SESSION - 1

Graduate Aptitude Test in Engineering

Question Paper Name: EE:ELECTRICAL ENGINEERING 7th Feb Shift 1
Number of Questions : 65
Total Marks: 100.0

Wrong answer for MCQ will result in negative marks, (-1/3) for 1 mark Questions and (-2/3) for 2 marks

General Aptitude
Number of Questions: 10
Section Marks: 15.0

Q.1 to Q.5 carry 1 mark each & Q.6 to Q.10 carry 2 marks

1. Didn't you buy _____ when you went shopping?   **(GATE EE 2015)**

   (a) any paper   (b) much paper   (c) no paper   (d) a few paper

2. Which of the following options is the closest in meaning to the sentence below?
   She enjoyed herself immensely at the party.   **(GATE EE 2015)**

   (a) She had a terrible time at the party

   (b) She had a horrible time at the party

   (c) She had a terrific time at the party

   (d) She had a terrifying time at the party

3. Which one of the following combinations is incorrect?   **(GATE EE 2015)**

   (a) Acquiescence - Submission   (c) Flippancy - Lightness

   (b) Wheedle - Roundabout   (d) Profligate - Extravagant

4. Based on the given statements, select the most appropriate option to solve the given question.
   If two floors in a certain building are 9 feet apart, how many steps are there in a set of stairs that extends from the first floor to the second floor of the building?
   Statements:

   (I) Each step is 3/4 foot high.

   (II) Each step is 1 foot wide.   **(GATE EE 2015)**

   (a) Statement I alone is sufficient, but statement II alone is not sufficient.

   (b) Statement II alone is sufficient, but statement I alone is not sufficient.

   (c) Both statements together are sufficient, but neither statement alone is sufficient.

   (d) Statement I and II together are not sufficient.

5. Given Set $A = \{2, 3, 4, 5\}$ and Set $B = \{11, 12, 13, 14, 15\}$, two numbers are randomly selected, one from each set. What is the probability that the sum of the two numbers equals 16? **(GATE EE 2015)**

   (a) 0.20 (b) 0.25 (c) 0.30 (d) 0.33

6. Select the alternative meaning of the underlined part of the sentence.
   The chain snatchers <u>took to their heels</u> when the police party arrived. **(GATE EE 2015)**

   (a) took shelter in a thick jungle (b) open indis-criminate fire (c) took to flight (d) unconditionally surrendered

7. The given statement is followed by some courses of action. Assuming the statement to be true, decide the correct option. **(GATE EE 2015)**
   Statement:
   There has been a significant drop in the water level in the lakes supplying water to the city.
   Course of action:

   (I) The water supply authority should impose a partial cut in supply to tackle the situation.

   (II) The government should appeal to all the residents through mass media for minimal use of water.

   (III) The government should ban the water supply in lower areas.

   (a) Statements I and II follow. (c) Statements II and III follow.

   (b) Statements I and III follow. (d) All statements follow.

8. The pie chart below has the breakup of the number of students from different departments in anengineering college for the year 2012. The proportion of male to female students in each department is 5:4. There are 40 males in Electrical Engineering. What is the difference between the numbers of female students in the Civil department and the female students in the Mechanical department? **(GATE EE 2015)**
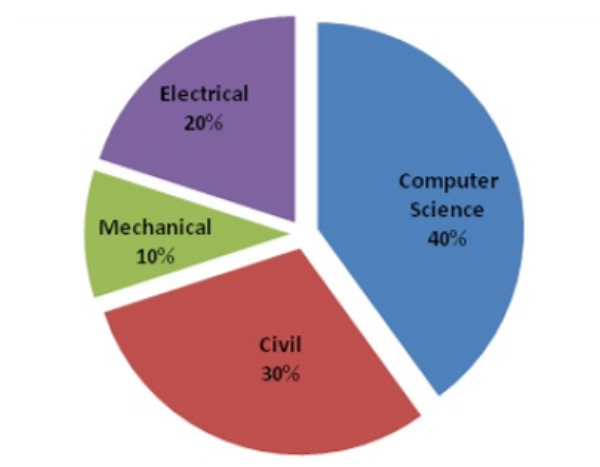

Figure 1:

9. The probabilities that a student passes in Mathematics, Physics and Chemistry are m, p, and c respectively. Of these subjects, the student has 75% chance of passing in at least one, a 50% chance of passing in at least two and a 40% chance of passing in exactly two. Following relations are drawn in m, p, c:

(I) p + m + c = 27/20
(II) p + m + c = 13/20
(III) (p) × (m) × (c) = 1/10 **(GATE EE 2015)**

   (a) Only relation I is true.

   (b) Only relation II is true.

   (c) Relations II and III are true.

   (d) Relations I and III are true.

10. The number of students in a class who have answered correctly, wrongly, or not attempted each question in an exam, are listed in the table below. The marks for each question are also listed. There is no negative or partial marking. **(GATE EE 2015)**

Q No.	Marks	Answered Correctly	Answered Wrongly	Not Attempted
1	2	21	17	6
2	3	15	27	2
3	1	11	29	4
4	2	23	18	3
5	5	31	12	1

What is the average of the marks obtained by the class in the examination?

   (a) 2.290   (b) 2.970   (c) 6.795   (d) 8.795

ELECTRICAL ENGINNEERING
Number of Questions:55
Section Marks: 85

Q.11 to Q.35 carry 1 mark each & Q.36 to Q.65 carry 2 marks each.

11. A random variable X has probability density function **(GATE EE 2015)**

$$f(x) = \begin{cases} a + bx, & 0 < x < 1 \\ 0, & \text{otherwise} \end{cases}.$$

If the expected value $E[X] = \frac{2}{3}$, then $\Pr[X < 0.5]$ is _____.

12. If a continuous function f(x) does not have a root in the interval $[a, b]$, then which one of the following statements is TRUE? **(GATE EE 2015)**

   (a) $f(a) \cdot f(b) = 0$

   (b) $f(a) \cdot f(b) < 0$

   (c) $f(a) \cdot f(b) > 0$

   (d) $\frac{f(a)}{f(b)} \leq 0$

13. If the sum of the diagonal elements of a 2×2 matrix is -6, then the maximum possible value of the determinant of the matrix is _____. **(GATE EE 2015)**

14. Consider a function $\mathbf{f} = \frac{\hat{r}}{r^2}$, where r is the distance from the origin and $\hat{r}$ is the unit vector in the radial direction. The divergence of this function over a sphere of radius R, which includes the origin, is **(GATE EE 2015)**

    (a) 0   (b) 2π (c) 4π (d) $R\pi$

15. When the Wheatstone bridge shown in the figure is used to find the value of resistor R_x, the galvanometer G indicates zero current when $R_1 = 50\Omega$, $R_2 = 65\Omega$, and $R_3 = 100\Omega$. If R_3 is known with $\pm5\%$ tolerance on its nominal value of $100\ \Omega$, what is the range of R_x in Ohms? **(GATE EE 2015)**
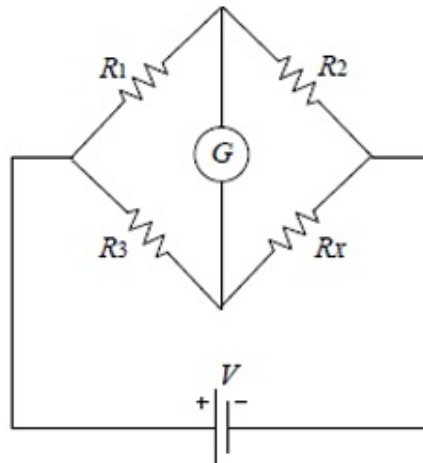
Figure 2:

(a) [a] [123.50, 136.50]   C [117.00, 143.00]

    B [125.89, 134.12]   D [120.25, 139.75]

16. A $(0 - 50\text{ A})$ moving coil ammeter has a voltage drop of 0.1 V across its terminals at full scale deflection. The external shunt resistance (in milliohms) needed to extend its range to $(0 - 500\text{ A})$ is _____. **(GATE EE 2015)**

17. Of the four characteristics given below, which are the major requirements for an instrumentation amplifier? **(GATE EE 2015)**

    (a) P. High common mode rejection ratio

    (b) Q. High input impedance

    (c) R. High linearity

    (d) S. High output impedance

    (a) P, Q, and R only   (c) P, Q, and S only

    (b) P and R only   (d) Q, R, and S only

18. In the following chopper, the duty ratio of switch S is 0.4. If the inductor and capacitor are sufficiently large to ensure continuous inductor current and ripple free capacitor voltage, the charging current (in Ampere) of the 5 V battery, under steady-state, is _____. **(GATE EE 2015)**
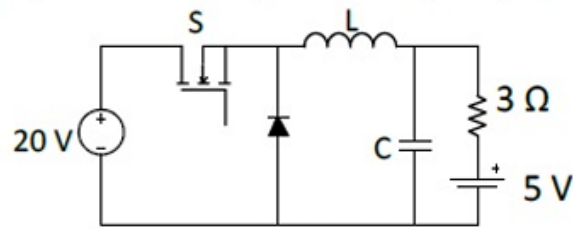
Figure 3:

19. A moving average function is given by $y(t) = \frac{1}{T} \int_{t-T}^{t} u(\tau)\,d\tau.$. If the input u is a sinusoidal signal of frequency Hz, then in steady state, the output y will lag u (in degree) by _____. **(GATE EE 2015)**

20. The impulse response $g(t)$ of a system, G, is as shown in Figure (a). What is the maximum value attained by the impulse response of two cascaded blocks of G as shown in Figure (b)? **(GATE EE 2015)**
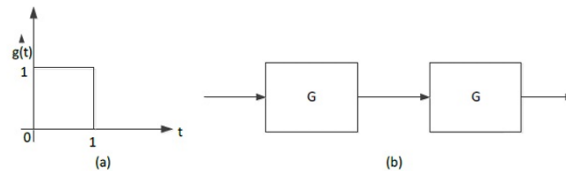

Figure 4:

(a) $\frac{2}{3}$ (b) $\frac{3}{4}$ (c) $\frac{4}{5}$ (d) 1

21. Consider a one-turn rectangular loop of wire placed in a uniform magnetic field as shown in the figure. The plane of the loop is perpendicular to the field lines. The resistance of the loop is $0.4\,\Omega$, and its inductance is negligible. The magnetic flux density (in Tesla) is a function of time, and is given by $B(t) = 0.25 \sin \omega t$, where $\omega = 2\pi \times 50$ radian/second. The power absorbed (in Watt) by the loop from the magnetic field is _____. **(GATE EE 2015)**
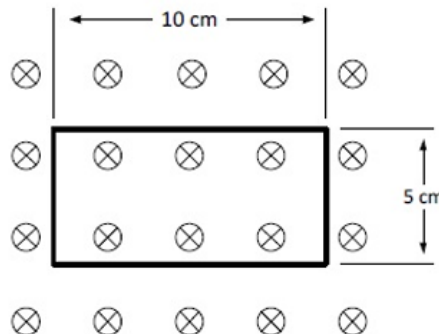

Figure 5:

22. A steady current I is flowing in the $-x$ direction through each of two infinitely long wires at $y = \pm\frac{L}{2}$ as shown in the figure. The permeability of the medium is μ_0. The **B**-field at $(0, L, 0)$ is **(GATE EE 2015)**
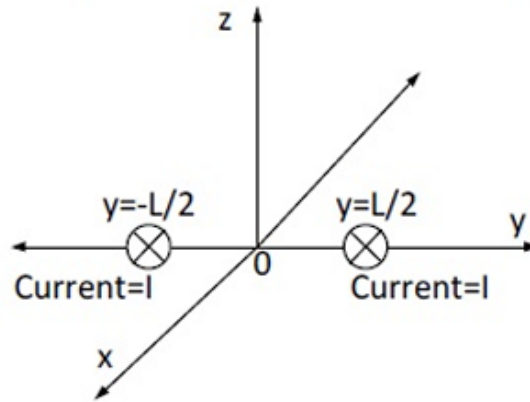

Figure 6:

