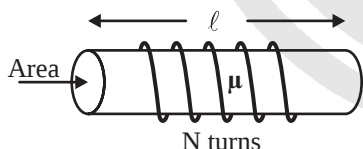
SOLUTIONS

1. (a)

Given: Kirchhoff's Current Law**Explanation:** Kirchhoff's Current Law works on the principle of conservation of charge.

Hence, the correct option is (a).

2. (c)

Given: Number of turn, length, area of cross section of a coil with permeability**Explanation:**

$$\therefore B = \frac{\mu NI}{\ell}$$

$$\phi = BA = \frac{\mu NI}{\ell} A$$

$$\text{Total flux} = \phi N = \frac{\mu N^2 IA}{\ell}$$

$$\phi = LI$$

$$L = \frac{\mu N^2 A}{\ell}$$

Inductance depends permeability, number of turns, area of cross section and length.

Hence, the correct option is (c).

3. (b)

Given: 100 μF capacitor stores 10 mJ of energy.**Explanation:**

Electrostatic energy in capacitor

$$E_c = \frac{1}{2} CV^2$$

$$V = \sqrt{\frac{2E_c}{C}} = \sqrt{\frac{2 \times 10 \times 10^{-3}}{100 \times 10^{-6}}}$$

$$V = 14.1421 \text{ V}$$

$$q = CV = 100 \times 10^{-6} \times 14.1421$$

$$q = 1.414 \times 10^{-3} \text{ C}$$

Hence, the correct option is (b).

4. (c)

Given: 12 V automobile light rated at 30 W**Explanation:**

$$\therefore I = \frac{q}{t}$$

$$P = VI$$

$$I = \frac{30}{12} = 2.5 \text{ A}$$

$$q = 2.5 \times 1 \text{ minute} = 2.5 \times 60 \text{ sec}$$

$$q = 150 \text{ C}$$

Hence, the correct option is (c).

5. (b)

Given: Capacitor energized by square wave.



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**ELECTRONICS &
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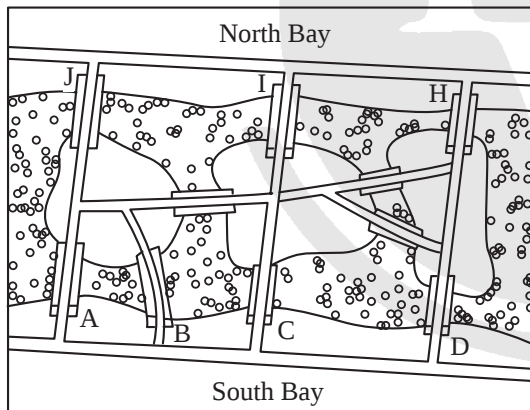
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Quantitative Aptitude

Data Interpretation

- Three hundred passengers are travelling in white, silver and black cars; each of these cars is carrying 6, 5 and 3 passengers, respectively. If the number of white and silver cars is equal and there is only one black car, what is the total number of cars? **[ESE-2017]**
 (a) 52 (b) 53
 (c) 54 (d) 55
- The following map shows the 10 bridges and 3 islands between the suburbs of North Bay and South Bay. During your morning workout, you decide to jog over each bridge exactly once. Which one of the following statements is correct? **[ESE-2024]**



- You want to start from North Bay and that your workout concludes after you jog over the 'D' bridge.
 - You want to start from North Bay and that your workout concludes after you jog over the 'E' bridge.
 - You want to start from North Bay and that your workout concludes after you jog over the bridge.
 - You want to start from North Bay and that your workout concludes after you jog over the 'G' bridge.
- Fifty people were asked to rank their preferences of five varieties of chocolate candy, using 1 for their favorite and 5 for their least favorite. The results are shown in the table below.

