# GATE : 1994
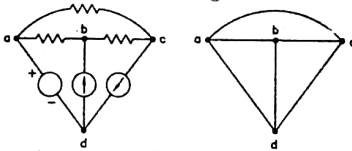
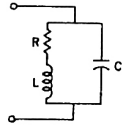## EE : Electrical Engineering

Duration : Three Hours                                      Maximum Marks : 150

### SECTION -A
### (100 MARKS)

1. Each statement below is accompanied by several answers of which only one is correct. Indicate the correct answer. Each question carries ONE mark.

(1 × 20 = 20)

1.1. Figure shows a d.c. resistive network and its graph is drawn aside. A 'proper tree' chosen for analysing the network will contain the edges.



(a) ab, bc, ad          (b) ab, bc, ca

(c) ab, bd, cd          (d) ac, bd, ad

1.2. At resonance, the given parallel circuit constituted by an iron-cored coil and a capacitor behaves like



(a) an open–circuit

(b) a short–circuit

(c) a pure resistor of value R

(d) a pure resistor of value much higher than R

1.3. If a two–port network is passive, then we have,with the usual notation,the following relationship

(a) $h_{12} = h_{21}$          (b) $h_{12} = -h_{21}$

(c) $h_{11} = h_{22}$          (d) $h_{11} \cdot h_{22} - h_{12} \cdot h_{21} = 1$

1.4. When a charge is given to a conductor

(a) it distributes uniformly all over the surface

(b) it distributes uniformly all over the volume

(c) it distributes on the surface, inversely proportional to the radius of curvature

(d) it stays where it was placed

1.5. When a transformer winding suffers a short–circuit, the adjoining turns of the same winding experience

(a) an attractive force          (b) a repulsive force

(c) no force          (d) none of the above

1.6. Skew is used in induction motors in order to reduce torque due to

(a) time harmonics

(b) space harmonics

(c) slot harmonics

(d) reverse rotating fields

1.7. Two transformers of identical voltages but of different capacities are operating in parallel. For satisfactory load sharing

(a) impedences must be equal

(b) per-unit impedences must be equal

(c) per-unit impedences and $\dfrac{X}{R}$ ratios must be equal

(d) impedences and $\dfrac{X}{R}$ ratios must be equal

1.8. In a 400 kV network, 350 kV is recorded at a 400 kV bus. The reactive power absorbed by a shunt rated for 50 MVAR, 400 kV connected at the bus is

(a) 61.73 MVAR          (b) 55.56 MVAR

(c) 45 MVAR          (d) 40.5 MVAR

1.9. HVDC Transmission is preferred to EHV – AC because

(a) HVDC terminal equipment are inexpensive

(b) VAR compensation is not required in HVDC systems

(c) system stability can be improved

(d) Harmonics – problem is avoided

**1.10.** The matrix of any state–space equations for the transfer function $c(s)/R(s)$ of the system, shown below in Figure. is
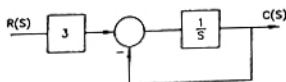


(a) $\begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$     (b) $\begin{bmatrix} 0 & 1 \\ 0 & -1 \end{bmatrix}$

(c) $[-1]$     (d) $[3]$

**1.11.** The pole–zero configuration of a phase–lead compensator is given by
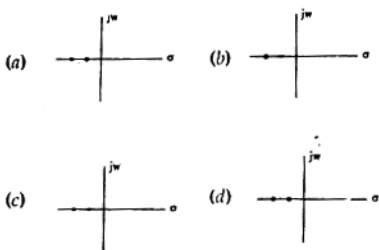


**1.12.** A $5 \times 7$ matrix has all its entries equal to $-1$. The rank of the matrix is

(a) 7     (b) 5

(c) 1     (d) zero

**1.13.** The eigen–values of the matrix $\begin{bmatrix} a & 1 \\ a & 1 \end{bmatrix}$ are

(a) $(a+1), 0$     (b) $a, 0$

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

**1.14.** A 0–10 mA PMMC ammeter reads 4 mA in a circuit. Its bottom control spring snaps suddenly. The meter will now read nearly

(a) 10 mA     (b) 8 mA

(c) 2 mA     (d) zero

**1.15.** A Lissajous pattern, as shown in Figure, is observed on the screen of a CRO when voltages of frequencies $f_x$ and $f_y$ are applied to the $x$ and $y$ plates respectively. $f_x : f_y$ is then equal to
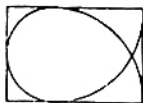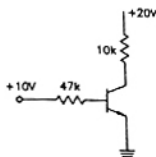


(a) 3 : 2     (b) 1 : 2

(c) 2 : 3     (d) 2 : 1

**1.16.** The number of comparisons carried out in a 4–bit flash–type A/D converter is

(a) 16     (b) 15

(c) 4     (d) 3

**1.17.** In the transistor circuit shown in Figure, collector-to-ground voltage is + 20 V. Which of the follwing is the probable cause of error ?



