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**UGC-NET Previous Solved Papers : Electronic Science**


**First Edition : 2023**

# Preface

**B. Singh** (Ex. IES)

It is commonly said "Teaching is the profession which creates all other professions" and "Research is the new knowledge"; so aren't these professions an instruments to serve the nation?

Of course yes, from Dr.S.Radhakrishnan to Dr. APJ Abdul Kalam, they will be remembered for their marvellous works, apart from technical jobs in engineering services or PSUs, this is equally a good choice to contribute in the saga of India's development. UGC-NET provides opportunity for budding engineers to become future renowned scholars of this country and entire world.

This is one such exam which opens a direct gateway to lectureship in colleges, universities as an Assistant Professor and also to make remarkable progress in the field of research by awarding JRF.

Preparation of any exam is complete only when set of variety of questions is practised. To help all the students in their preparation MADE EASY team made efforts and came up with compilation of all previous years' questions of UGC-NET exam with accurate and detailed solutions. This book is not only helpful for UGC-NET but also for GATE, ISRO, DRDO, HAL, BARC, CIL, BHEL, BEL, UPPCL, GAIL, DMRC and other competitive exams and other competitive exams for engineering graduates.

I would like to give credit to MADE EASY team for solving previous years' questions with correctness and making it a medium to serve students. Providing good study material and quality guidance are two ways to help each and every student and this book fulfils my aim to contribute in success of every aspirant.

With Best Wishes

**B. Singh (Ex-IES)**

CMD, MADE EASY Group

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# UGC NET : 2020

## (Exam held on 5th November, 2020)

**1.** In case of varactor diode with hyper-abrupt junction the sensitivity ($S$) value for $m = -\frac{5}{3}$ is

(a) 2 (b) 3

(c) 1 (d) $\frac{1}{2}$

**2.** For an ideal MS contact between a metal and a $P$-type semiconductor. The relation between barrier height $q\phi_{(B_{po})}$ is given by

(a) $q\phi_{(B_{po})} = q(\phi_m - \chi)$

(b) $q\phi_{(B_{po})} = \frac{Eg}{2} - q(\phi_m - \chi)$

(c) $q\phi_{(B_{po})} = q(\chi - \phi_m)$

(d) $q\phi_{(B_{po})} = Eg - q(\phi_m - \chi)$

**3.** The Debye length $L_D$ is characteristic length for semiconductor and is defined as

(a) $L_D = \sqrt{\frac{\epsilon_s kT}{qN}}$ (b) $L_D = \sqrt{\frac{\epsilon_s kT}{q^2 N}}$

(c) $L_D = \sqrt{\frac{2\epsilon_s kT}{q^2 N}}$ (d) $L_D = \sqrt{\frac{\epsilon_s kT}{2qN}}$

**4.** The depletion layer width at thermal equilibrium for a one-sided abrupt junction is

(a) $W_D = \sqrt{\frac{\epsilon_s}{qN}\left(\psi_{bi} - \frac{2kT}{q}\right)}$

(b) $W_D = \sqrt{\frac{2\epsilon_s}{qN}\left(\psi_{bi} - \frac{2kT}{q}\right)}$

(c) $W_D = \sqrt{\frac{2\epsilon_s}{qN}\left(\psi_{bi} - \frac{kT}{q}\right)}$

(d) $W_D = \sqrt{\frac{\epsilon_s}{qN}\left(\psi_{bi} - \frac{kT}{q}\right)}$

**5.** Number of ways in which a Schottky defect can occur in silicon is given by

(a) $\frac{N!}{(N-n_s)!}$ (b) $\frac{N!}{n_s!}$

(c) $\frac{N!}{N-n_s!}$ (d) $\frac{N!}{(N-n_s)!\,n_s!}$

**6.** What would be system pressure of Si-MBE system in order to achieve $5 \times 10^7$ cm mean free path($L$) of atoms?

(a) $10^{-7}$ torr (b) $10^{-8}$ torr

(c) $10^{-9}$ torr (d) $10^{-10}$ torr

**7.** Which plasma analytical technique involves placement of conducting probe smaller than particle mean free path directly in the plasma?