	Rankings					
Caramel center	5	4	4	4	2	4
Vanilla center	1	5	5	5	5	5
Almond center	4	1	1	3	4	2
Solid chocolate	3	2	3	2	1	1
Number of voters	17	11	9	8	3	2

According to the table (see the column in grey), three voters ranked solid chocolate first, caramel centers second, almond centers third, toffee centers fourth, and vanilla centers fifth. According to this table, which variety of candy would win the taste test using the plurality voting system? **[ESE-2024]**

- Almond centers
 - Vanilla centers
 - Toffee centers
 - Caramel centers
- The members of a club are going to elect a president from four nominees. In each first-place vote receives 4 points, each second-place vote receives 3 points, each third-place vote receives 2 points, and each last place vote receives 1 point. If the 100 members of the club mark their ballots as shown in the table below, who will be elected president? **[ESE-2024]**

	Rankings					
Avalon	2	2	2	2	3	2
Branson	1	4	4	4	2	1
Columbus	3	3	1	3	1	3
Dunkirk	4	1	3	1	4	4
Number of voters	30	24	18	12	10	6

- Avalon
- Branson
- Columbus
- Dunkirk

Numerical Computation

5. Rajiv spends 40% of his salary on food, 20% on house rent, 10% on entertainment and 10% on conveyance. If his savings at the month end are ₹ 2,000, then his monthly salary is [ESE-2017]

(a) ₹ 6,000
(b) ₹ 8,000
(c) ₹ 10,000
(d) ₹ 12,000

6. A total of 324 notes comprising of ₹ 20 and ₹ 50 denominations make a sum of ₹ 12,450. The number of ₹ 20 notes is [ESE-2017]

(a) 200 (b) 144
(c) 125 (d) 110

7. Five Men can paint a building in 20 days, 8 Women can paint the same building in 25 days and 10 Boys can paint it in 30 days. If a team has 2 Men, 6 Women and 5 Boys, how long will it take to paint the building? [ESE-2017]

(a) 12 days
(b) 13 days
(c) 14 days
(d) 15 days

8. A group of workers estimate to finish a work in 10 days, but 5 workers could not join the work. If the rest of them finished the work in 12 days, the number of members present in the team originally is [ESE-2017]

(a) 50 (b) 45
(c) 35 (d) 30

9. A small production unit now works 6 days per week with

$3\frac{1}{3}$ hours of first shift every one of the 6 days and 3

hours of second shift for each of the first 5 days. Wage negotiations led to an agreement to work on 5 days a

week with both shifts together clocking $7\frac{1}{2}$ hours per

day with an 8% increase in weekly wages. How much change in the hourly production would mean parity in the agreement for both management and employees?

[ESE-2018]

(a) 3.68%
(b) 2.15%
(c) 1.82%
(d) 1.33%

10. Let the sum of the squares of successive integers 0, 1, 2, ..., n - 1, n be denoted by S. Let the sum of the cubes of the same integers be denoted by C. It is desirable that

$\frac{C}{S}$, as n increases in steps of 'unity' from 'zero', is given

by the series: $\frac{0}{1}, \frac{3}{3}, \frac{9}{5}, \frac{18}{7}, \frac{30}{9}, \dots$ (for n = 0, 1, 2, 3, 4, ...).

What will this ratio be for n = 8? [ESE-2018]

(a) $\frac{108}{17}$ (b) $\frac{103}{17}$
(c) $\frac{103}{15}$ (d) $\frac{100}{15}$

11. Given that 0.8 is one root of the equation

$x^3 - 0.6x^2 - 1.84x + 1344 = 0$. The other roots of the equations will be- [ESE-2018]

(a) 1.1 and -1.4 (b) -1.2 and 1.4
(c) 1.2 and -1.4 (d) -1.1 and 1.4

12. The equation, $x^3 - 8x^2 + 37x - 50 = 0$ is factored and it has $(3 + 4i)$ as one of its roots. What is the real roots of this equation? [ESE-2018]