(a) $-\dfrac{4\mu_0 I}{3\pi L}\,\hat{z}$ (b) $+\dfrac{4\mu_0 I}{3\pi L}\,\hat{z}$ (c) 0   (d) $-\dfrac{3\mu_0 I}{4\pi L}\,\hat{z}$

23. Consider the circuit shown in the figure. In this circuit $R = 1\,\mathrm{k\Omega}$, and $C = 1\,\mu\mathrm{F}$. The input voltage is sinusoidal with a frequency of 50 Hz, represented as a phasor with magnitude V_i and phase angle 0 radian as shown in the figure. The output voltage is represented as a phasor with magnitude V_o and phase angle δ radian. What is the value of the output phase angle δ (in radian) relative to the phase angle of the input voltage? **(GATE EE 2015)**
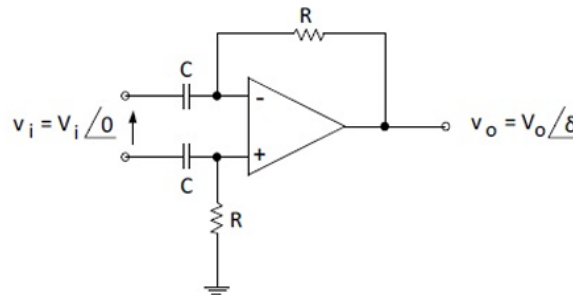

Figure 7:

(a) 0   (b) π (c) $\pi/2$ (d) $-\pi/2$

24. In the given circuit, the silicon transistor has $\beta = 75$ and a collector voltage $V_C = 9\,\mathrm{V}$. Then the ratio of R_B and R_C is _____. **(GATE EE 2015)**
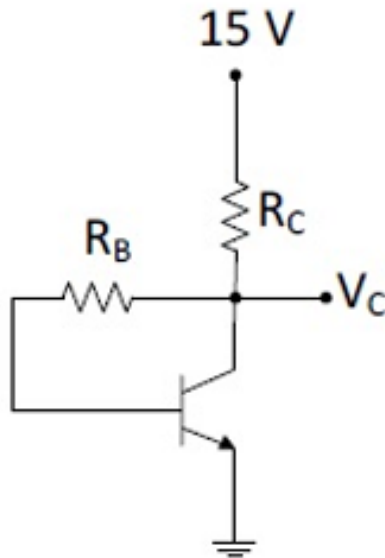
Figure 8:

25. In the 4×1 multiplexer, the output F is given by $F = A \oplus B$. Find the required input $I_3 I_2 I_1 I_0$. **(GATE EE 2015)**

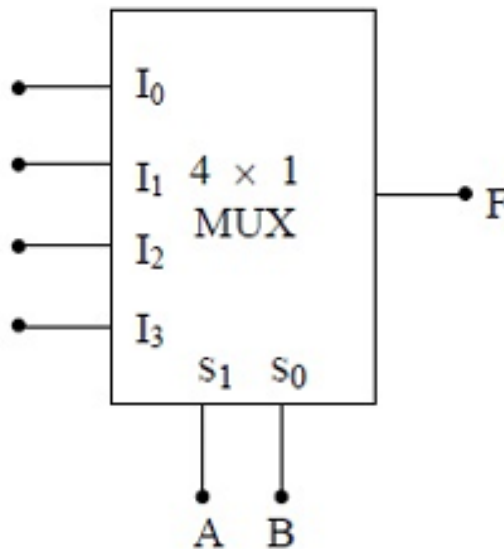

Figure 9:

(a) 1010   (b) 0110   (c) 1000   (d) 1110

26. Consider a HVDC link which uses thyristor based line-commutated converters as shown in the figure. For a power flow of 750 MW from System 1 to System 2, the voltages at the two ends, and the current, are given by: $V_1 = 500$ kV, $V_2 = 485$ kV and $I = 1.5$ kA. If the direction of power flow is to be reversed (that is, from System 2 to System 1) without changing the electrical connections, then which one of the following combinations is feasible? **(GATE EE 2015)**
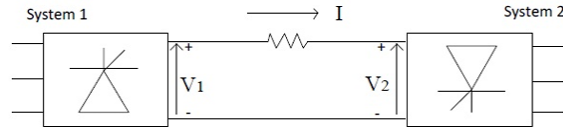
Figure 10:

(a) $V_1 = -500$ kV, $V_2 = -485$ kV and $I = 1.5$ kA

(b) $V_1 = -485$ kV, $V_2 = -500$ kV and $I = 1.5$ kA

(c) $V_1 = 500$ kV, $V_2 = 485$ kV and $I = -1.5$ kA

(d) $V_1 = -500$ kV, $V_2 = -485$ kV and $I = -1.5$ kA

27. Base load power plants are   **(GATE EE 2015)**
    P: wind farms.
    Q: run-of-river plants.
    R: nuclear power plants.
    S: diesel power plants.

    (a) P, Q and S only   (c) P, Q and R only

    (b) P, R and S only   (d) Q and R only

28. The voltages developed across the 3 Ω and 2 Ω resistors shown in the figure are 6 V and 2 V respectively, with the polarity as marked. What is the power (in Watt) delivered by the 5 V voltage source?   **(GATE EE 2015)**

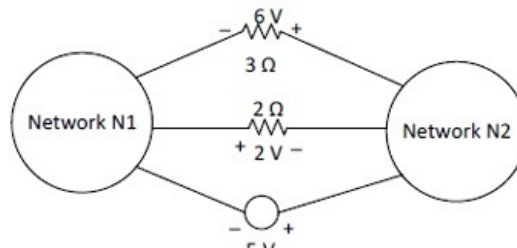Figure 11:

(a) 5   (b) 7   (c) 10   (d) 14

29. For the given circuit, the Thevenin equivalent is to be determined. The Thevenin voltage, V_{Th} (in Volt), seen from terminal AB is _____.   **(GATE EE 2015)**
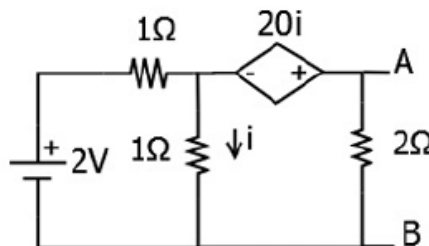

Figure 12:

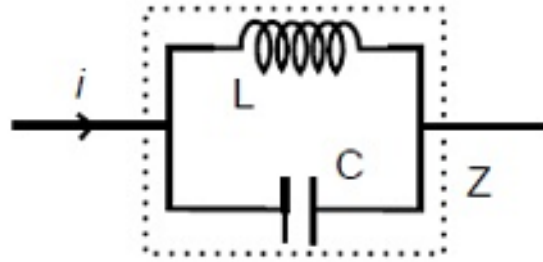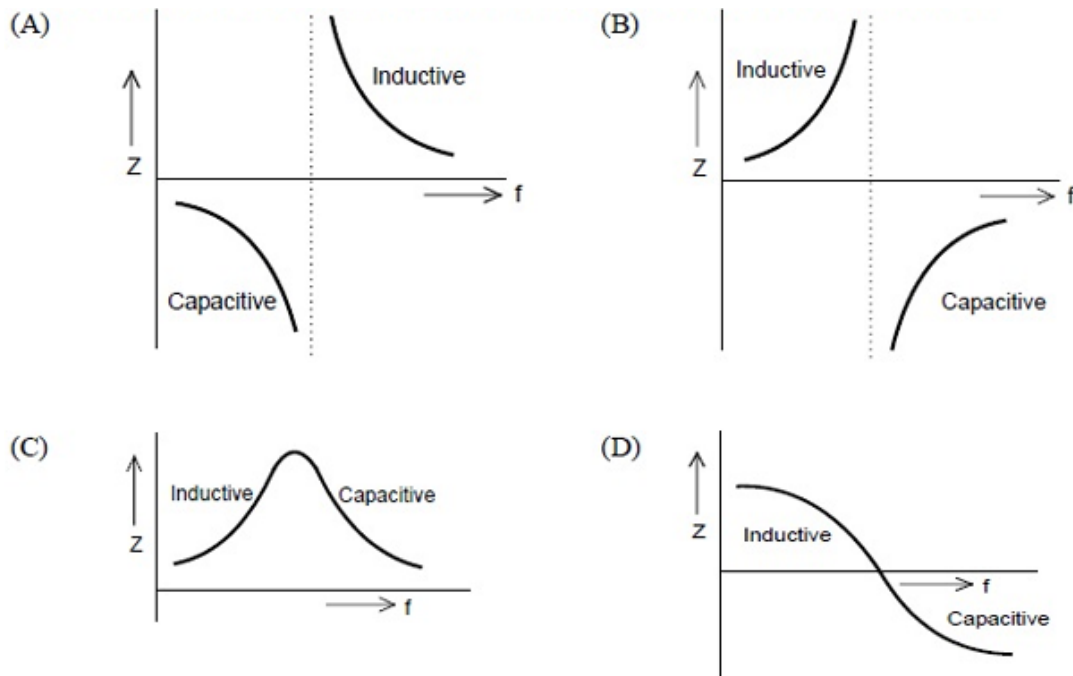30. An inductor is connected in parallel with a capacitor as shown in the figure

Figure 13:

As the frequency of current i is increased, the increased, the impedence (Z) of the network varies as **(GATE EE 2015)**

31. A separately excited DC generator has an armature resistance of $0.1\,\Omega$ and negligible armature inductance. At rated field current and rated rotor speed, its open-circuit voltage is 200 V. When this generator is operated at half the rated speed, with half the rated field current, an uncharged $1000\,\mu F$ capacitor is suddenly connected across the armature terminals. Assume that the speed remains unchanged during the transient. At what time (in microsecond) after the capacitor is connected will the voltage across it reach 25 V? **(GATE EE 2015)**

   (a) 62.25   (b) 69.3   (c) 73.25   (d) 77.3

32. The self inductance of the primary winding of a single phase, 50 Hz, transformer is 800 mH, and that of the secondary winding is 600 mH. The mutual inductance between

these two windings is 480 mH. The secondary winding of this transformer is short circuited and the primary winding is connected to a 50 Hz, single phase, sinusoidal voltage source. The current flowing in both the windings is less than their respective rated currents. The resistance of both windings can be neglected. In this condition, what is the effective inductance (in mH) seen by the source? **(GATE EE 2015)**

(a) 416   (b) 440   (c) 200   (d) 920

33. The primary mmf is least affected by the secondary terminal conditions in a

(GATE EE 2015)

(a) power transformer   (c) current transformer

(b) potential transformer   (d) distribution transformer

34. A Bode magnitude plot for the transfer function $G(s)$ of a plant is shown in the figure. Which one of the following transfer functions best describes the plant? **(GATE EE 2015)**
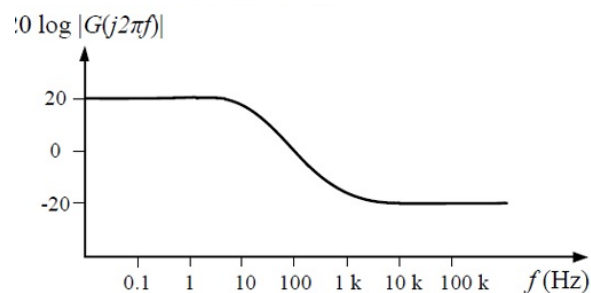

Figure 14:

(a) $\dfrac{1000(s + 10)}{s + 1000}$ (b) $\dfrac{10(s + 10)}{s(s + 1000)}$ (c) $\dfrac{s + 1000}{10s(s + 10)}$ (d) $\dfrac{s + 1000}{10(s + 10)}$

35. For the signal-flow graph shown in the figure, which one of the following expressions is equal to the transfer function $\dfrac{Y(s)}{X_2(s)}\Big|_{X_1(s)=0}$? **(GATE EE 2015)**
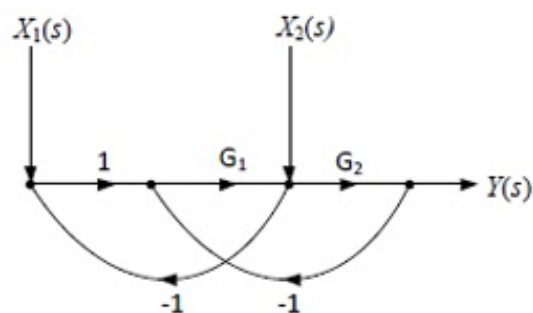

Figure 15:

(a) $\dfrac{G_1}{1 + G_2(1 + G_1)}$ (b) $\dfrac{G_2}{1 + G_1(1 + G_2)}$ (c) $\dfrac{G_1}{1 + G_1 G_2}$ (d) $\dfrac{G_2}{1 + G_1 G_2}$

36. The maximum value of a such that the matrix $\begin{pmatrix} -3 & 0 & 0 & -2 \\ 1 & -1 & 0 & 0 \\ 0 & a & -2 \end{pmatrix}$ has three linearly

    independent real eigenvectors is   **(GATE EE 2015)**

    (a) $\dfrac{2}{3\sqrt{3}}$ (b) $\dfrac{1}{3\sqrt{3}}$ (c) $\dfrac{1 + 2\sqrt{3}}{3\sqrt{3}}$ (d) $\dfrac{1 + \sqrt{3}}{3\sqrt{3}}$

37. A solution of the ordinary differential equation $\dfrac{d^2y}{dt^2} + 5\dfrac{dy}{dt} + 6y = 0$ is such that $y(0) = 2$

    and $y(1) = -1 - \dfrac{3}{e^3}$. The value of $\frac{dy}{dt}(0)$ is _____.   **(GATE EE 2015)**

38. The signum function is given by $sgn(x) = \begin{cases} \dfrac{x}{|x|}, & x \neq 0 \\ 0, & x = 0 \end{cases}$ The Fourier series expansion of

    $sgn(\cos(t))$ has   **(GATE EE 2015)**

    (a) only sine terms with all harmonics.
    (b) only cosine terms with all harmonics.
    (c) only sine terms with even numbered harmonics.
    (d) only cosine terms with odd numbered harmonics.