(a) Collector–emitter terminals shorted

(b) Emitter to ground connection open

(c) 10 kΩ resistor open

(d) collector–base terminals shorted

**1.18.** The contents of the accumulator in an 8085 microprocessor is altered after the execution of the instruction.

(a) CMPC     (b) CPI 3 A

(c) ANI 5 C     (d) ORA A

**1.19.** A switched mode power supply operating at 20 kHz to 100 kHz range uses as the main switching element

(a) Thyristor     (b) MOSFET

(c) Triac     (d) UJT

**1.20.** Referring to the Figure. the type of load is
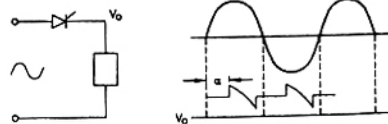


(a) inductive load     (b) resistive load

(c) dc motor     (d) capacitive load

**2.** Indicate whether the following statements are TRUE or FALSE. Write the indicating work fully and legibly. A 'FALSE' answer must be accompanied by a very brief (preferably one or two sentences) justification. Each correct answer carries ONE mark.

$(1 \times 15 = 15)$

**2.1.** Superposition principle is not applicable to a network containing time–varying resistors.

**2.2.** In electrostatic field $\Delta \times \vec{E} \equiv 0$.

**2.3.** Static magnetic fields induce currents in closed conducting loops.

**2.4.** A 3–phase induction motor coupled to a pump is operating at normal speed. If one line gets disconnected, the motor stops.

**2.5.** In a power–system, the 3–phase fault MVA is always higher than the single–line–to–ground fault MVA at a bus.

**2.6.** The charging current of a 400 kV transmission line is more than that of a 220 kV line of the same length.

**2.7.** The closed loop system, of Figure, is stable if the transfer function $T(s) = \dfrac{C(s)}{R(s)}$ is stable.
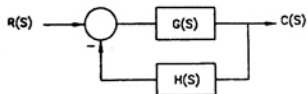


**2.8.** If two vectors $u$ and $v$ in a plane are linearly independent, then, they can not be collinear.

**2.9.** The value of X, after the execution of the last line of the following Fortran routine is 2.0

$$X = 2.0 \qquad 1 = 3 / (4 - x) + 1.2 \qquad X = 1$$

**2.10.** A precise measurement guarantees accuracy of the measured quantity.

**2.11.** A piezo–electric pick up is an example for an active transducer.

**2.12.** A practical R–C sinusoidal oscillator is built using a positive feedback amplifier with a closed loop–gain slightly less than unity.

**2.13.** An analog comparator is a high–gain amplifier whose output is always either in positive or in negative saturation.

**2.14.** A line–commutated inverter changes dc voltage to ac voltage.

**2.15.** The output voltage of a six–pulse double star rectifier is the same as that of a three–phase half–wave rectifier.

**3.** In each of the following problems, there are Four items on the left hand side (marked A, B, C, D) and Six items on the right hand side (marked P, Q, R, S, T, U). Pick the items from the right hand side which match properly with the items on the left hand side and write as a matched pair (such as B → T). Each proper matching carries one mark. (Note that in each problem, there will be only four such pairs).

**3.1.** Match the waveforms on the left–hand side with the correct mathematical description listed on the right hand side.
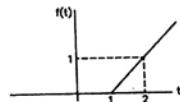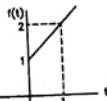
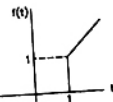| Wave form | $f(t)$ |
|---|---|

(a)
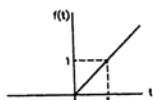


(P) $t \cdot u (t - 1)$

(b)



(Q) $(t + 1) \cdot u (t - 1)$
(R) $t \cdot u (t)$

(c)



(S) $(t + 1) \cdot u (t)$
(T) $(t - 1) \cdot u (t)$
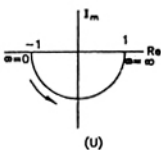
(d)
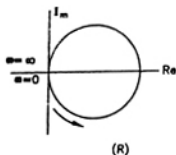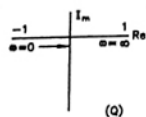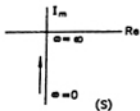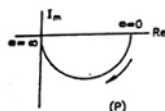


(U) $(t - 1) \cdot u (t - 1$

(U) $(t - 1) \cdot u (t - 1)$

**3.2.** Match the appropriate item from the right hand side with those on the left hand side.

(a) Line charge  
(b) Magnetic Flux Density  
(c) Displacement current  
(d) Power flow  

(P) Maxwell  
(Q) Poynting's Vector  
(R) Transmission line conductors  
(S) Biot–Savart's law  
(T) Gauss's law  
(U) Faraday's law

**3.3.** Match the polar plots for the following functions on the left hand side
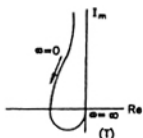