(a) 2 (b) 4
(c) 6.5 (d) 13

13. What is the form of the function $f(x)$ for the following data? [ESE-2018]

x	0	1	2	3
f(x)	3	6	11	18

(a) $x^2 + 2x + 3$ (b) $x^2 - 2x + 3$
(c) $x^2 + 2x - 3$ (d) $x^2 - 2x - 3$

14. What is the maximum value of z, if $z = 10x + 6y$ subject to the constraints [ESE-2018]

$3x + y \leq 12, 2x + 5y \leq 34, x \geq 0, y \geq 0$

(a) 56 (b) 52
(c) 52 (d) 40

15. The objective function $z = 3x_1 + 5x_2$ is to be maximized subjected to constraints. [ESE-2018]

$x_1 + 2x_2 \leq 200$

$x_1 + x_2 \leq 150$

$x_1, x_2 \geq 0$

The values of x_1 and x_2 in this context are, respectively

(a) 100 and 75 (b) 125 and 75
(c) 100 and 50 (d) 125 and 50



ANSWER KEY

- | | | | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 1. (d) | 2. (b) | 3. (c) | 4. (b) | 5. (c) | 6. (c) | 7. (d) | 8. (d) | 9. (a) | 10. (a) |
| 11. (c) | 12. (a) | 13. (a) | 14. (a) | 15. (c) | 16. (c) | 17. (c) | 18. (b) | 19. (a) | 20. (a) |
| 21. (c) | 22. (b) | 23. (c) | 24. (b) | 25. (a) | 26. (a) | 27. (b) | 28. (c) | 29. (a) | 30. (d) |
| 31. (b) | 32. (b) | 33. (b) | 34. (c) | 35. (d) | 36. (c) | 37. (a) | 38. (b) | 39. (b) | 40. (b) |
| 41. (b) | 42. (a) | 43. (c) | 44. (d) | 45. (a) | 46. (c) | 47. (a) | 48. (a) | 49. (d) | 50. (b) |
| 51. (b) | 52. (d) | 53. (b) | 54. (c) | 55. (d) | 56. (a) | 57. (b) | | | |



SOLUTIONS

1. (d)

Given,

Total passengers = 300

and white, silver & Black car carrying 6, 5 & 3 passengers respectively.

Let, no. of white cars be x , so no. of Silver cars is also x .

now, Total passenger will be

$$6x + 5x + (3 \times 1) = 300$$

$$\Rightarrow 11x = 297$$

$$\Rightarrow x = 27$$

So, Total no. of cars = $x + x + 1$

$$\Rightarrow 27 + 27 + 1$$

$$\Rightarrow 55$$

2. (b)

H to G to E to J to A to B to F to C to D to E

3. (c)

Caramel Center (1) Rank = 0

Vanilla Center (1) Rank = 17

Almond Center (1) Rank = 8

Toffee center (1) Rank = $11 + 9 = 20$

Solid Chocolate (1) Rank = $3 + 2 = 5$

4. (b)

Avalon $\rightarrow 180 + 30 = 210$

Branson $\rightarrow 30 + 216 + 26 = 272$

Column bus $\rightarrow 244$

Dunkirk $\rightarrow 225$

5. (c)

Total expenditure = $40\% + 20\% + 10\% + 10\% = 80\%$

$\therefore$ Savings = $(100 - 80) = 20\%$

Thus 20% of income = 2,000

$$\text{Income} = 2,000 \times \frac{100}{20} = 10,000$$

6. (c)

If we consider all 324 notes to be of ₹ 50, then

Amount = $324 \times 50 = 16200$

But Amount given = 12450

Difference = $(16200 - 12450) = 3750$

The difference of ₹ 30 gives ₹ 20 notes every time

$$\therefore \text{₹ 20 notes} = \frac{3750}{30} = 125$$

OR

₹ 20 notes = T ; ₹ 50 notes = F

$$T + F = 324$$

$$20T + 50F = 12450$$

$$50T + 50F = 16200 \quad (324 \times 50)$$

$$\begin{array}{r} - \quad + \quad - \\ \hline -30T = -3750 \end{array}$$

$$T = \frac{3750}{30} = 125$$

7. (d)