39. Two players, A and B, alternately keep rolling a fair dice. The person to get a six first wins the game. Given that player A starts the game, the probability that A wins the game is   **(GATE EE 2015)**

    (a) 5/11   (b) 1/2   (c) 7/13   (d) 6/11

40. An unbalanced DC Wheatstone bridge is shown in the figure. At what value of p will the magnitude of V_0 be maximum?   **(GATE EE 2015)**
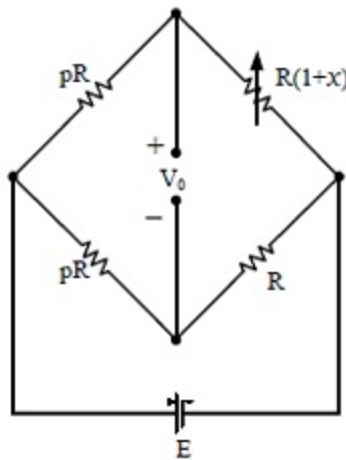

Figure 16:

(a) $\sqrt{1+x}$ (b) $1+x$ (c) $1/\sqrt{1+x}$ (d) $\sqrt{1-x}$

41. The circuit shown is meant to supply a resistive load R_L from two separate DC voltage sources. The switches S1 and S2 are controlled so that only one of them is ON at any instant. S1 is turned on for 0.2 ms and S2 is turned on for 0.3 ms in a 0.5 ms switching cycle time period. Assuming continuous conduction of the inductor current and negligible ripple on the capacitor voltage, the output voltage V_o (in Volt) across R_L is _____.   **(GATE EE 2015)**

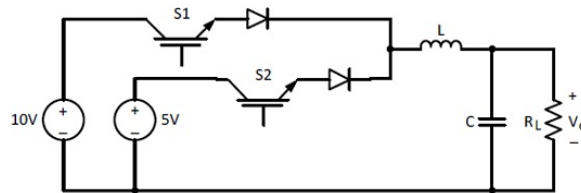Figure 17:

42. A self commutating switch SW, operated at duty cycle δ is used to control the load voltage as shown in the figure.   **(GATE EE 2015)**
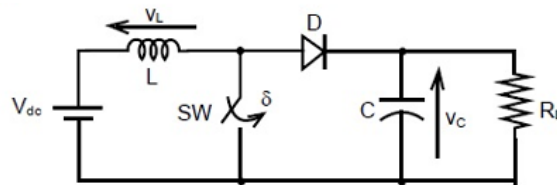

Figure 18:

Under steady state operating conditions, the average voltage across the inductor and the capacitor respectively, are

(a) $V_L = 0$ and $V_C = \frac{1}{1-\delta}V_{dc}$ (c) $V_L = 0$ and $V_C = \frac{\delta}{1-\delta}V_{dc}$

(b) $V_L = \frac{\delta}{2}V_{dc}$ and $V_C = \frac{1}{1-\delta}V_{dc}$ (d) $V_L = \frac{\delta}{2}V_{dc}$ and $V_C = \frac{\delta}{1-\delta}V_{dc}$

43. The single-phase full-bridge voltage source inverter (VSI), shown in figure, has an output frequency of 50 Hz. It uses unipolar pulse width modulation with switching frequency of 50 kHz and modulation index of 0.7. For $V_{in} = 100$ V DC, $L = 9.55$ mH, $C = 63.66\,\mu$F, and $R = 5\,\Omega$, the amplitude of the fundamental component in the output voltage V_o (in Volt) under steady-state is _____.   **(GATE EE 2015)**
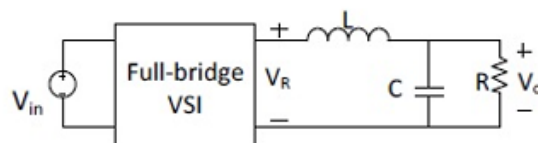

Figure 19:

44. A 3-phase 50 Hz square wave (6-step) VSI feeds a 3-phase, 4 pole induction motor. The VSI line voltage has a dominant 5th harmonic component. If the operating slip of the motor with respect to fundamental component voltage is 0.04, the slip of the motor with respect to 5th harmonic component of voltage is _____. **(GATE EE 2015)**

45. Consider a discrete time signal given by **(GATE EE 2015)**

$$x[n] = (-0.25)^n u[n] + (0.5)^n u[-n-1]$$

The region of convergence of its Z-transform would be

(a) the region inside the circle of radius 0.5 and centered at origin

(b) the region outside the circle of radius 0.25 and centered at origin

(c) the annular region between the two circles, both centered at origin and having radii 0.25 and 0.5

(d) the entire Z plane

46. A parallel plate capacitor is partially filled with glass of dielectric constant 4.0 as shown below. The dielectric strengths of air and glass are 30 kV/cm and 300 kV/cm, respectively. The maximum voltage (in kilovolts), which can be applied across the capacitor without any breakdown, is _____. **(GATE EE 2015)**
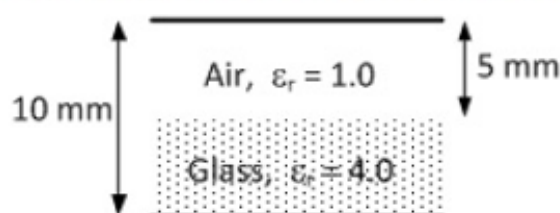

Figure 20:

47. The figure shows a digital circuit constructed using negative edge triggered J-K flip flops. Assume a starting state of $Q_2 Q_1 Q_0 = 000$. This state $Q_2 Q_1 Q_0 = 000$ will repeat after _____ number of cycles of the clock CLK. **(GATE EE 2015)**
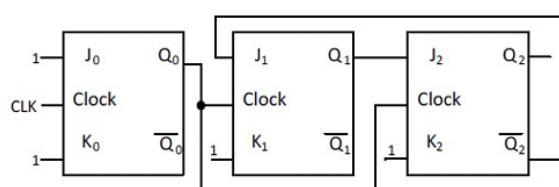

Figure 21:

48. $f(A, B, C, D) = \prod M(0, 1, 3, 4, 5, 7, 9, 11, 12, 13, 14, 15)$ is a maxterm representation of a Boolean function $f(A, B, C, D)$, where A is the MSB and D is the LSB. The equivalent minimized representation of this function is **(GATE EE 2015)**

(a) $(A + C + D)(A + B + D)$

(b) $ACD + ABD$

(c) $ACD + ABCD + ABCD$

(d) $(B + C + D)(A + B + C + D)(A + B + C + D)$

49. The op-amp shown in the figure has a finite gain $A = 1000$ and an infinite input resistance. A step-voltage $V_1 = 1$ mV is applied at the input at time $t = 0$ as shown. Assuming that the operational amplifier is not saturated, the time constant (in millisecond) of the output voltage V_o is **(GATE EE 2015)**
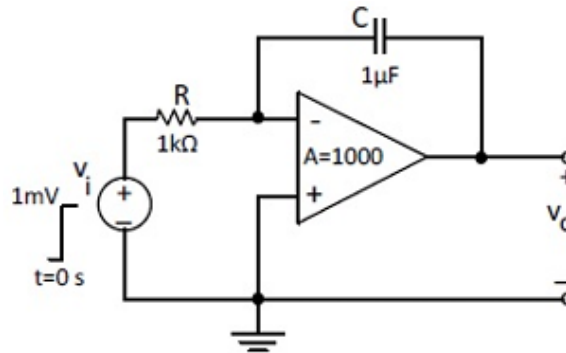

Figure 22:

(a) 1001   (b) 101   (c) 11   (d) 1

50. An 8-bit, unipolar Successive Approximation Register type ADC is used to convert 3.5 V to digital equivalent output. The reference voltage is +5 V. The output of the ADC, at the end of 3rd clock pulse after the start of conversion, is **(GATE EE 2015)**

(a) 1010 0000   (b) 1000 0000   (c) 0000 0001   (d) 0000 0011

51. Consider the economic dispatch problem for a power plant having two generating units. The fuel costs in Rs/MWh along with the generation limits for the two units are given below: **(GATE EE 2015)**
$C_1(P_1) = 0.01P_1^2 + 30P_1 + 10; \quad 100 \le P_1 \le 150$ MW
$C_2(P_2) = 0.05P_2^2 + 10P_2 + 10; \quad 100 \le P_2 \le 180$ MW.
The incremental cost (in Rs/MWh) of the power plant when it supplies 200 MW is
_____.

52. Determine the correctness or otherwise of the following Assertion [a] and the Reason [r].
Assertion: Fast decoupled load flow method gives approximate load flow solution because it uses several assumptions.
Reason: Accuracy depends on the power mismatch vector tolerance. **(GATE EE 2015)**

(a) Both [a] and [r] are true and [r] is the correct reason for [a].

(b) Both [a] and [r] are true but [r] is not the correct reason for [a].

(c) Both [a] and [r] are false.

(d) [a] is false and [r] is true.

