Duration : Three Hours Maximum Marks : 150

**Q.1—Q.30 carry one mark each.**

**Q.1** Consider the network graph shown in Fig. Q.1. Which one of the following is NOT a *tree* of this graph?

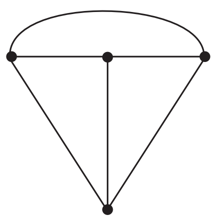
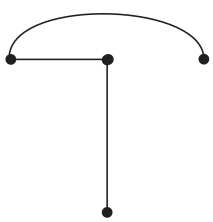
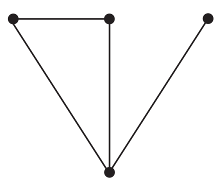


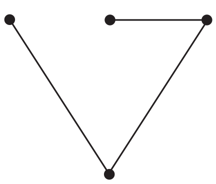
Fig Q.1



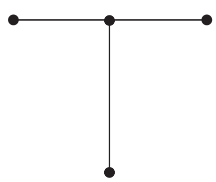
(A)



(B)



(C)



(D)

**Q.2** The equivalent inductance measured between the terminals 1 and 2 for the circuit shown in Fig. Q.2 is

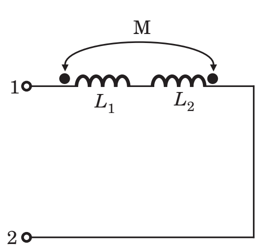



Fig Q.2

(A) $L_1 + L_2 + M$ (B) $L_1 + L_2 - M$

(C) $L_1 + L_2 + 2M$ (D) $L_1 + L_2 - 2M$

**Q.3** The circuit shown in Fig. Q.3, with $R = 1/3\Omega$, $L = 1/4$ H, $C = 3$ F has input voltage $v(t) = \sin 2t$. The resulting current $i(t)$ is

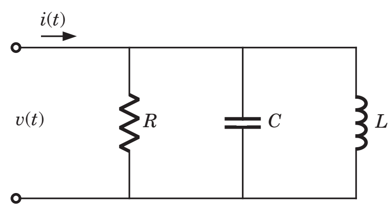



Fig Q.3

(A) $5\sin(2t + 53.1°)$ (B) $5\sin(2t - 53.1°)$

(C) $25\sin(2t + 53.1°)$ (D) $25\sin(2t - 53.1°)$

**Q.4** For the circuit shown in Fig. Q.4, the time constant $RC = 1$ ms. The input voltage is $v_i(t) = \sqrt{2}\sin 10^3 t$. The output voltage $v_o(t)$ is equal to

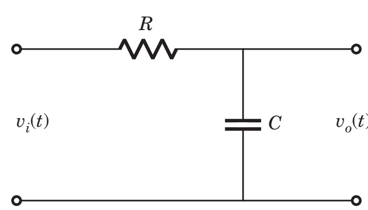



Fig Q4.

(A) $\sin(10^3\,t - 45°)$ (B) $\sin(10^3\,t + 45°)$

(C) $\sin(10^3\,t - 53°)$ (D) $\sin(10^3\,t + 53°)$

**Q.5** For the R-L circuit shown in Fig. Q.5, the input voltage $v_i(t) = u(t)$. The current $i(t)$ is

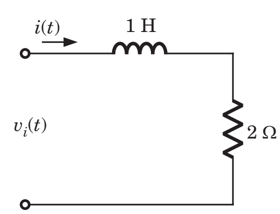
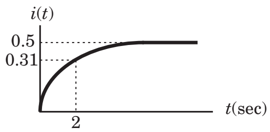
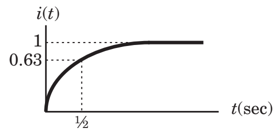


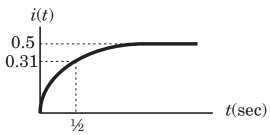

Fig Q.5



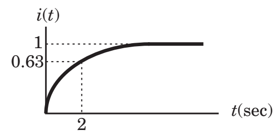

(A)




(B)




(C)




(D)

**Q.6** The impurity commonly used for realizing the base region of a silicon n-p-n transistor is

(A) Gallium (B) Indium

(C) Boron (D) Phosphorus

**Q.7** If for a silicon n-p-n transistor, the base-to-emitter voltage ($V_{BE}$) is 0.7 V and the collector-to-base voltage ($V_{CB}$) is 0.2 V, then the transistor is operating in the

(A) normal active mode (B) saturation mode

(C) inverse active mode (D) cutoff mode

**Q.8** Consider the following statements S1 and S2.

S1 : The β of a bipolar transistor reduces if the base width is increased.

S2 : The β of a bipolar transistor increases if the doping concentration in the base is increased.

Which one of the following is correct ?

(A) S1 is FALSE and S2 is TRUE

(B) Both S1 and S2 are TRUE

(C) Both S1 and S2 are FALSE

(D) S1 is TRUE and S2 is FALSE

**Q.9** An ideal op-amp is an ideal

(A) voltage controlled current source

(B) voltage controlled voltage source

(C) current controlled current source

(D) current controlled voltage source

**Q.10** Voltage series feedback (also called series-shunt feedback) results in

(A) increase in both input and output impedances

(B) decrease in both input and output impedances

(C) increase in input impedance and decrease in output impedance

(D) decrease in input impedance and increase in output impedance

**Q.11** The circuit in Fig. Q.11 is a

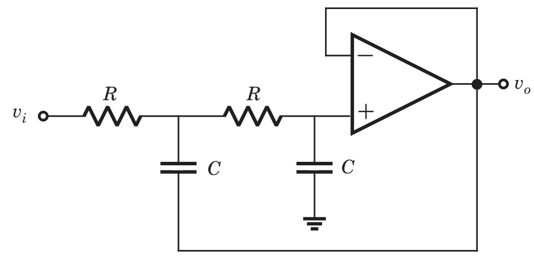



Fig Q.11

(A) low-pass filter (B) high-pass filter

(C) band-pass filter (D) band-reject filter

**Q.12** Assuming $V_{CEsat} = 0.2$ V and $\beta = 50$, the minimum base current ($I_B$) required to drive the transistor in Fig. Q.12 to saturation is

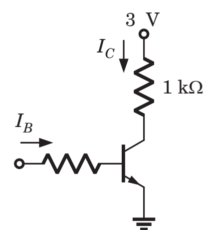



Fig Q12.