(a) $\dfrac{s}{(s+1)(s+2)}$

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

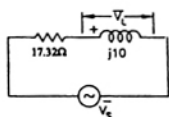(c) $\dfrac{s^2-1}{s^2+1}$

(d) $\dfrac{1}{s^2+10}$

**3.4.** Given Figure shows a two-stage small signal transistor feedback amplifier. Match the defective component (listed on the left hand side below) with its probable effect on the circuit (listed on the right hand side below)
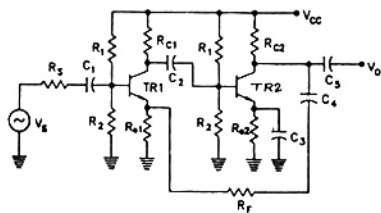


(a) Capacitor $C_1$ is open    (P) All dc voltages normal normal, $v_o$ increases marginally

(b) Capacitor $C_3$ is open    (Q) Collector of TRZ is at $V_{CC}$, $v_o = 0$

(c) Capacitor $C_4$ is open    (R) All dc voltages normal, gain of 2nd stage increase $v_o$ decrease

(d) $Rc_2$ is shorted    (S) All dc voltages normal, $v_o = 0$

(T) All dc voltages normal, overall gain of the amplifier increases, $v_o$ increases

(U) No change

**3.5.** Match the items on the right hand side with those on left hand side

(a) Commutation    (P) Resistive load

(b) V–curves    (Q) Inductive load

(c) Free wheeling diode    (R) Capacitive load

(d) Overlap    (S) Interpole

(T) Source Inductance

(U) Synchronous motor

**4.** Fill in the blanks with the correct answer

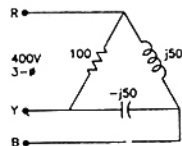**4.1.** In the given circuit, the voltage $\overline{V}_x$ has a phase



angle of _____ with respect to $\overline{V}_s$.

**4.2.** A set of 3 equal resistors, each of value $R_x$, connected in star across RYB of given Figure. consumes the same power as the unbalanced delta-connected load shown. The value of $R_x$ is _____ $\Omega$.



**4.3.** A hollow conductor is at a potential V. The potential at any point inside the hollow is _____

**4.4.** The inductance of a coil is proportional to the _____ of the number of turns, all other parameters remaining the same.

**4.5.** A six pole 50 Hz induction motor rotating at 1400 rpm is in _____ mode.

**4.6.** In a varibale frequency induction motor drive, the voltage must be varied _____ to the frequency.

**4.7.** In a system, there are two generators operating in parallel. One generator, of rating 250 MVA, has an inertia–constant of 6 MJ/MVA while the other generator of 150 MVA has an inertia-constant of 4 MJ/MVA. The inertia-constant for the combined system on 100 MVA common base is _____ MJ/MVA.

**4.8.** The increase in resistance due to non-uniform distribution of current in a conductor is known as _____ effect.

**4.9.** The number of positive real roots of the equation $s^3 - 2s + 2 = 0$ is _____

**4.10.** If $f(t)$ is the step-response of a linear time-invariant system, then its impulse response is given by _____

**4.11.** The number of linearly independent solutions of the system of equations

$$\begin{bmatrix} 1 & 0 & 2 \\ 1 & -1 & 0 \\ 2 & -2 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = 0, \text{ is equal to } \underline{\hspace{2cm}}$$

**4.12.** The value of the integral $\int_{-5}^{+6} e^{-2t} \, \partial(t-1)\, dt$ is equal to _____

**4.13.** The light load adjustment is carried out on a single–phase house–service energy meter under _____ power factor conditions.

**4.14.** _____ torque is not provided in an electromagnetic flux meter.

**4.15.** Given figure, shows a non-inverting op-amp summer with $V_1 = 2$ V and $V_2 = -1$V. The output voltage $V_0 =$ _____
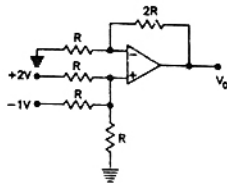


**4.16.** The stack pointer of a microprocessor is at A $\phi\phi$ 1. At the end of excution of following instructions, the value of stack pointer is _____

| | |
|---|---|
| PUSH | PSW |
| X | THL |
| PUSH | D |
| JMP FC | 70 H |

**4.17.** A triac can be triggered by a gate pulse of _____ polarity.

**4.18.** Thyristor circuits that directly convert polyphse ac voltages from one frequency to another frequency are called _____

# ANSWERS

1.1 (a)   1.2 (d)   1.3 (d)   1.4 (a)   1.5 (a)   1.6 (c)   1.7 (c)   1.8 (d)   1.9 (c)  1.10 (c)

1.11 (a)   1.12 (c)   1.13 (a)   1.14 (d)   1.15 (b)   1.16 (b)   1.17 (b)   1.18 (c)   1.19 (b) 1.20 (c)