53. A 50 Hz generating unit has *H*-constant of 2 MJ/MVA. The machine is initially operating in steady state at synchronous speed, and producing 1 pu of real power. The initial value of the rotor angle δ is 5°, when a bolted three phase to ground short circuit fault occurs at the terminal of the generator. Assuming the input mechanical power to remain at 1 pu, the value of δ in degrees, 0.02 second after the fault is
_____.   **(GATE EE 2015)**

54. A sustained three-phase fault occurs in the power system shown in the figure. The current and voltage phasors during the fault (on a common reference), after the natural transients have died down, are also shown. Where is the fault located?**(GATE EE 2015)**
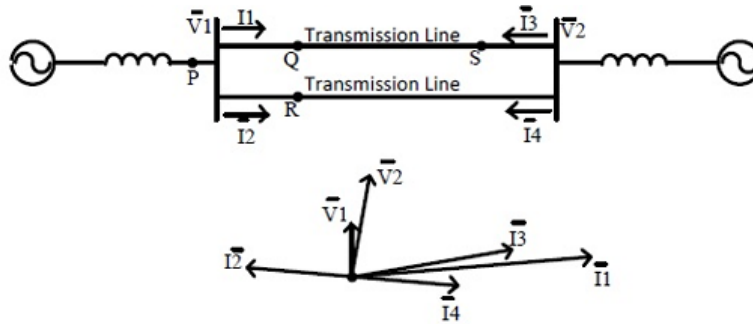

Figure 23:

   (a) Location P   (b) Location Q   (c) Location R   (d) Location S

55. The circuit shown in the figure has two sources connected in series. The instantaneous voltage of the AC source (in Volt) is given by $v(t) = 12 \sin t$. If the circuit is in steady state, then the rms value of the current (in Ampere) flowing in the circuit is
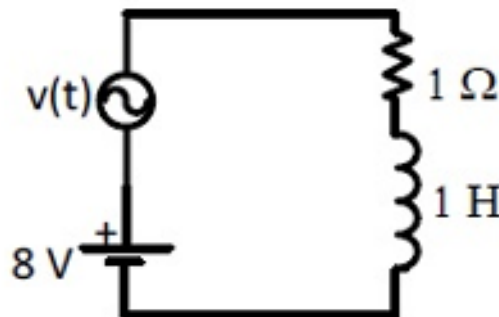_____.   **(GATE EE 2015)**

Figure 24:

56. In a linear two-port network, when 10 V is applied to Port 1, a current of 4 A flows through Port 2 when it is short-circuited. When 5 V is applied to Port 1, a current of 1.25 A flows through a 1 Ω resistance connected across Port 2. When 3 V is applied to Port 1, the current (in Ampere) through a 2 Ω resistance connected across Port 2 is
_____.   **(GATE EE 2015)**

57. In the given circuit, the parameter k is positive, and the power dissipated in the 2 Ω resistor is 12.5 W. The value of k is _____. **(GATE EE 2015)**
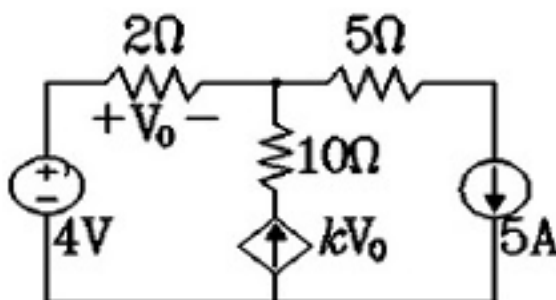

Figure 25:

58. A separately excited DC motor runs at 1000 rpm on no load when its armature terminals are connected to a 200 V DC source and the rated voltage is applied to the field winding. The armature resistance of this motor is 1 Ω. The no-load armature current is negligible. With the motor developing its full load torque, the armature voltage is set so that the rotor speed is 500 rpm. When the load torque is reduced to 50% of the full load value under the same armature voltage conditions, the speed rises to 520 rpm. Neglecting the rotational losses, the full load armature current (in Ampere) is _____. **(GATE EE 2015)**

59. A DC motor has the following specifications: 10 hp, 37.5 A, 230 V; flux/pole = 0.01 Wb, number of poles = 4, number of conductors = 666, number of parallel paths = 2. Armature resistance = 0.267 Ω. The armature reaction is negligible and rotational losses are 600 W. The motor operates from a 230 V DC supply. If the motor runs at 1000 rpm, the output torque produced (in Nm) is _____. **(GATE EE 2015)**

60. A 200/400 V, 50 Hz, two-winding transformer is rated at 20 kVA. Its windings are connected as an auto-transformer of rating 200/600 V. A resistive load of 12 Ω is connected to the high voltage (600 V) side of the auto-transformer. The value of equivalent load resistance (in Ohm) as seen from low voltage side is _____. **(GATE EE 2015)**

61. Two single-phase transformers T_1 and T_2 each rated at 500 kVA are operated in parallel. Percentage impedances of T_1 and T_2 are $(1 + j6)$ and $(0.8 + j4.8)$, respectively. To share a load of 1000 kVA at 0.8 lagging power factor, the contribution of T_2 (in kVA) is _____. **(GATE EE 2015)**

62. In the signal flow diagram given in the figure, u_1 and u_2 are possible inputs whereas y_1 and y_2 are possible outputs. When would the SISO system derived from this diagram be controllable and observable? **(GATE EE 2015)**
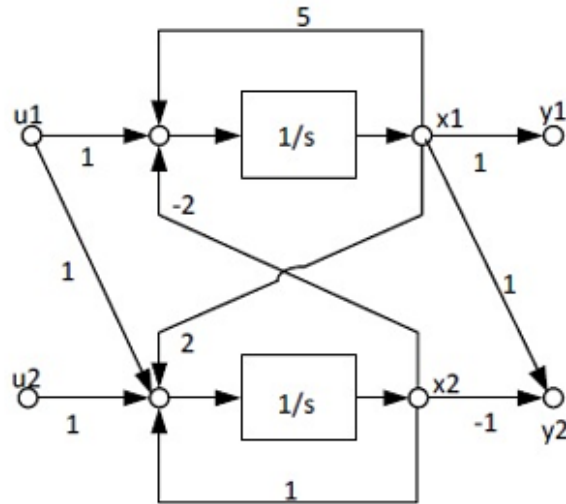
Figure 26:

(a) When u_1 is the only input and y_1 is the only output.

(b) When u_2 is the only input and y_1 is the only output.

(c) When u_1 is the only input and y_2 is the only output.

(d) When u_2 is the only input and y_2 is the only output.

63. The transfer function of a second order real system with a perfectly flat magnitude response of unity has a pole at $(2 - j3)$. List all the poles and zeroes. **(GATE EE 2015)**

(a) Poles at $(2 \pm j3)$, no zeroes.

(b) Poles at $(\pm 2 - j3)$, one zero at origin.

(c) Poles at $(2 - j3)$, $(-2 + j3)$, zeroes at $(-2 - j3)$, $(2 + j3)$.

(d) Poles at $(2 \pm j3)$, zeroes at $(-2 \pm j3)$.

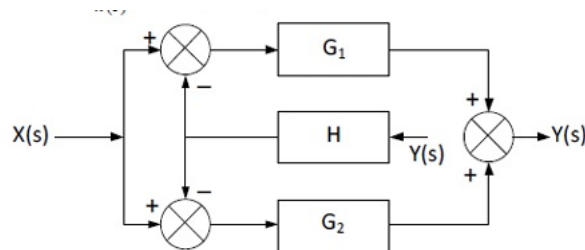64. Find the transfer function $\dfrac{Y(s)}{X(s)}$ of the system given below. **(GATE EE 2015)**

Figure 27:

(a) $\dfrac{G_1}{1 - HG_1} + \dfrac{G_2}{1 - HG_2}$

(b) $\dfrac{G_1}{1 + HG_1} + \dfrac{G_2}{1 + HG_2}$

(c) $\dfrac{G_1 + G_2}{1 + H(G_1 + G_2)}$

(d) $\dfrac{G_1 + G_2}{1 - H(G_1 + G_2)}$

65. The open loop poles of a third order unity feedback system are at $0, -1, -2$. Let the frequency corresponding to the point where the root locus of the system transits to unstable region be K. Now suppose we introduce a zero in the open loop transfer function at -3, while keeping all the earlier open loop poles intact. Which one of the following is TRUE about the point where the root locus of the modified system transits to unstable region? **(GATE EE 2015)**

   (a) It corresponds to a frequency greater than K

   (b) It corresponds to a frequency less than K

   (c) It corresponds to a frequency K

   (d) Root locus of modified system never transits to unstable region

SESSION - 2

Graduate Aptitude Test in Engineering

Question Paper Name: EE:ELECTRICAL ENGINEERING 7th Feb Shift 1
Number of Questions : 65
Total Marks: 100.0

Wrong answer for MCQ will result in negative marks, (-1/3) for 1 mark Questions and (-2/3) for 2 marks

General Aptitude
Number of Questions: 10
Section Marks: 15.0

Q.1 to Q.5 carry 1 mark each & Q.6 to Q.10 carry 2 marks each.

1. We _____ our friend's birthday and we _____ how to make it up to him. **(GATE EE 2015)**

    (a) completely forgot — don't just know
    (b) forgot completely — don't just know
    (c) completely forgot — just don't know
    (d) forgot completely — just don't know

2. Choose the statement where underlined word is used correctly. **(GATE EE 2015)**

    (a) The industrialist had a personnel jet.
    (b) I write my experience in my personnel diary.
    (c) All personnel are being given the day off.
    (d) Being religious is a personnel aspect.

3. A generic term that includes various items of clothing such as a skirt, a pair of trousers and a shirt is **(GATE EE 2015)**

    (a) fabric   (b) textile   (c) fibre   (d) apparel

4. Based on the given statements, select the most appropriate option to solve the given question. **(GATE EE 2015)**

    What will be the total weight of 10 poles each of same weight?

    Statements:

    (I) One fourth of the weight of a pole is 5 kg.
    (II) The total weight of these poles is 160 kg more than the total weight of two poles.

    (a) Statement I alone is not sufficient.
    (b) Statement II alone is not sufficient.
    (c) Either I or II alone is sufficient.
    (d) Both statements I and II together are not sufficient.

5. Consider a function $f(x) = 1 - |x|$ on $-1 \leq x \leq 1$. The value of x at which the function attains a maximum, and the maximum value of the function are: **(GATE EE 2015)**

(a) $0, -1$ (b) $-1, 0$ (c) $0, 1$ (d) $-1, 2$

6. Out of the following four sentences, select the most suitable sentence with respect to grammar and usage: **(GATE EE 2015)**

   (a) Since the report lacked needed information, it was of no use to them.

   (b) The report was useless to them because there were no needed information in it.

   (c) Since the report did not contain the needed information, it was not real useful to them.

   (d) Since the report lacked needed information, it would not had been useful to them.

7. In a triangle PQR, PS is the angle bisector of $\angle QPR$ and $\angle QPS = 60°$. What is the length of PS? **(GATE EE 2015)**

   (a) $\dfrac{(q+r)}{qr}$ (b) $\dfrac{qr}{(q+r)}$ (c) $\sqrt{(q^2 + r^2)}$ (d) $\dfrac{(q+r)^2}{qr}$

8. If p, q, r, s are distinct integers such that: **(GATE EE 2015)**
   $f(p, q, r, s) = \max(p, q, r, s)$
   $g(p, q, r, s) = \min(p, q, r, s)$
   $h(p, q, r, s) = $ remainder of $(p \times q)/(r \times s)$ if $(p \times q) > (r \times s)$ or remainder of $(r \times s)/(p \times q)$ if $(r \times s) > (p \times q)$
   Also, a function $fgh(p, q, r, s) = f(p, q, r, s) \times g(p, q, r, s) \times h(p, q, r, s)$
   Also the same operations are valid with two variable functions of the form $f(p, q)$.
   What is the value of $fg(h(2, 5, 7, 3), 4, 6, 8)$?

9. If the list of letters, P, R, S, T, U is an arithmetic sequence, which of the following are also in arithmetic sequence? **(GATE EE 2015)**

   (a) $2P, 2R, 2S, 2T, 2U$

   (b) $P - 3, R - 3, S - 3, T - 3, U - 3$

   (c) P^2, R^2, S^2, T^2, U^2

   (a) I only (b) I and II (c) II and III (d) I and III

10. Four branches of a company are located at $M, N, O,$ and P. M is north of N at a distance of 4 km; P is south of O at a distance of 2 km; N is southeast of O by 1 km. What is the distance between M and P in km? **(GATE EE 2015)**

    (a) (A) 5.34 (b) (B) 6.74 (c) (C) 28.5 (d) (D) 45.49

11. Given $f(z) = g(z) + h(z)$, where f, g, h are complex valued functions of a complex variable z. Which one of the following statements is TRUE? **(GATE EE 2015)**

   (a) If $f(z)$ is differentiable at z_0, then $g(z)$ and $h(z)$ are also differentiable at z_0.

   (b) If $g(z)$ and $h(z)$ are differentiable at z_0, then $f(z)$ is also differentiable at z_0.

   (c) If $f(z)$ is continuous at z_0, then it is differentiable at z_0.

   (d) If $f(z)$ is differentiable at z_0, then so are its real and imaginary parts.