(A) 56 μA (B) 140 mA

(C) 60 μA (D) 3 mA

**Q.13** A master-slave flip-flop has the characteristic that

(A) change in the input is immediately reflected in the output

(B) change in the output occurs when the state of the master is affected

(C) change in the output occurs when the state of the slave is affected

(D) both the master and the slave states are affected at the same time

**Q.14** The range of signed decimal numbers that can be represented by 6-bit 1's complement numbers is

(A) –31 to +31 (B) –63 to +64

(C) –64 to +63 (D) –32 to +31

**Q.15** A digital system is required to amplify a binary-encoded audio signal. The user should be able to control the gain of the amplifier from a minimum to a maximum in 100 increments. The minimum number of bits required to encode, in straight binary, is

(A) 8 (B) 6

(C) 5 (D) 7

**Q.16** Choose the correct one from among the alternatives A, B, C, D after matching an item from Group 1 with the most appropriate item in Group 2.

| **Group 1** | **Group 2** |
|---|---|
| P: Shift register | 1: Frequency division |
| Q: Counter | 2: Addressing in memory chips |
| R: Decoder | 3: Serial to parallel data conversion |

| (A) | (B) | (C) | (D) |
|---|---|---|---|
| P–3 | P–3 | P–2 | P–1 |
| Q–2 | Q–1 | Q–1 | Q–3 |
| R–1 | R–2 | R–3 | R–2 |

**Q.17** Fig. Q.17 shows the internal schematic of a TTL AND-OR-Invert (AOI) gate. For the inputs shown in Fig. Q.17, the output $Y$ is

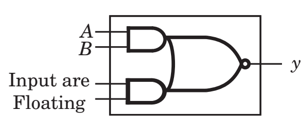


Fig Q.17

(A) 0 (B) 1

(C) AB (D) $\overline{\text{AB}}$

**Q.18** Fig. Q.18 is the voltage transfer characteristic of

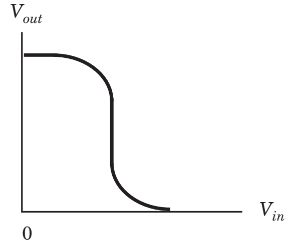


Fig Q.18

(A) an NMOS inverter with enhancement mode transistor as load

(B) an NMOS inverter with depletion mode transistor as load

(C) a CMOS inverter

(D) a BJT inverter

**Q.19** The impulse response $h[n]$ of a linear time-invariant system is given by

$$h[n] = u[n+3] + u[n-2] - 2u[n-7]$$

where $u[n]$ is the unit step sequence. The above system is

(A) stable but not causal

(B) stable and causal

(C) causal but unstable

(D) unstable and not causal

**Q.20** The distribution function $F_X(x)$ of a random variable $X$ is shown in Fig. Q.20. The probability that $X = 1$ is

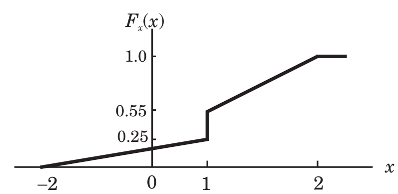


Fig Q.20

(A) zero (B) 0.25

(C) 0.55 (D) 0.30

**Q.21** The z-transform of a system is

$$H(z) = \frac{z}{z - 0.2}$$

If the ROC is $|z| < 0.2$, then the impulse response of the system is

(A) $(0.2)^n u[n]$ (B) $(0.2)^n u[-n-1]$

(C) $-(0.2)^n u[n]$ (D) $-(0.2)^n u[-n-1]$

**Q.22** The Fourier transform of a conjugate symmetric function is always

(A) imaginary (B) conjugate anti-symmetric

(C) real (D) conjugate symmetric

**Q.23** The gain margin for the system with open-loop transfer function

$$G(s)H(s) = \frac{2(1+s)}{s^2}, \text{ is}$$

(A) $\infty$ (B) 0

(C) 1 (D) $-\infty$

**Q.24** Given

$$G(s)H(s) = \frac{K}{s(s+1)(s+3)},$$

the point of intersection of the asymptotes of the root loci with the real axis is

(A) –4 (B) 1.33

(C) –1.33 (D) 4

**Q.25** In a PCM system, if the code word length is increased from 6 to 8 bits, the signal to quantization noise ratio improves by the factor

(A) 8/6 (B) 12

(C) 16 (D) 8

**Q.26** An AM signal is detected using an envelope detector. The carrier frequency and modulating signal frequency are 1 MHz and 2 kHz respectively. An appropriate value for the time constant of the envelope detector is

(A) 500 μsec (B) 20 μsec

(C) 0.2 μsec (D) 1 μsec

**Q.27** An AM signal and a narrow-band FM signal with identical carriers, modulating signals and modulation indices of 0.1 are added together. The resultant signal can be closely approximated by

(A) broadband FM (B) SSB with carrier

(C) DSB-SC (D) SSB without carrier

**Q.28** In the output of a DM speech encoder, the consecutive pulses are of opposite polarity during time interval $t_1 \le t \le t_2$. This indicates that during this interval

(A) the input to the modulator is essentially constant

(B) the modulator is going through slope overload

(C) the accumulator is in saturation

(D) the speech signal is being sampled at the Nyquist rate

**Q.29** The phase velocity of an electromagnetic wave propagating in a hollow metallic rectangular waveguide in the $TE_{10}$ mode is

(A) equal to its group velocity

(B) less than the velocity of light in free space

(C) equal to the velocity of light in free space

(D) greater than the velocity of light in free space

**Q.30** Consider a lossless antenna with a directive gain of +6 dB. If 1 mW of power is fed to it the total power radiated by the antenna will be

(A) 4 mW (B) 1 mW

(C) 7 mW (D) 1/4 mW

**Q. 31–Q.90 carry two marks each.**

**Q.31** For the lattice circuit shown in Fig. Q.31, $Z_a = j2\,\Omega$ and $Z_b = 2\,\Omega$. The values of the open circuit impedance parameters

$$Z = \begin{bmatrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{bmatrix} \text{ are}$$