$$5 \text{ Men per day} = \frac{1}{20}$$

$$\therefore 1 \text{ Man} = \frac{1}{20 \times 5} = \frac{1}{100}$$



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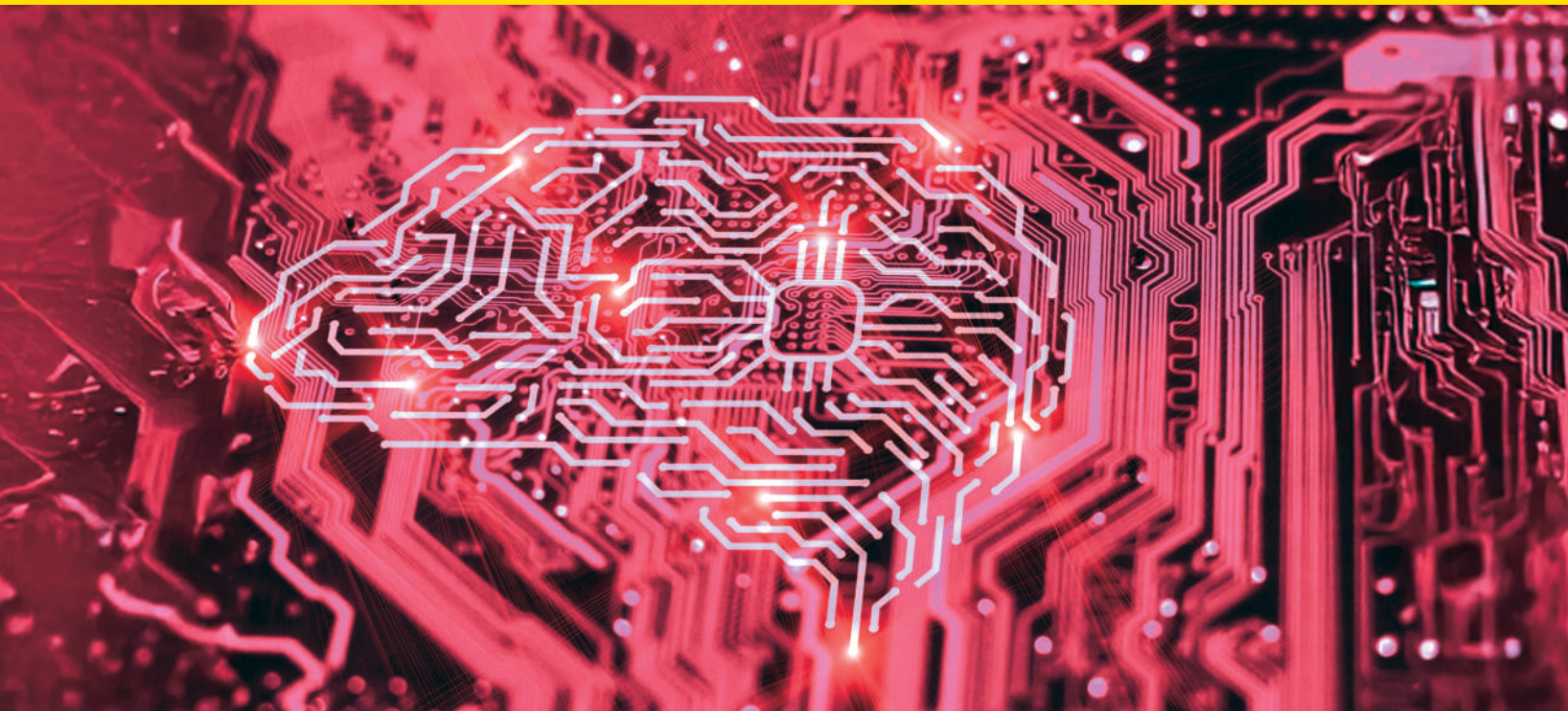
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$$G = 6.67 \times 10^{-11} (N \cdot m^2 / kg^2)$$
$$g = 9.8 m/s^2$$

$$F = \frac{G m_1 m_2}{r^2}$$

$$T = 2\pi \sqrt{\frac{m}{k}}$$

$$\Phi_B = \int \vec{B} \cdot d\vec{A}$$

$$W = \int p dV$$

$$(x^2) = m x^{2-1} a b^2$$
$$a^2 \sqrt{b^2 + c^2}$$

$$(x^h) = h x^{h-1}$$
$$4x^2 + y + ab$$
$$x = a^2 + b^2$$

$$\sqrt{\sum (x_i - y_i)^2}$$

$$a = \frac{\Delta v}{\Delta t}$$

$$v = v_0 + at$$
$$w = w_0 + at$$



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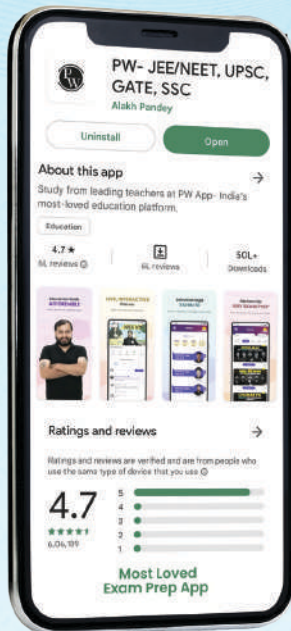
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