12. We have a set of 3 linear equations in 3 unknowns. '$X \equiv Y$' means X and Y are equivalent statements and '$X \not\equiv Y$' means X and Y are not equivalent statements.
   P: There is a unique solution.
   Q: The equations are linearly independent.
   R: All eigenvalues of the coefficient matrix are nonzero.
   S: The determinant of the coefficient matrix is nonzero.
   Which one of the following is TRUE? **(GATE EE 2015)**

   (a) (A) $P \equiv Q \equiv R \equiv S$

   (c) (C) $P \equiv Q \not\equiv R \equiv S$

   (b) (B) $P \equiv R \not\equiv Q \equiv S$

   (d) (D) $P \not\equiv Q \not\equiv R \not\equiv S$

13. Match the following. **(GATE EE 2015)**

   P. Stokes's Theorem
   Q. Gauss's Theorem
   R. Divergence Theorem
   S. Cauchy's Integral Theorem

   1. $\oiint D.ds = Q$
   2. $\oint f(z)dz = 0$
   3. $\iiint (\nabla . A)dv = \oiint A.ds$
   4. $\iint (\nabla \times A).ds = \oint A.dl$

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

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

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

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

14. The Laplace transform of $f(t) = \dfrac{2\sqrt{t}}{\sqrt{\pi}}$ is $s^{-3/2}$. The Laplace transform of $g(t) = \dfrac{1}{\sqrt{\pi t}}$ is **(GATE EE 2015)**

   (a) $\dfrac{3}{2}s^{-5/2}$

   (b) $s^{-1/2}$

   (c) $s^{1/2}$

   (d) $s^{3/2}$

15. Match the following. **(GATE EE 2015)**

Instrument Type	Used for
P. Permanent magnet moving coil	1. DC Only
Q. Moving iron connected through current transformer	2. AC Only
R. Rectifier	3. AC and DC
S. Electrodynamometer	

(a) P-1, Q-2, R-1, S-3 (c) P-1, Q-2, R-3, S-3

(b) P-1, Q-3, R-1, S-2 (d) P-3, Q-1, R-2, S-1

16. A 3-phase balanced load which has a power factor of 0.707 is connected to a balanced supply. The power consumed by the load is 5 kW. The power is measured by the two-wattmeter method. The readings of the two wattmeters are **(GATE EE 2015)**

(a) 3.94 kW and 1.06 kW (c) 5.00 kW and 0.00 kW

(b) 2.50 kW and 2.50 kW (d) 2.96 kW and 2.04 kW

17. A capacitive voltage divider is used to measure the bus voltage V_{bus} in a high-voltage 50 Hz AC system as shown in the figure. The measurement capacitors C_1 and C_2 have tolerances of $\pm 10\%$ on their nominal capacitance values. If the bus voltage V_{bus} is 100 kV rms, the maximum rms output voltage V_{out} (in kV), considering the capacitor tolerances, is_____. **(GATE EE 2015)**
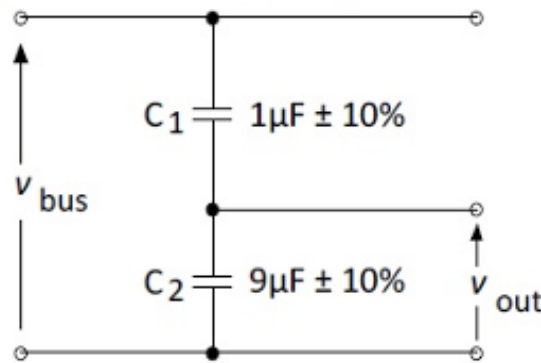
Figure 28:

18. In the following circuit, the input voltage V_{in} is $100\sin(100\pi t)$. For $100\pi RC = 50$, the average voltage across R (in Volts) under steady-state is nearest **(GATE EE 2015)**
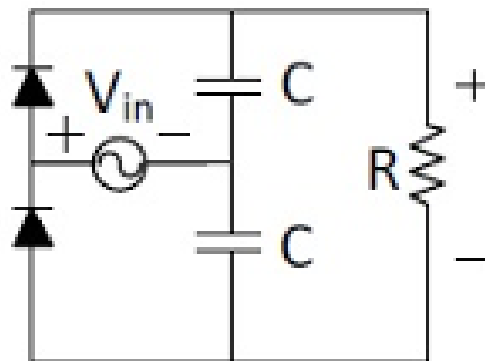
Figure 29:

(a) 100   (b) 31.8   (c) 200   (d) 63.6

19. Two semi-infinite dielectric regions are separated by a plane boundary at $y = 0$. The dielectric constants of region 1 ($y < 0$) and region 2 ($y > 0$) are 2 and 5, respectively. Region 1 has uniform electric field

$$\mathbf{E} = 3\hat{a}_x + 4\hat{a}_y + 2\hat{a}_z, \tag{1}$$

where $\hat{a}_x, \hat{a}_y, \hat{a}_z$ are unit vectors along the x, y, z axes, respectively. The electric field in region 2 is **(GATE EE 2015)**

(a) $3\hat{a}_x + 1.6\hat{a}_y + 2\hat{a}_z$ (c) $1.2\hat{a}_x + 4\hat{a}_y + 0.8\hat{a}_z$

(b) $1.2\hat{a}_x + 4\hat{a}_y + 2\hat{a}_z$ (d) $3\hat{a}_x + 10\hat{a}_y + 0.8\hat{a}_z$

20. A circular turn of radius 1 m revolves at 60 rpm about its diameter aligned with the x-axis as shown in the figure. The value of μ_0 is $4\pi \times 10^{-7}$ in SI unit. If a uniform magnetic field intensity **(GATE EE 2015)**

$$\mathbf{H} = 10^7 \hat{z}\, \text{A/m} \tag{2}$$

is applied, then the peak value of the induced voltage, V_{turn} (in Volts), is
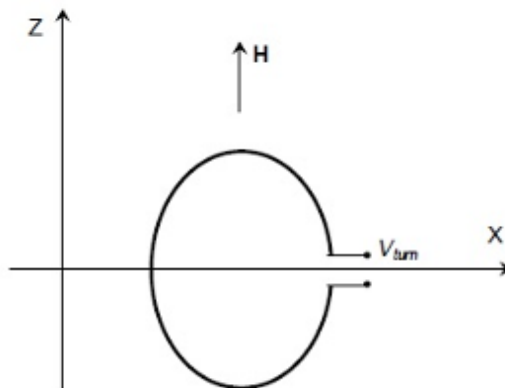
Figure 30:

21. The operational amplifier shown in the figure is ideal. The input voltage (in Volt) is

$$V_i = 2\sin(2\pi \times 2000t) \tag{3}$$

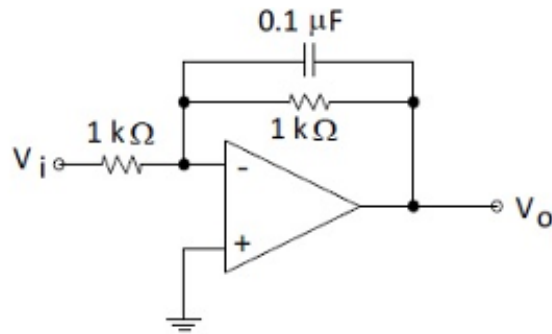The amplitude of the output voltage V_o (in Volt) is _____ **(GATE EE 2015)**

Figure 31:

22. In the following circuit, the transistor is in active mode and $V_C = 2\,\text{V}$. To get $V_C = 4\,\text{V}$, we replace R_C with R'_C. Then the ratio R'_C/R_C is _____ **(GATE EE 2015)**
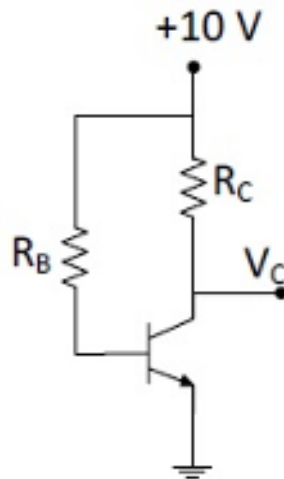

Figure 32:

23. Consider the following Sum of Products expression, F.

$$F = ABC + \overline{A}BC + AB\overline{C} + \overline{A}B\overline{C} \qquad (4)$$

The equivalent Product of Sums expression is **(GATE EE 2015)**

(a) $(A + \overline{B} + C)(\overline{A} + B + C)(\overline{A} + B + \overline{C})$

(b) $(A + B + \overline{C})(A + \overline{B} + C)(\overline{A} + B + C)$

(c) $(A + B + \overline{C})(A + \overline{B} + C)(A + B + C)$

(d) $(\overline{A} + \overline{B} + C)(A + B + \overline{C})(A + B + C)$

24. The filters F1 and F2 having characteristics as shown in Figures (a) and (b) are connected as shown in Figure (c).
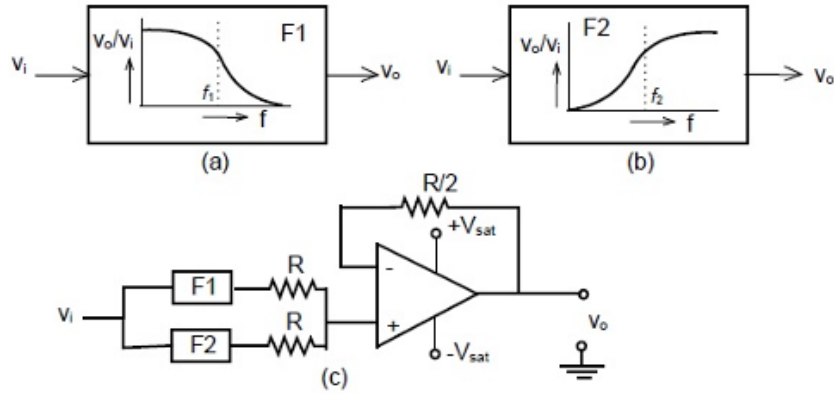
Figure 33:

The cut-off frequencies of F1 and F2 are f_1 and f_2 respectively. If $f_1 < f_2$, the resultant circuit exhibits the characteristic of a **(GATE EE 2015)**

(a) Band-pass filter

(b) Band-stop filter

(c) All pass filter

(d) High-Q filter

25. When a bipolar junction transistor is operating in the saturation mode, which one of the following statements is TRUE about the state of its collector-base (CB) and the base-emitter (BE) junctions? **(GATE EE 2015)**

   (a) The CB junction is forward biased and the BE junction is reverse biased.

   (b) The CB junction is reverse biased and the BE junction is forward biased.

   (c) Both the CB and BE junctions are forward biased.

   (d) Both the CB and BE junctions are reverse biased.