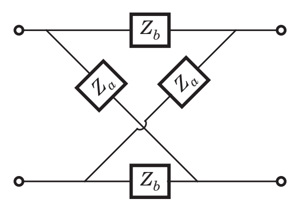



Fig Q.31

(A) $\begin{bmatrix} 1-j & 1+j \\ 1+j & 1+j \end{bmatrix}$ (B) $\begin{bmatrix} 1-j & 1+j \\ -1+j & 1-j \end{bmatrix}$

(C) $\begin{bmatrix} 1+j & 1+j \\ 1-j & 1-j \end{bmatrix}$ (D) $\begin{bmatrix} 1-j & -1+j \\ -1-j & 1-j \end{bmatrix}$

**Q.32** The circuit shown in Fig. Q.32 has initial current $i_L(0^-) = 1$ A through the inductor and an initial voltage $v_C(0^-) = -1$ V across the capacitor. For input $v(t) = u(t)$, the Laplace transform of the current $i(t)$ for $t > 0$ is

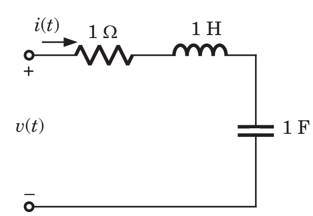



Fig Q.32

(A) $\frac{s}{s^2+s+1}$ (B) $\frac{s+2}{s^2+s+1}$

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

**Q.33** Consider the Bode magnitude plot shown in Fig. Q.33. The transfer function $H(s)$ is

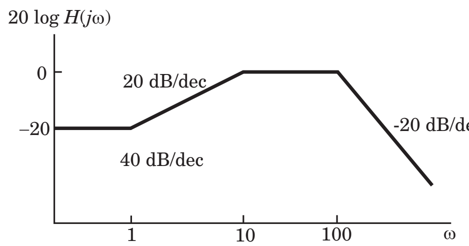


Fig Q.33

(A) $\frac{(s+10)}{(s+1)(s+100)}$  (B) $\frac{10(s+1)}{(s+10)(s+100)}$

(C) $\frac{10^2(s+1)}{(s+10)(s+100)}$  (D) $\frac{10^3(s+100)}{(s+1)(s+10)}$

**Q.34** The transfer function $H(s) = \frac{V_o(s)}{V_i(s)}$ of an R–L–C circuit is given by

$$H(s) = \frac{10^6}{s^2 + 20s + 10^6}$$

The Quality factor (Q-factor) of this circuit is

(A) 25  (B) 50

(C) 100  (D) 5000

**Q.35** For the circuit shown in Fig. Q.35, the initial conditions are zero. Its transfer function $H(s) = V_C(s)/V_i(s)$ is

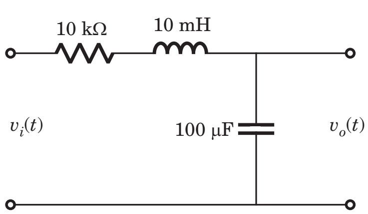


Fig Q35.

(A) $\frac{1}{s^2 + 10^3 s + 10^6}$  (B) $\frac{10^6}{s^2 + 10^3 s + 10^6}$

(C) $\frac{10^3}{s^2 + 10^3 s + 10^6}$  (D) $\frac{10^6}{s^2 + 10^6 s + 10^6}$

**Q. 36** A system described by the following differential equation

$$\frac{d^2y}{dt^2} + 3\frac{dy}{dt} + 2y = x(t)$$

is initially at rest. For input $x(t) = 2u(t)$, the output $y(t)$ is

(A) $(1 - 2e^{-t} + e^{-2t})u(t)$

(B) $(1 + 2e^{-t} - e^{-2t})u(t)$

(C) $(0.5 + e^{-t} + 1.5e^{-2t})u(t)$

(D) $(0.5 + 2e^{-t} + 2e^{-2t})u(t)$

**Q.37** Consider the following statements S1 and S2.

S1 : At the resonant frequency the impedance of a series R–L–C circuit is zero.

S2 : In a parallel G–L–C circuit, increasing the conductance G results in increase in its Q factor.

Which one of the following is correct ?

(A) S1 is FALSE and S2 is TRUE

(B) Both S1 and S2 are TRUE

(C) S1 is TRUE and S2 is FALSE

(D) Both S1 and S2 are FALSE

**Q.38**. In an abrupt p–n junction, the doping concentrations on the p-side and n-side are $N_A = 9 \times 10^{16}/\text{cm}^3$ respectively. The p-n junction is reverse biased and the total depletion width is 3 μm. The depletion width on the p-side is

(A) 2.7 μm  (B) 0.3 μm

(C) 2.25 μm  (D) 0.75 μm

**Q.39** The resistivity of a uniformly doped n-type silicon sample is 0.5 Ω-cm. If the electron mobility $(\mu_n)$ is 1250 cm²/V-sec and the charge of an electron is $1.6 \times 10^{-19}$ Coulomb, the donor impurity concentration $(N_D)$ in the sample is

(A) $2 \times 10^{16}/\text{cm}^3$  (B) $1 \times 10^{16}/\text{cm}^3$

(C) $2.5 \times 10^{15}/\text{cm}^3$  (D) $5 \times 10^{15}/\text{cm}^3$

**Q.40** Consider an abrupt p-n junction. Let $V_{bi}$ be the built-in potential of this junction and $V_R$ be the applied reverse bias. If the junction capacitance $(C_j)$ is 1 pF for $V_{bi} + V_R = 1$ V, then for $V_{bi} + V_R = 4$ V, $C_j$ will be

(A) 4 pF  (B) 2 pF

(C) 0.25 pF  (D) 0.5 pF

**Q.41** Consider the following statements S1 and S2.

S1 : The threshold voltage $(V_T)$ of a MOS capacitor decreases with increase in gate oxide thickness.

S2 : The threshold voltage $(V_T)$ of a MOS capacitor decreases with increase in substrate doping concentration.

Which one of the following is correct ?

(A) S1 is FALSE and S2 is TRUE

(B) Both S1 and S2 are TRUE

(C) Both S1 and S2 are FALSE

(D) S1 is TRUE and S2 is FALSE

**Q.42** The drain of an n-channel MOSFET is shorted to the gate so that $V_{GS} = V_{DS}$ . The threshold voltage $(V_T)$ of the MOSFET is 1 V. If the drain current $(I_D)$ is 1 mA for $V_{GS} = 2$ V, then for $V_{GS} = 3$ V, $I_D$ is

(A) 2 mA (B) 3 mA

(C) 9 mA (D) 4 mA

**Q.43** The longest wavelength that can be absorbed by silicon, which has the bandgap of 1.12 eV, is 1.1 μm. If the longest wavelength that can be absorbed by another material is 0.87 μm, then the bandgap of this material is

(A) 1.416 eV (B) 0.886 eV

(C) 0.854 eV (D) 0.706 eV

**Q.44** The neutral base width of a bipolar transistor, biased in the active region, is 0.5 μm. The maximum electron concentration and the diffusion constant in the base are $10^{14}/\text{cm}^3$ and $D_n = 25\,\text{cm}^2/\text{sec}$ respectively. Assuming negligible recombination in the base, the collector current density is (the electron charge is $1.6 \times 10^{-19}$ Coulomb)

(A) 800 A/cm$^2$ (B) 9 A/cm$^2$

(C) 200 A/cm$^2$ (D) 2 A/cm$^2$

**Q.45** Assume that the β of the transistor is extremely large and $V_{BE} = 0.7$ V, $I_C$ and $V_{CE}$ in the circuit shown in Fig. Q.45 are

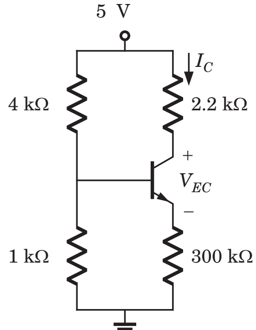


Fig Q.45

(A) $I_C = 1\,\text{mA}, \quad V_{CE} = 4.7$ V

(B) $I_C = 0.5\,\text{mA}, \quad V_{CE} = 3.75$ V

(C) $I_C = 1\,\text{mA}, \quad V_{CE} = 2.5$ V

(D) $I_C = 0.5\,\text{mA}, \quad V_{CE} = 3.9$ V

**Q.46** A bipolar transistor is operating in the active region with a collector current of 1 mA. Assuming that the β of the transistor is 100 and the thermal voltage $(V_T)$ is 25 mV, the transconductance $(g_m)$ and the input resistance $(r_\pi)$ of the transistor in the common emitter configuration, are

(A) $g_m = 25$ mA/V and $r_\pi = 15.625$ kΩ

(B) $g_m = 40$ mA/V and $r_\pi = 4.0$ kΩ

(C) $g_m = 25$ mA/V and $r_\pi = 2.5$ kΩ

(D) $g_m = 40$ mA/V and $r_\pi = 2.5$ kΩ

**Q.47** The value of C required for sinusoidal oscillations of frequency 1 kHz in the circuit of Fig. Q.47 is

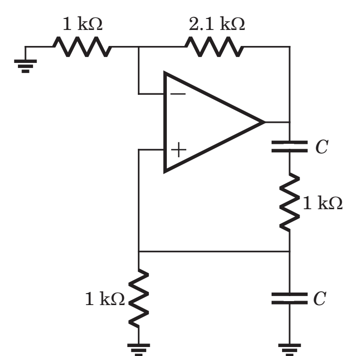


Fig Q.47

(A) $\frac{1}{2\pi}\,\mu$F (B) $2\pi\,\mu$F

(C) $\frac{1}{2\pi\sqrt{6}}\,\mu$F (D) $2\pi\sqrt{6}\,\mu$F

**Q.48** In the op-amp circuit given in Fig. Q.48, the load current $i_L$ is

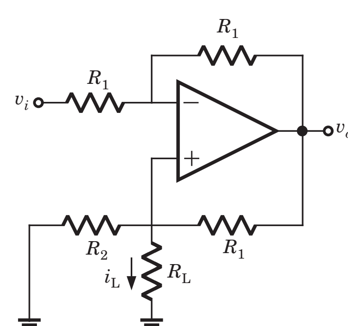


Fig Q.48

(A) $-\frac{v_s}{R_2}$ (B) $\frac{v_s}{R_2}$

(C) $-\frac{v_s}{R_L}$ (D) $\frac{v_s}{R_1}$

**Q.49** In the voltage regulator shown in Fig. Q.49, the load current can vary from 100 mA to 500 mA. Assuming that the Zener diode is ideal (i.e., the Zener knee current is negligibly small and Zener resistance is zero in the breakdown region), the value of $R$ is

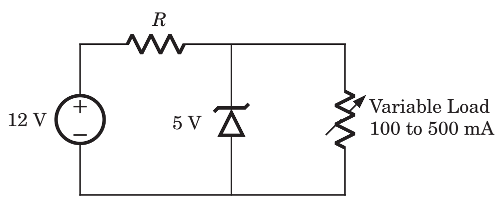



Fig Q.49

(A) 7 Ω (B) 70 Ω

(C) 70/3 Ω (D) 14 Ω

**Q.50** In a full-wave rectifier using two ideal diodes, $V_{dc}$ and $V_m$ are the dc and peak values of the voltage respectively across a resistive load. If PIV is the peak inverse voltage of the diode, then the appropriate relationships for this rectifier are

(A) $V_{dc} = \frac{V_m}{\pi}$ , PIV $= 2V_m$

(B) $I_{dc} = 2\frac{V_m}{\pi}$ , PIV $= 2V_m$

(C) $V_{dc} = 2\frac{V_m}{\pi}$ , PIV $= V_m$

(D) $V_{dc} = \frac{V_m}{\pi}$ , PIV $= V_m$

**Q. 51** The minimum number of 2-to-1 multiplexers required to realize a 4-to-1 multiplexer is

(A) 1 (B) 2

(C) 3 (D) 4

**Q.52** The Boolean expression $AC + B\overline{C}$ is equivalent to

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

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

(C) $AC + B\overline{C} + \overline{B}C + ABC$

(D) $ABC + \overline{A}B\overline{C} + AB\overline{C} + A\overline{B}C$

**Q.53** 11001, 1001 and 111001 correspond to the 2's complement representation of which one of the following sets of numbers ?