26. The synchronous generator shown in the figure is supplying active power to an infinite bus via two short, lossless transmission lines, and is initially in steady state. The mechanical power input to the generator and the voltage magnitude E are constant. If one line is tripped at time t_1 by opening the circuit breakers at the two ends (although there is no fault), then it is seen that the generator undergoes a stable transient. Which one of the following waveforms of the rotor angle δ shows the transient correctly? **(GATE EE 2015)**
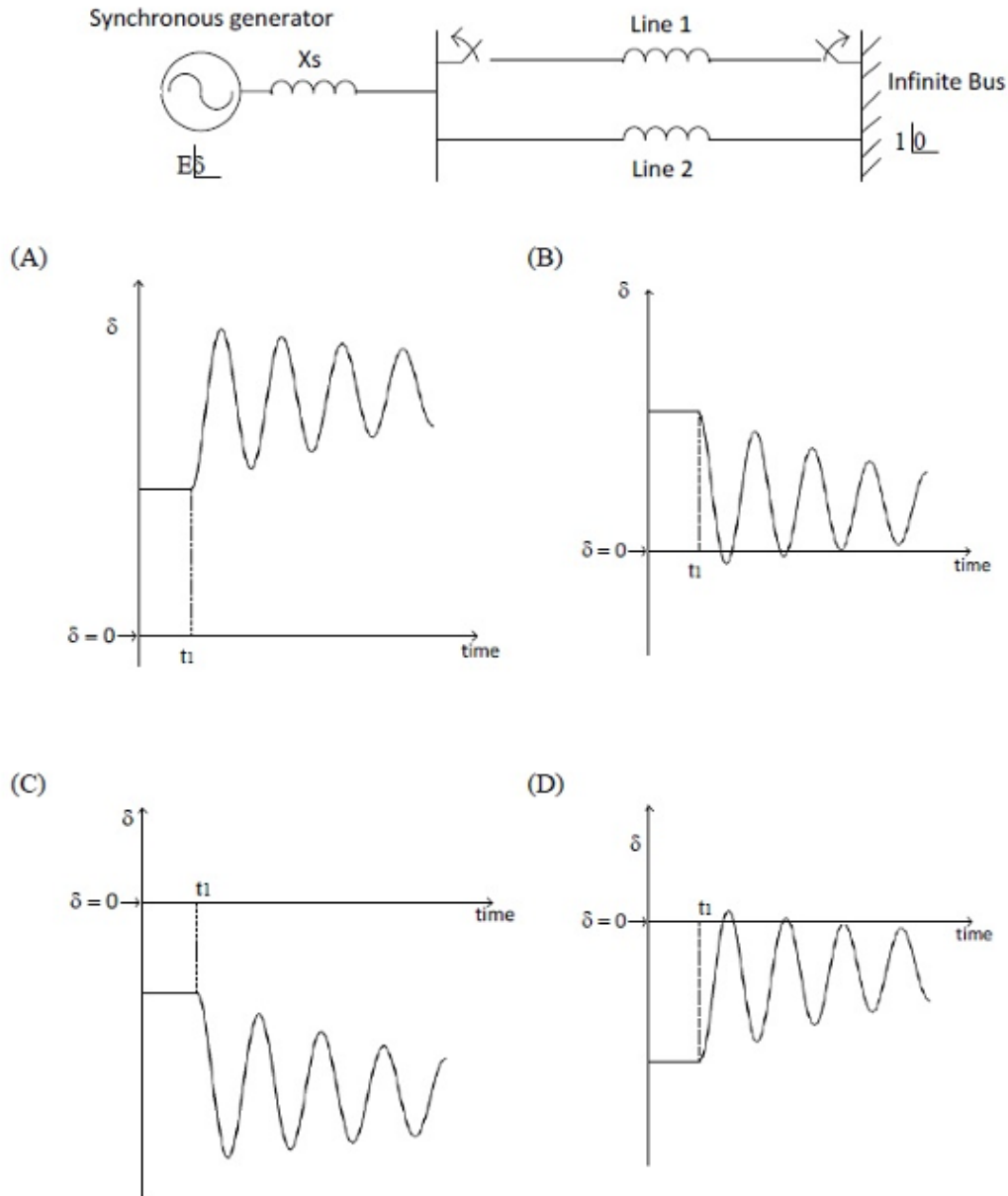
Figure 34:

27. A 3-bus power system network consists of 3 transmission lines. The bus admittance matrix of the uncompensated system is

$$\begin{pmatrix} -j6 & j3 & j4 \\ j3 & -j7 & j5 \\ j4 & j5 & -j8 \end{pmatrix} \text{pu.}$$

If the shunt capacitance of all transmission lines is 50% compensated, the imaginary part of the 3rd row 3rd column element (in pu) of the bus admittance matrix after compensation is **(GATE EE 2015)**

(a) $-j7.0$ (b) $-j8.5$ (c) $-j7.5$ (d) $-j9.0$

28. A series RL circuit is excited at $t = 0$ by closing a switch as shown in the figure. Assuming zero initial conditions, the value of $\frac{d^2i}{dt^2}$ at $t = 0^+$ is   **(GATE EE 2015)**
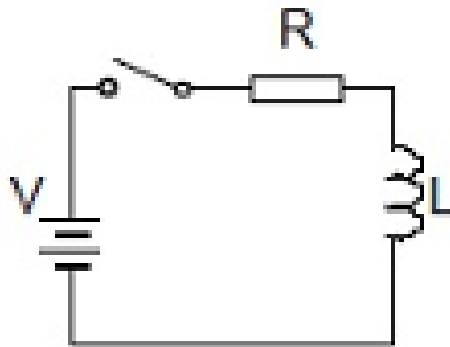
Figure 35:

(a) $\dfrac{V}{L}$ (b) $-\dfrac{V}{R}$ (c) 0   (d) $-\dfrac{RV}{L^2}$

29. The current i (in Ampere) in the 2 Ω resistor of the given network is _____
(GATE EE 2015)
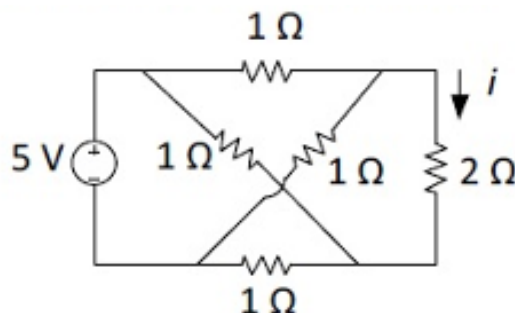
Figure 36:

30. Find the transformer ratios a and b such that the impedance (Z_{in}) is resistive and equals 2.5 Ω when the network is excited with a sine wave voltage of angular frequency of 5000 rad/s.   **(GATE EE 2015)**
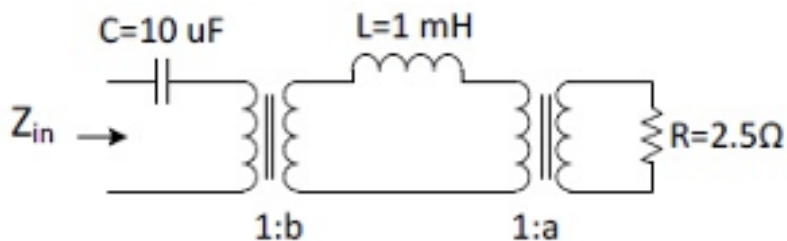
Figure 37:

(a) $a = 0.5, \quad b = 2.0$ (c) $a = 1.0, \quad b = 1.0$

(b) $a = 2.0, \quad b = 0.5$ (d) $a = 4.0, \quad b = 0.5$

31. A shunt-connected DC motor operates at its rated terminal voltage. Its no-load speed is 200 radian/second. At its rated torque of 500 Nm, its speed is 180 radian/second. The motor is used to directly drive a load whose load torque T_L depends on its rotational speed ω_r (in radian/second), such that $T_L = 2.78 \times \omega_r$. Neglecting rotational losses, the steady-state speed (in radian/second) of the motor, when it drives this load, is _____

(GATE EE 2015)

32. The figure shows the per-phase equivalent circuit of a two-pole three-phase induction motor operating at 50 Hz. The "air-gap" voltage, V_g across the magnetizing inductance, is 210 V rms, and the slip, s, is 0.05. The torque (in Nm) produced by the motor is _____

(GATE EE 2015)
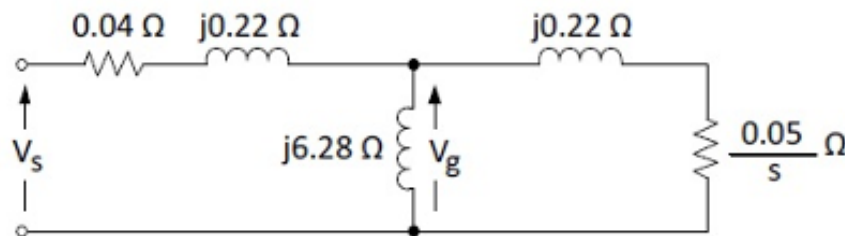
Figure 38:

33. A 4-pole, separately excited, wave wound DC machine with negligible armature resistance is rated for 230 V and 5 kW at a speed of 1200 rpm. If the same armature coils are reconnected to form a lap winding, what is the rated voltage (in volts) and power (in kW) respectively at 1200 rpm of the reconnected machine if the field circuit is left unchanged?   **(GATE EE 2015)**

(a) 230 and 5   (b) 115 and 5   (c) 115 and 2.5   (d) 230 and 2.5

34. An open loop control system results in a response of $e^{-2t}(\sin 5t + \cos 5t)$ for a unit impulse input. The DC gain of the control system is _____   **(GATE EE 2015)**

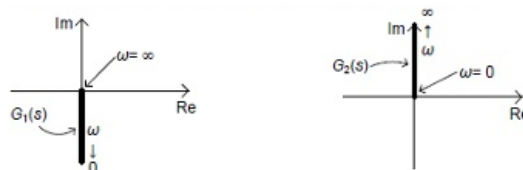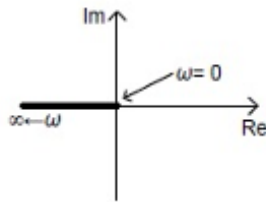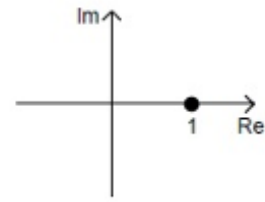35. Nyquist plots of two functions $G_1(s)$ and $G_2(s)$ are shown in figure.

Figure 39:

Nyquist plot of the product of $G_1(s)$ and $G_2(s)$ is   **(GATE EE 2015)**
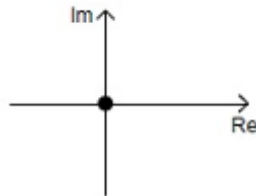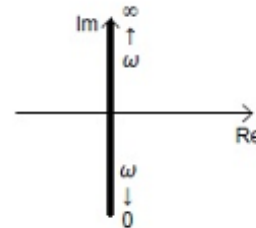
(A)

Im

ω= 0

∞←ω

Re

(B)

Im

1   Re

(C)

Im

Re

(D)

Im   ∞
      ↑
      ω

Re

ω
↓
0

36. The volume enclosed by the surface $f(x, y) = e^x$ over the triangle bounded by the lines $x = y$, $x = 0$, $y = 1$ in the xy plane is _____ **(GATE EE 2015)**

37. Two coins R and S are tossed. The 4 joint events $H_R H_S$, $T_R T_S$, $H_R T_S$, $T_R H_S$ have probabilities $0.28, 0.18, 0.30, 0.24$ respectively, where H represents head and T represents tail. Which one of the following is TRUE? **(GATE EE 2015)**

(a) The coin tosses are independent.

(b) R is fair, S is not.

(c) S is fair, R is not.

(d) The coin tosses are dependent.

38. A differential equation $\frac{di}{dt} - 0.2i = 0$ is applicable over $-10 < t < 10$. If $i(4) = 10$, then $i(-5)$ is _____ **(GATE EE 2015)**

39. Consider a signal defined by **(GATE EE 2015)**

$$x(t) = \begin{cases} e^{j10t} & \text{for } |t| \le 1 \\ 0 & \text{for } |t| > 1 \end{cases} \tag{5}$$

Its Fourier Transform is

(a) $\dfrac{2\sin(\omega - 10)}{\omega - 10}$

(c) $\dfrac{2\sin\omega}{\omega - 10}$

(b) $2e^{j10}\dfrac{\sin(\omega - 10)}{\omega - 10}$

(d) $e^{j10\omega}\dfrac{2\sin\omega}{\omega}$

40. The coils of a wattmeter have resistances 0.01 Ω and 1000 Ω; their inductances may be neglected. The wattmeter is connected as shown in the figure, to measure the power consumed by a load, which draws 25 A at power factor 0.8. The voltage across the load

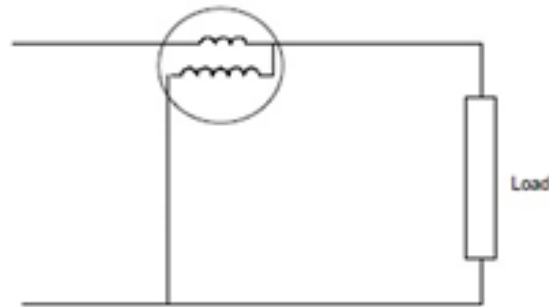terminals is 30 V. The percentage error on the wattmeter reading is _____ **(GATE EE 2015)**

Figure 40:

41. A buck converter feeding a variable resistive load is shown in the figure. The switching frequency of the switch S is 100 kHz and the duty ratio is 0.6. The output voltage V_o is 36 V. Assume that all the components are ideal, and that the output voltage is ripple-free. The value of R (in Ohm) that will make the inductor current (i_L) just continuous is _____. **(GATE EE 2015)**
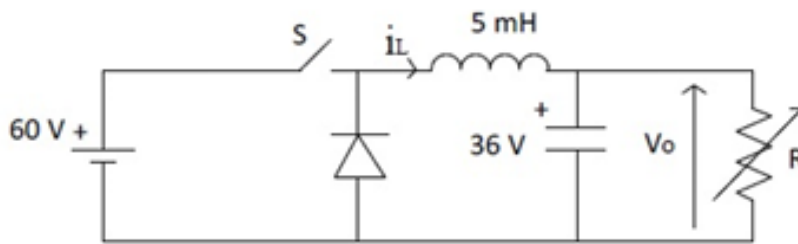

Figure 41:

42. For the switching converter shown in the following figure, assume steady-state operation. Also assume that the components are ideal, the inductor current is always positive and continuous and switching period is T_s. If the voltage V_L is as shown, the duty cycle of the switch S is _____. **(GATE EE 2015)**
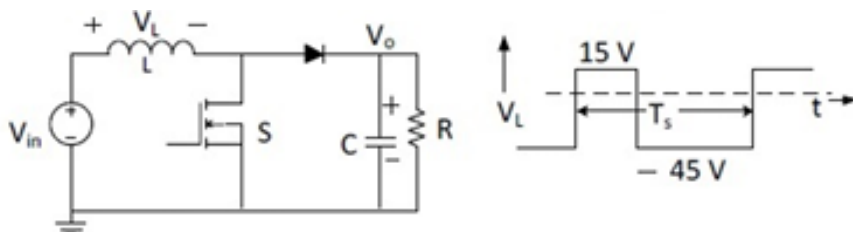

Figure 42:

43. In the given rectifier, the delay angle of the thyristor T_1 measured from the positive going zero crossing of V_s is 30°. If the input voltage V_s is $100\sin(100\pi t)$ V, the average voltage across R (in Volt) under steady-state is _____. **(GATE EE 2015)**
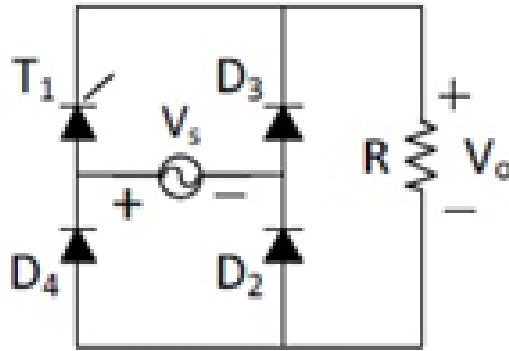
Figure 43:

44. For linear time invariant systems, that are Bounded Input Bounded Output stable, which one of the following statements is TRUE? **(GATE EE 2015)**

    (a) The impulse response will be integrable, but may not be absolutely integrable.

    (b) The unit impulse response will have finite support.

    (c) The unit step response will be absolutely integrable.

    (d) The unit step response will be bounded.

45. The z-Transform of a sequence $x[n]$ is given as $X(z) = 2z + 4 - 4/z + 3/z^2$. If $y[n]$ is the first difference of $x[n]$, then $Y(z)$ is given by **(GATE EE 2015)**

    (a) $2z + 2 - 8/z + 7/z^2 - 3/z^3$

    (b) $2z - 2 - 6/z + 1/z^2 - 3/z^3$

    (c) $-2z - 2 + 8/z - 7/z^2 + 3/z^3$

    (d) $4z - 2 - 8/z - 1/z^2 + 3/z^3$

46. Two semi-infinite conducting sheets are placed at right angles to each other as shown in the figure. A point charge of $+Q$ is placed at a distance of d from both sheets. The net force on the charge is $\frac{Q^2}{4\pi\epsilon_0 d^2} K$ where K is given by **(GATE EE 2015)**
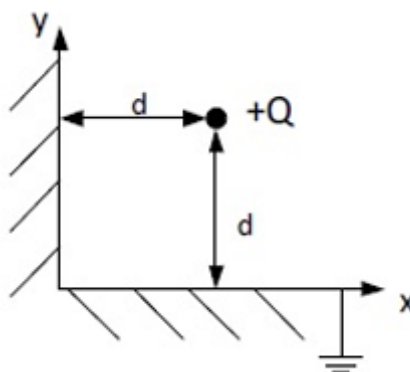

Figure 44:

(a) 0   (b) $\frac{1}{4}i - \frac{1}{4}j$ (c) $-\frac{1}{8}i - \frac{1}{8}j$ (d) $\frac{1-2\sqrt{2}}{8\sqrt{2}}i + \frac{1-2\sqrt{2}}{8\sqrt{2}}j$

47. In the following sequential circuit, the initial state (before the first clock pulse) of the circuit is $Q_1 Q_0 = 00$. The state $(Q_1 Q_0)$, immediately after the 333rd clock pulse is
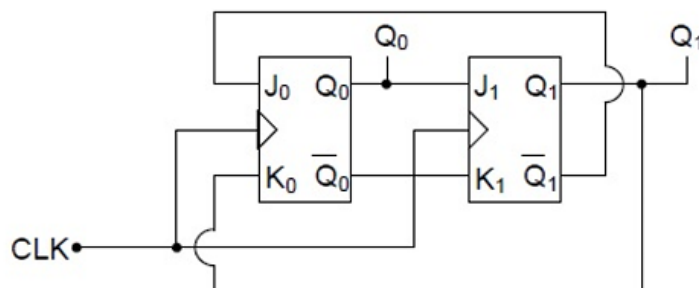**(GATE EE 2015)**

Figure 45:

(a) 00   (b) 01   (c) 10   (d) 11

48. A Boolean function $f(A, B, C, D) = \prod(1, 5, 12, 15)$ is to be implemented using an 8×1 multiplexer (A is MSB). The inputs ABC are connected to the select inputs S_2, S_1, S_0 of the multiplexer respectively.
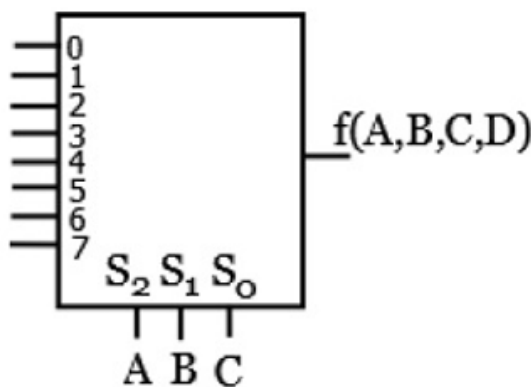

Figure 46:

Which one of the following options gives the correct inputs to pins 0,1,2,3,4,5,6,7 in order?
(GATE EE 2015)

(a) $D, 0, D, 0, 0, 0, D, D$

(b) $D, 1, D, 1, 1, 1, D, D$

(c) $D, 1, D, 1, 1, 1, D, D$

(d) $D, 0, D, 0, 0, 0, D, D$

49. The saturation voltage of the ideal op-amp shown below is ± 10 V. The output voltage v_o of the following circuit in the steady-state is
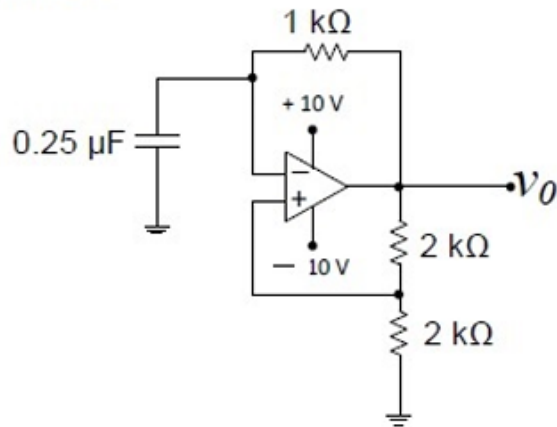**(GATE EE 2015)**

Figure 47:

(a) square wave of period 0.55 ms

(c) square wave of period 0.25 ms

(b) triangular wave of period 0.55 ms

(d) triangular wave of period 0.25 ms

50. The incremental costs (in Rupees/MWh) of operating two generating units are functions of their respective powers P_1 and P_2 in MW, and are given by

$$\frac{dC_1}{dP_1} = 0.2P_1 + 50$$

$$\frac{dC_2}{dP_2} = 0.24P_2 + 40$$

where

$$20MW \leq P_1 \leq 150 \text{ MW}, \quad 20MW \leq P_2 \leq 150 \text{ MW}.$$

For a certain load demand, P_1 and P_2 have been chosen such that $\frac{dC_1}{dP_1} = 76$ Rs/MWh and $\frac{dC_2}{dP_2} = 68.8$ Rs/MWh. If the generations are rescheduled to minimize the total cost, then P_2 is _____.   **(GATE EE 2015)**

51. A composite conductor consists of three conductors of radius R each. The conductors are arranged as shown below. The geometric mean radius (GMR) (in cm) of the composite conductor is kR. The value of k is _____.   **(GATE EE 2015)**
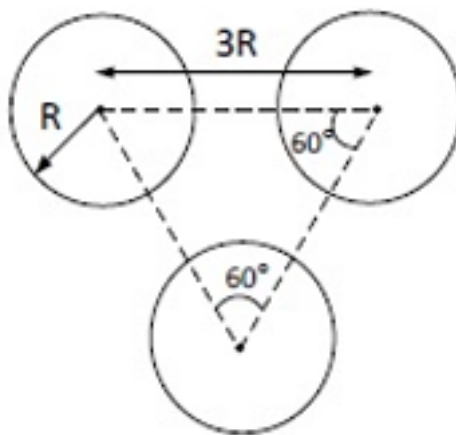

Figure 48:

52. A 3-phase transformer rated for 33 kV/11 kV is connected in delta/star as shown in figure. The current transformers (CTs) on low and high voltage sides have a ratio of 500/5. Find the currents i_1 and i_2, if the fault current is 300 A as shown in figure.
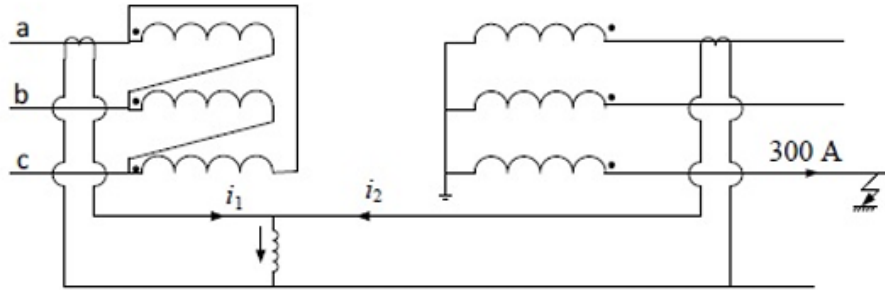
(GATE EE 2015)

Figure 49:

(a) $i_1 = 1/\sqrt{3}$ A, $i_2 = 0$ A

(b) $i_1 = 0$, $i_2 = 0$ A

(c) $i_1 = 0$, $i_2 = 1/\sqrt{3}$ A

(d) $i_1 = 1/\sqrt{3}$ A, $i_2 = 1/\sqrt{3}$ A

53. A balanced (positive sequence) three-phase AC voltage source is connected to a balanced, star connected load through a star-delta transformer as shown in the figure. The line-to-line voltage rating is 230 V on the star side, and 115 V on the delta side. If the magnetizing current is neglected and $I_s = 100\angle 0°$ A, then what is the value of I_p in Ampere?
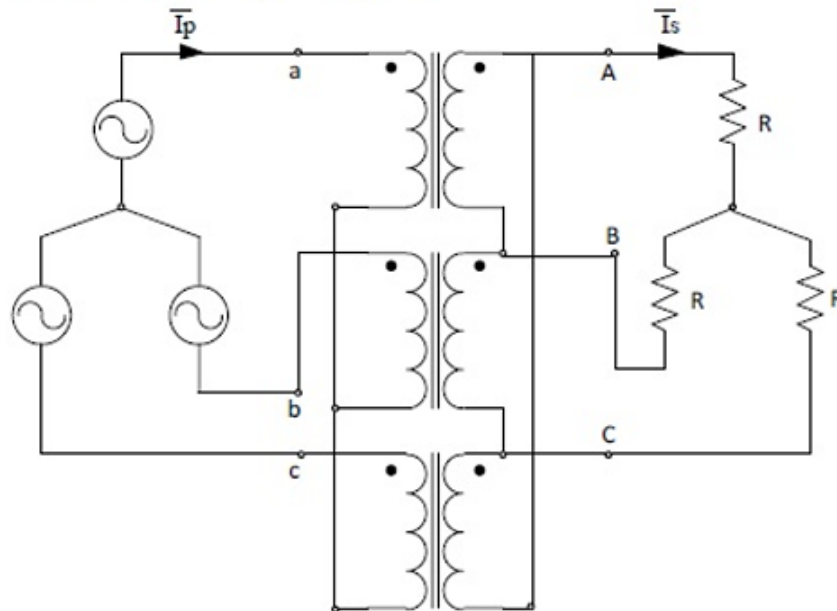
(GATE EE 2015)