(A) 25, 9 and 57 respectively

(B) –6, –6 and –6 respectively

(C) –7, –7 and –7 respectively

(D) –25, –9 and –57 respectively

**Q.54** The 8255 Programmable Peripheral Interface is used as described below.

(i) An A/D converter is interfaced to a microprocessor through an 8255. The conversion is initiated by a signal from the 8255 on Port C. A signal on Port C causes data to be stobed into Port A.

(ii) Two computers exchange data using a pair of 8255s. Port A works as a bidirectional data port supported by appropriate handshaking signals.

The appropriate modes of operation of the 8255 for (i) and (ii) would be

(A) Mode 0 for (i) and Mode 1 for (ii)

(B) Mode 1 for (i) and Mode 2 for (ii)

(C) Mode 2 for (i) and Mode 0 for (ii)

(D) Mode 2 for (i) and Mode 1 for (ii)

**Q.55** The number of memory cycles required to execute the following 8085 instructions

(i) LDA 3000H

(ii) LXI D, FOF1H

would be

(A) 2 for (i) and 2 for (ii)

(B) 4 for (i) and 2 for (ii)

(C) 3 for (i) and 3 for (ii)

(D) 3 for (i) and 4 for (ii)

**Q.56** In the modulo-6 ripple counter shown in Fig. Q.56, the output of the 2-input gate is used to clear the J–K flip-flops.

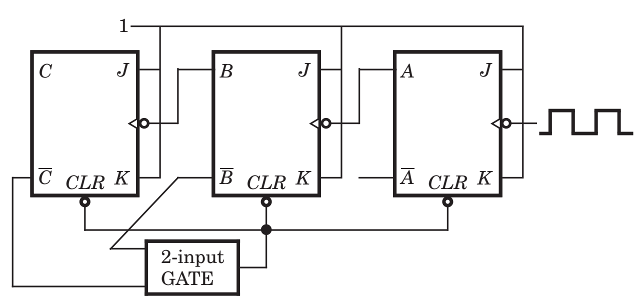



Fig Q56.

The 2-input gate is

(A) a NAND gate (B) a NOR gate

(C) an OR gate (D) an AND gate

**Q.57** Consider the sequence of 8085 instructions given below

LXI H, 9258

MOV A, M

CMA

MOV M , A

Which one of the following is performed by this sequence?

(A) Contents of location 9258 are moved to the accumulator

(B) Contents of location 9258 are compared with the contents of the accumulator

(C) Contents of location 8529 are complemented and stored in location 8529

(D) Contents of location 5892 are complemented and stored in location 5892

**Q.58** A Boolean function $f$ of two variables $x$ and $y$ is defined as follows :

$$f(0,\,0)=f(0,\,1)=f(1,\,1)=1;\quad f(1,\,0)=0$$

Assuming complements of $x$ and $y$ are not available, a minimum cost solution for realizing $f$ using only 2-input NOR gates and 2-input OR gates (each having unit cost) would have a total cost of

(A) 1 unit (B) 4 units

(C) 3 units (D) 2 units

**Q.59** It is desired to multiply the numbers 0AH by 0BH and store the result in the accumulator. The numbers are available in registers B and C respectively. A part of the 8085 program for this purpose is given below:

```
        MVI A, 00H
LOOP:   __________
        __________
        __________
        HLT
        END
```

The sequence of instructions to complete the program would be

(A) JNZ LOOP, ADD B, DCR C

(B) ADD B, JNZ LOOP, DCR C

(C) DCR C, JNZ LOOP, ADD B

(D) ADD B, DCR C, JNZ LOOP

**Q.60** A 1 kHz sinusoidal signal is ideally sampled at 1500 samples /sec and the sampled signal is passed through an ideal low-pass filter with cut-off frequency 800 Hz. The output signal has the frequency

(A) zero Hz (B) 0.75 kHz

(C) 0.5 kHz (D) 0.25 kHz

**Q.61** A rectangular pulse train $s(t)$ as shown in Fig. Q.61 is convolved with the signal $\cos^2(4\pi\times10^3t)$. The convolved signal will be a

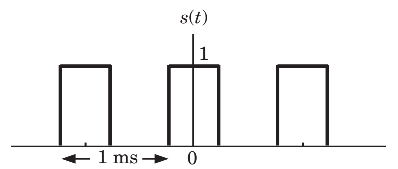



Fig Q.61

(A) DC (B) 12 kHz sinusoid

(C) 8 kHz sinusoid (D) 14 kHz sinusoid

**Q.62** Consider the sequence

$$x[n]=[-4-j5\quad 1+j2\quad 5]$$
$$\uparrow$$

The conjugate anti-symmetric part of the sequence is

(A) $[-4-j2.5\quad j2\quad 4-j2.5]$

(B) $[-j2.5\quad 1\quad j2.5]$

(C) $[-j2.5\quad j2\quad 0]$

(D) $[-4\quad 1\quad 4]$

**Q.63** A causal LTI system is described by the difference equation

$$2y[n]=\alpha y[n-2]-2x[n]+\beta x[n-1]$$

The system is stable only if

(A) $|\alpha|=2,\ |\beta|<2$

(B) $|\alpha|>2,\ |\beta|>2$

(C) $|\alpha|<2,$ any value of $\beta$

(D) $|\beta|<2,$ any value of $\alpha$

**Q.64** A causal system having the transfer function

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

is excited with $10u(t)$. The time at which the output reaches 99% of its steady state value is

(A) 2.7 sec (B) 2.5 sec

(C) 2.3 sec (D) 2.1 sec

**Q.65** The impulse response $h[n]$ of a linear time invariant system is given as

$$h[n] = \begin{cases} -2\sqrt{2} & n = 1, -1 \\ 4\sqrt{2} & n = 2, -2 \\ 0 & \text{otherwise} \end{cases}$$

If the input to the above system is the sequence $e^{j\pi n/4}$, then the output is

(A) $4\sqrt{2}e^{j\pi n/4}$ (B) $4\sqrt{2}e^{-j\pi n/4}$

(C) $4e^{j\pi n/4}$ (D) $-4e^{j\pi n/4}$

**Q.66** Let $x(t)$ and $y(t)$ with Fourier transforms $F(f)$ and $Y(f)$ respectively be related as shown in Fig. Q.66. Then $Y(f)$ is

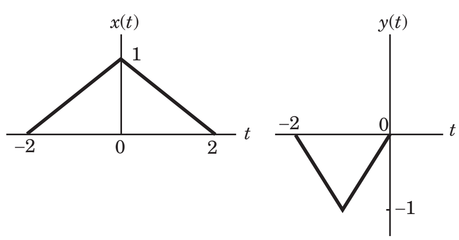



Fig Q.66

(A) $-\frac{1}{2}X(f/2)e^{-j2\pi f}$ (B) $-\frac{1}{2}X(f/2)e^{j2\pi f}$

(C) $-X(f/2)\,e^{j2\pi f}$ (D) $-X(f/2)\,e^{-j2\pi f}$

**Q.67** A system has poles at 0.01 Hz, 1 Hz and 80 Hz; zeros at 5 Hz, 100 Hz and 200 Hz. The approximate phase of the system response at 20 Hz is

(A) –90° (B) 0°

(C) 90° (D) –180°

**Q.68** Consider the signal flow graph shown in Fig. Q.68. The gain $\frac{x_5}{x_1}$ is

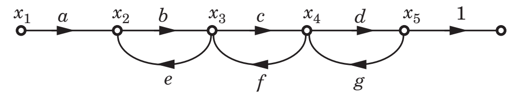



Fig Q.68

(A) $\frac{1-(be+cf+dg)}{abcd}$

(B) $\frac{bedg}{1-(be+cf+dg)}$

(C) $\frac{abcd}{1-(be+cf+dg)+bedg}$

(D) $\frac{1-(be+cf+dg)+bedg}{abcd}$

**Q.69** If $\mathbf{A} = \begin{bmatrix} -2 & 2 \\ 1 & -3 \end{bmatrix}$, then $\sin At$ is

(A) $\begin{bmatrix} \sin(-4t) + 2\sin(-t) & -\sin(-4t) + 2\sin(-t) \\ -\sin(-4t) + \sin(-t) & 2\sin(-4t) + \sin(-t) \end{bmatrix}$

(B) $\begin{bmatrix} \sin(-2t) & \sin(2t) \\ \sin(t) & \sin(-3t) \end{bmatrix}$

(C) $\begin{bmatrix} \sin(4t) + 2\sin(t) & 2\sin(-4t) - 2\sin(-t) \\ -\sin(-4t) + \sin(t) & 2\sin(4t) + \sin(t) \end{bmatrix}$

(D) $\begin{bmatrix} \cos(-t) + 2\cos(t) & 2\cos(-4t) - 2\sin(-t) \\ -\cos(-4t) + \sin(-t) & -2\cos(4t) + \cos(t) \end{bmatrix}$

**Q.70** The open-loop transfer function of a unity feedback system is

$$G(s) = \frac{K}{s(s^2+s+2)(s+3)}$$

The range of K for which the system is stable is

(A) $\frac{21}{4} > K > 0$ (B) $13 > K > 0$

(C) $\frac{21}{4} < K < \infty$ (D) $-6 < K < \infty$

**Q.71** For the polynomial

$$P(s) = s^5 + s^4 + 2s^3 + 2s^2 + 3s + 15$$

the number of roots which lie in the right half of the $s$-plane is

(A) 4 (B) 2

(C) 3 (D) 1

**Q.72** The state variable equations of a system are :

$$\dot{x}_1 = -3x_1 - x_2 = u,\ \dot{x}_2 = 2x_1 \quad , \quad y = x_1 + u$$

The system is

(A) controllable but not observable

(B) observable but not controllable

(C) neither controllable nor observable

(D) controllable and observable

**Q.73** Given $\mathbf{A} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$, the state transition matrix $e^{At}$ is given by

(A) $\begin{bmatrix} 0 & e^{-t} \\ e^{-t} & 0 \end{bmatrix}$ (B) $\begin{bmatrix} 0 & e^{t} \\ e^{t} & 0 \end{bmatrix}$

(C) $\begin{bmatrix} e^{-t} & 0 \\ 0 & e^{-t} \end{bmatrix}$ (D) $\begin{bmatrix} e^{t} & 0 \\ 0 & e^{t} \end{bmatrix}$

**Q.74** Consider the signal $x(t)$ shown in Fig. Q.74. Let $h(t)$ denote the impulse response of the filter matched to $x(t)$, with $h(t)$ being non-zero only in the interval 0 to 4 sec. The slope of $h(t)$ in the interval $3 < t < 4$ sec is

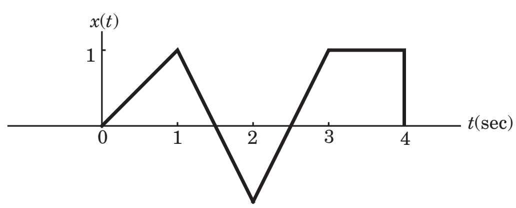


Fig. Q.74

(A) ½ $\sec^{-1}$ (B) $-1 \sec^{-1}$

(C) $-1/2 \sec^{-1}$ (D) $1 \sec^{-1}$

**Q.75** A 1 mW video signal having a bandwidth of 100 MHz is transmitted to a receiver through a cable that has 40 dB loss. If the effective one-sided noise spectral density at the receiver is $10^{-20}$ Watt/Hz, then the signal-to-noise ratio at the receiver is

(A) 50 dB (B) 30 dB

(C) 40 dB (D) 60 dB

**Q.76** A 100 MHz carrier of 1V amplitude and a 1 MHz modulating signal of 1V amplitude are fed to a balanced modulator. The output of the modulator is passed through an ideal high-pass filter with cut-off frequency of 100 MHz. The output of the filter is added with 100 MHz signal of 1V amplitude and 90° phase shift as shown in Fig. Q.76. The envelope of the resultant signal is