Figure 50:

(a) $50\angle 230°$ 　　　(b) $50\angle -30°$ 　　　(c) $50\sqrt{3}\angle 230°$ 　　　(d) $200\angle 230°$

54. In the given network $V_1 = 100\angle 0°$ V, $V_2 = 100\angle -120°$ V, $V_3 = 100\angle +120°$ V. The phasor current i (in Ampere) is 　　　**(GATE EE 2015)**

Figure 51:
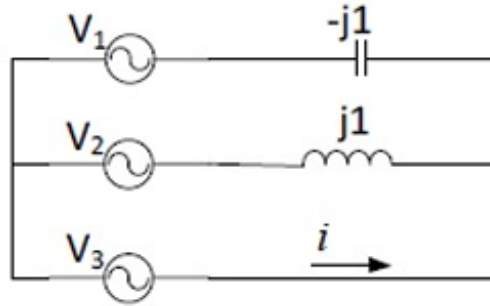
(a) $173.2\angle-60°$ (b) $173.2\angle120°$ (c) $100.0\angle-60°$ (d) $100.0\angle120°$

55. A symmetrical square wave of 50% duty cycle has amplitude of ±15 V and time period of 0.4π ms. This square wave is applied across a series RLC circuit with $R = 5\,\Omega$, $L = 10$ mH, and $C = 4\,\mu$F. The amplitude of the 5000 rad/s component of the capacitor voltage (in Volt) is ——————. **(GATE EE 2015)**
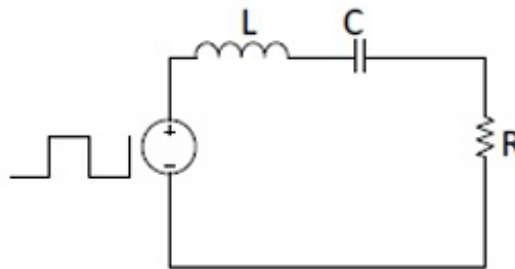

Figure 52:

56. Two identical coils each having inductance L are placed together on the same core. If an overall inductance of αL is obtained by interconnecting these two coils, the minimum value of α is ——————. **(GATE EE 2015)**

57. A three-winding transformer is connected to an AC voltage source as shown in the figure. The number of turns are as follows: $N_1 = 100$, $N_2 = 50$, $N_3 = 50$. If the magnetizing current is neglected, and the currents in two windings are $I_2 = 2\angle30°$ A and $I_3 = 2\angle150°$ A, then what is the value of the current I_1 in Ampere? **(GATE EE 2015)**
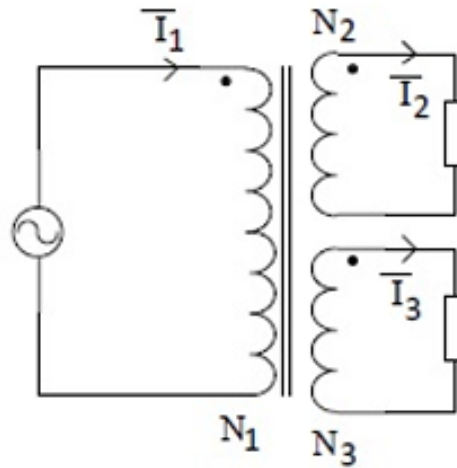
Figure 53:

(a) $1\angle 290°$ (b) $1\angle 270°$ (c) $4\angle 290°$ (d) $4\angle 270°$

58. With an armature voltage of 100 V and rated field winding voltage, the speed of a separately excited DC motor driving a fan is 1000 rpm, and its armature current is 10 A. The armature resistance is 1 Ω. The load torque of the fan load is proportional to the square of the rotor speed. Neglecting rotational losses, the value of the armature voltage (in Volt) which will reduce the rotor speed to 500 rpm is ——————. **(GATE EE 2015)**

59. A three-phase, 11 kV, 50 Hz, 2 pole, star connected, cylindrical rotor synchronous motor is connected to an 11 kV, 50 Hz source. Its synchronous reactance is 50 Ω per phase, and its stator resistance is negligible. The motor has a constant field excitation. At a particular load torque, its stator current is 100 A at unity power factor. If the load torque is increased so that the stator current is 120 A, then the load angle (in degrees) at this load is ——————. **(GATE EE 2015)**

60. A 220 V, 3-phase, 4-pole, 50 Hz inductor motor of wound rotor type is supplied at rated voltage and frequency. The stator resistance, magnetizing reactance, and core loss are negligible. The maximum torque produced by the rotor is 225% of full load torque and it occurs at 15% slip. The actual rotor resistance is 0.03 Ω/phase. The value of external resistance (in Ohm) which must be inserted in a rotor phase if the maximum torque is to occur at start is ——————. **(GATE EE 2015)**

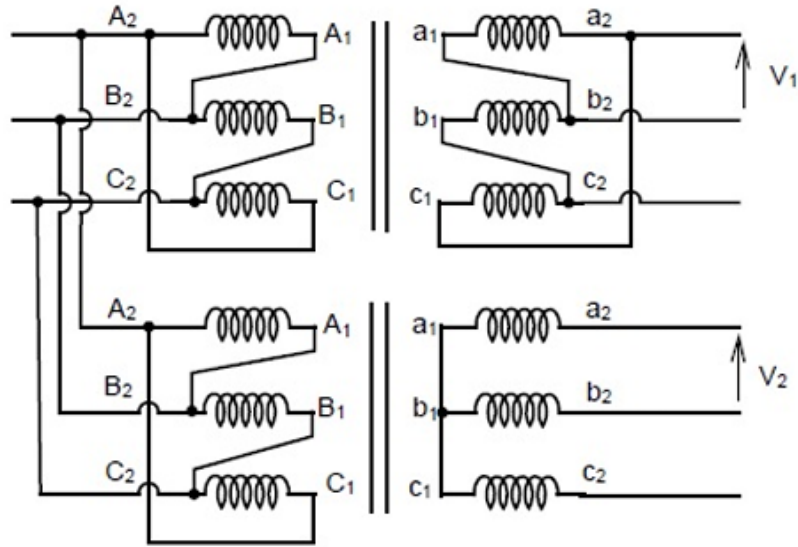61. Two three-phase transformers are realized using single-phase transformers as shown in the figure. **(GATE EE 2015)**

Figure 54:

The phase difference (in degree) between voltages V_1 and V_2 is _____.

62. The following discrete-time equations result from the numerical integration of the differential equations of an un-damped simple harmonic oscillator with state variables x and y. The integration time step is h. **(GATE EE 2015)**

$$\frac{x_{k+1} - x_k}{h} = y_k \tag{6}$$

$$\frac{y_{k+1} - y_k}{h} = -x_k \tag{7}$$

For this discrete-time system, which one of the following statements is TRUE?

(a) The system is not stable for $h > 0$

(b) The system is stable for $h > \frac{1}{2}$

(c) The system is stable for $0 < h < \frac{1}{\pi}$

(d) The system is stable for $\frac{1}{2\pi} < h < \frac{1}{2}$

63. The unit step response of a system with the transfer function $G(s) = \frac{1-2s}{1+s}$ is given by which one of the following waveforms? **(GATE EE 2015)**
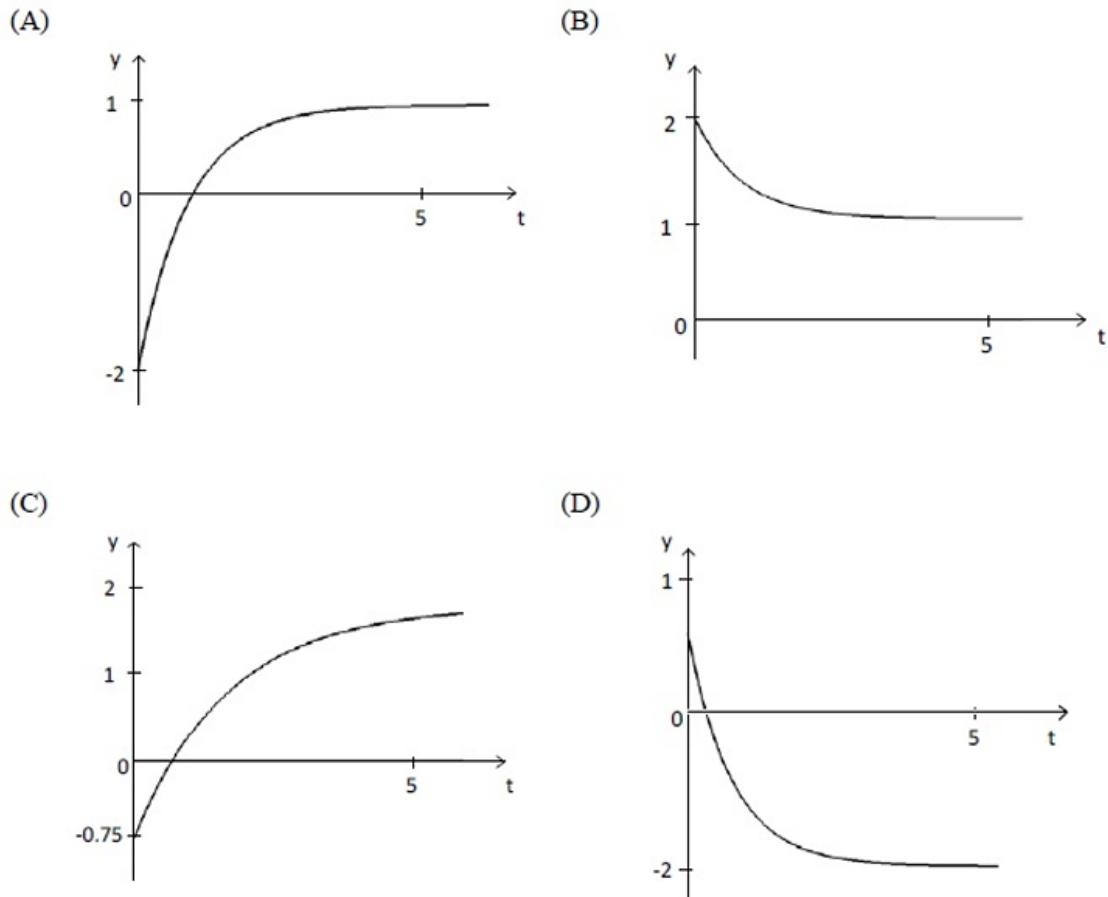
(A)

(B)

(C)

(D)

Figure 55:

64. An open loop transfer function $G(s)$ of a system is **(GATE EE 2015)**

$$G(s) = \frac{K}{s(s+1)(s+2)}$$

For a unity feedback system, the breakaway point of the root loci on the real axis occurs at,

(a) -0.42

(b) -1.58

(c) -0.42 and -1.58

(d) none of the above

65. For the system governed by the set of equations: **(GATE EE 2015)**

$$dx_1/dt = 2x_1 + x_2 + u$$
$$dx_2/dt = -2x_1 + u$$
$$y = 3x_1$$

the transfer function $Y(s)/U(s)$ is given by

(a) $\frac{3(s+1)}{(s^2-2s+2)}$

(b) $\frac{3(2s+1)}{(s^2-2s+1)}$

(c) $\frac{(s+1)}{(s^2-2s+1)}$

(d) $\frac{3(2s+1)}{(s^2-2s+2)}$