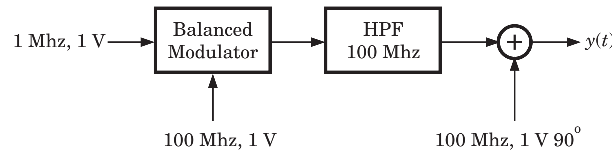


Fig Q.76

(A) constant (B) $\sqrt{1 + \sin(2\pi \times 10^6 t)}$

(C) $\sqrt{5/4 - \sin(2\pi \times 10^6 t)}$ (D) $\sqrt{5/4 + \cos(2\pi \times 10^6 t)}$

**Q.77** Two sinusoidal signals of same amplitude and frequencies 10 kHz and 10.1 kHz are added together. The combined signal is given to an ideal frequency detector. The output of the detector is

(A) 0.1 kHz sinusoid (B) 20.1 kHz sinusoid

(C) a linear function of time(D) a constant

**Q.78** Consider a binary digital communication system with equally likely 0's and 1's. When binary 0 is transmitted the voltage at the detector input can lie between the levels –0.25 V and +0.25 V with equal probability; when binary 1 is transmitted, the voltage at the detector can have any value between 0 and 1 V with equal probability. If the detector has a threshold of 0.2V (i.e. if the received signal is greater than 0.2V, the bit is taken as 1), the average bit error probability is

(A) 0.15 (B) 0.2

(C) 0.05 (D) 0.5

**Q.79** A random variable $X$ with uniform density in the interval 0 to 1 is quantized as follows:

$$\text{if } 0 \le X \le 0.3, \quad x_q = 0$$
$$\text{if } 0.3 \le X \le 1, \quad x_q = 0.7$$

where $x_q$ is the quantized value of $X$. The root-mean square value of the quantization noise is

(A) 0.573 (B) 0.198

(C) 2.205 (D) 0.266

**Q.80** Choose the correct one from among the alternatives A, B, C, D after matching an item from Group 1 with the most appropriate item in Group 2.

| **Group 1** | **Group 2** |
|---|---|
| 1 : FM | P : Slope overload |
| 2 : DM | Q : μ-law |

3 : PSK R : Envelope detector

4 : PCM S : Capture effect

T : Hilbert transfer

U : Matched filter

| (A) | (B) | (C) | (D) |
|---|---|---|---|
| 1–T | 1–S | 1–S | 1–U |
| 2–P | 2–U | 2–P | 2–R |
| 3–U | 3–P | 3–U | 3–S |
| 4–S | 4–T | 4–Q | 4–Q |

**Q.81** Three analog signals, having bandwidth 1200 Hz, 600 Hz and 600 Hz, are sampled at their respective Nyquist rates, encoded with 12 bit words, and time division multiplexed. The bit rate for the multiplexed signal is

(A) 1, 15.2 kbps (B) 28.8 kbps

(C) 27.6 kbps (D) 38.4 kbps

**Q.82** Consider a system shown in Fig. Q.82. Let $X(f)$ and $Y(f)$ denote the Fourier transforms of $x(t)$ and $y(t)$ respectively. The ideal HPF has the cutoff frequency 10 kHz.

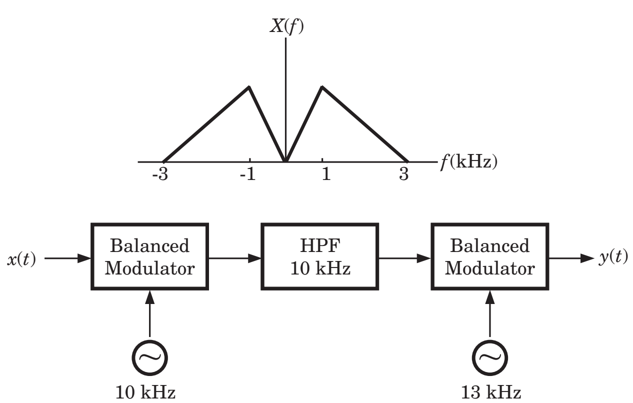



Fig Q.82

The positive frequencies where $Y(f)$ has spectral peaks are

(A) 1 kHz and 24 kHz (B) 2 kHz and 24 kHz

(C) 1 kHz and 14 kHz (D) 2 kHz and 14 kHz

**Q.83** A parallel plate air-filled capacitor has plate area of $10^{-4}$ m$^2$ and plate separation of $10^{-3}$ m. It is connected to a 0.5 V, 3.6 GHz source. The magnitude of the displacement current is ($\varepsilon_o = 1/36\pi \times 10^{-9}$ F/m)

(A) 10 mA (B) 100 mA

(C) 10 A (D) 1.59 mA

**Q.84** A source produces binary data at the rate of 10 kbps. The binary symbols are represented as shown in Fig.Q.84

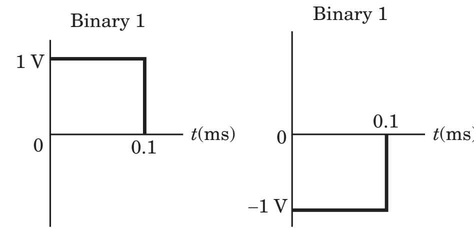



Fig Q.84

The source output is transmitted using two modulation schemes, namely Binary PSK (BPSK) and Quadrature PSK (QPSK). Let $B_1$ and $B_2$ be the bandwidth requirements of BPSK respectively. Assuming that the bandwidth of the above re tangular pulses is 10 kHz, $B_1$ and $B_2$ are

(A) $B_1 = 20$ kHz, $B_2 =$ kHz

(B) $B_1 = 10$ kHz, $B_2 = 10$ kHz

(C) $B_1 = 20$ kHz, $B_2 = 10$ kHz

(D) $B_1 = 10$ kHz, $B_2 = 10$ kHz

**Q.85** Consider a 300 Ω, quarter-wave long (at 1 GHz) transmission line as shown in Fig. Q.85. It is connected to a 10 V, 50Ω source at one end and is left open circuited at the other end. The magnitude of the voltage at the open circuit end of the line is

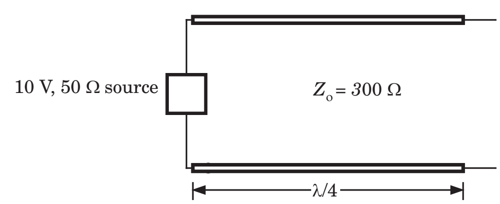



Fig Q.85

(A) 10 V (B) 5 V

(C) 60 V (D) 60/7 V

**Q.86** In a microwave test bench, why is the microwave signal amplitude modulated at 1 kHz ?

(A) To increase the sensitivity of measurement

(B) To transmit the signal to a far-off place

(C) To study amplitude modulation

(D) Because crystal detector fails at microwave frequencies

**Q.87** If $\vec{\mathbf{E}} = (\hat{\mathbf{a}}_x + j\hat{\mathbf{a}}_y)e^{jkz - j\omega t}$ and $\vec{\mathbf{H}} = (k/\omega\mu)(\hat{\mathbf{a}}_y + j\hat{\mathbf{a}}_x)e^{jkz - j\omega t}$,the time-averaged Poynting vector is

(A) null vector (B) $(k/\omega\mu)\hat{\mathbf{a}}_z$

(C) $(2k/\omega\mu)\hat{\mathbf{a}}_z$ (D) $(k/2\omega\mu)\hat{\mathbf{a}}_z$

**Q.88** Consider an impedance $Z = R + jX$ marked with point P in an impedance Smith chart as shown in Fig. Q.88. The movement from point P along a constant resistance circle in the clockwise direction by an angle 45° is equivalent to

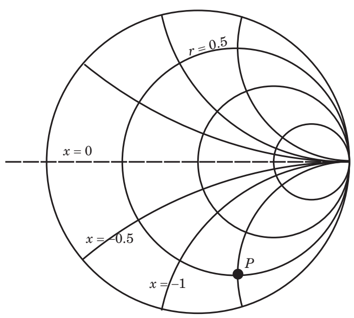


Fig. Q.88

(A) adding an inductance in series with Z

(B) adding a capacitance in series with Z

(C) adding an inductance in shunt across Z

(D) adding a capacitance in shunt across Z

**Q.89** A plane electromagnetic wave propagating in free space is incident normally on a large slab of loss-less, non-magnetic, dielectric material with $\varepsilon > \varepsilon_0$. Maxima and minima are observed when the electric field is measured in front of the slab. The maximum electric field is found to be 5 times the minimum field. The intrinsic impedance of the medium should be

(A) $120\pi\,\Omega$ (B) $60\pi\,\Omega$

(C) $600\pi\,\Omega$ (D) $24\pi\,\Omega$

**Q.90** A lossless transmission line is terminated in a load which reflects a part of the incident power. The measured VSWR is 2. The percentage of the power that is reflected back is

(A) 57.73 (B) 33.33

(C) 0.11 (D) 11.11

********

# Answersheet

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

# MCQ GATE-ECE by RK Kanodia

Kindly note that our publication **GATE-ECE by RK Kanodia**, has the following features that make it an excellent study material in comparison to other books available on the GATE exam:

1. **MCQs:** The book contains only solved Multiple choice questions (MCQ) which is the main requirement of the GATE exam. Each and every problem has its complete solution. **We understand that theoretical studies should be done from the standard book, that one has studied for the semester exams and thus one should use the same material to understand the concepts of the same.** We have deliberately excluded theoretical matter in the guide book so as not to mislead the students. However, wherever needed, satisfactory explanation of the formula has been included in the solution.

2. **Adherence to Pattern:** All Multiple choice questions are strictly according to the GATE pattern. Every problem selected and included in the book is a model problem for the preparation of the exam which would thus prepare and equip the students better. Kindly note, that the standard of **Multiple choice questions and their solution in every unit is much better than the ones available in a famous series of problems & solutions as far as GATE is concerned.**

3. **Levels of MCQs**: The Multiple choice questions included in this book are in a conceptually evolving method, allowing the student to progress from one level of complexity to another but always aiding in understanding the basic foundation of the subject. Thus, the MCQs gradually and scientifically advance from the basic level to a more complex level, helping in the systematic understanding of the problem rather than an abrupt one.

4. **Unit Division**: Each unit has been further sub-divided into separate chapters and not clustered together. Thus the non-combination of all the problems in a single unit makes the reader, to remain focused and able to manage his time during his preparation.

5. **Time Management**: Time is a very important factor in any competitive exam and the same applies for GATE too. It has been observed and concluded that if students can manage time, they can get a better score in GATE. **The solutions provided are extremely logical yet tricky** so that they save time when the student solve them in the examination, as they have already been used to solving difficult and tricky problems.

6. **Variety**: The book carries in it a large variety of problems. The words of one of the senior educators of a reputed coaching institute bear testimony to the fact wherein he comments that **"We can't expect so much variety of problems in a single book available in the market."**

7. **Includes Previous Exam Questions**: This **book contains questions on earlier IES, IAS & GATE exams that might be relevant to learn some concepts** but we have purposely not mentioned them in our book. We believe and strongly advocate that every year GATE contains new and unique problems.

8. **Less Erroneous**: The book has very few errors [less than 5%] compared to the other books available in the market which have upto 40% errors. This puts the students in a better and more comfortable situation as all the **errors are traceable due to availability of the complete solution** and moreover, the errors are never conceptual but data or typo mistakes. Kindly note that, all the errata will be soon available at our website www.nodia.co.in

9. **Attractive Format**: We understand student psychology and the fact that if the book is in an attractive format, the student would feel good in reading the book. This fact also heightens the interest to study in a student. Thus **the style of the book is so designed that it appeals to its readers,** yet is expressive and detailed.

10. **Aim** : The aim of the book is to provide quality material, a fact which can easily be seen in books available for the preparation of IIT-JEE, AIEEE, CPMT & CAT, but till date never observed in the material available GATE preparation. In other words, we want to provide ELITE material but which is also economical.

| | |
|---|---|
| **E** | **: Expressive** |
| **L** | **: Less Erroneous** |
| **I** | **: Individualistic** |
| **T** | **: Targeted approach** |
| **E** | **: Exhaustive content** |

We have received feedback, which state that the book fulfills more than what is stated above and thus it has been a great success last year, on all aspects. Everyone who got through, due to this book, has given excellent feedback. Reviews can be read at our website www.nodia.co.in.

However, nothing in the world can be achieved without the help of constructive criticism and thus we would be obliged if you can send across your feedback to make our book, a **GUIDE** in true sense of the word.

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