(a) Actinometry

(b) Lesser Induced Fluorescence

(c) Retarding Grid

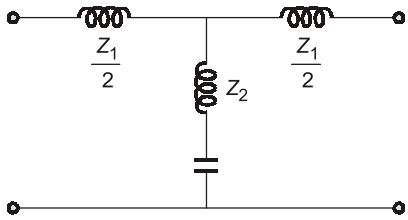
(d) Langmuir technique

**8.** Which gas is used in reactive plasma for etching all three i.e. silicides, silicon and silicon dioxide

(a) F2 (b) $SF_6$

(c) $CF_4 + O_2$ (d) $NF_3$

**9.** Consider a circuit as shown in figure




The circuit is

(a) Constant $K$ low-pass filter

(b) Constant $K$ high-pass filter

(c) The m-derived low-pass filter

(d) The m-derived high-pass filter

**10.** The region of convergence of the sequence $x[n] = \left(\frac{-1}{3}\right)^n u[n] - \left(\frac{1}{2}\right)^n u[-n-1]$ is

(a) $\frac{1}{3} < |z| < \frac{1}{2}$ (b) $|z| > \frac{1}{3}$

(c) $|z| < \frac{1}{2}$ (d) $\frac{1}{2} < |z| < \frac{1}{3}$

**11.** The Fourier series expansion of a periodic function with half wave symmetry contains
(a) only even harmonics
(b) only odd harmonics
(c) both even and odd harmonics
(d) no harmonics

**12.** The Fourier transform of $x^*[-n]$ is
(a) $X^*(e^{-j\omega})$ (b) $X^*(e^{j\omega})$
(c) $X^*(-e^{-j\omega})$ (d) $X^*(-e^{j\omega})$

**13.** The slew rate for a 741 is 0.5 V/μ second. The combination of maximum frequencies for an undistorted sine-wave output of 10 V peak and 1 V peak are approximately
(a) 8 kHz and 80 kHz (b) 48 kHz and 4.8 kHz
(c) 20 kHz and 2 kHz (d) 2 kHz and 20 kHz

**14.** Which of the following is not a component of basic Phase-Locked Loop (PLL)?
(a) Phase detector
(b) Voltage controlled oscillator
(c) Schmitt Trigger
(d) Low-pass filter

**15.** If $T_J$ and $T_A$ are junction temperature and ambient temperature respectively. $\theta_{JC}$, $\theta_{CS}$ and $\theta_{SA}$ are transistor thermal resistance, insulator thermal resistance and heat-sink thermal resistance respectively. The equation of maximum power dissipation is given by

(a) $P_D = \dfrac{T_J + T_A}{\theta_{JC} + \theta_{CS} + \theta_{SA}}$

(b) $P_D = \dfrac{T_J - T_A}{\theta_{JC} + \theta_{CS} + \theta_{SA}}$

(c) $P_D = \dfrac{T_A - T_J}{\theta_{JC} + \theta_{CS} + \theta_{SA}}$

(d) $P_D = \dfrac{T_J - T_A}{\theta_{JC} + \theta_{CS} - \theta_{SA}}$

**16.** If $V_{ref}$ is the output reference value and $V_{fs}$ is the ideal full-scale output voltage when the digital inputs are all 1. Which of the following equation is correct?

(a) $V_{ref} = V_{fs}\left(1 - \dfrac{1}{2^n}\right)$ (b) $V_{fs} = V_{ref}\left(\dfrac{1}{2^n} - 1\right)$

(c) $V_{fs} = V_{ref}\left(1 - \dfrac{1}{2^n}\right)$ (d) $V_{ref} = V_{fs}\left(\dfrac{1}{2^n} - 1\right)$

**17.** Which of the following statements is not correct about a CPLD (Complex Programmable Logic Device)?
(a) A CPLD is a logic device that consists of multiple SPLDs interconnected on a single chip.
(b) A CPLD is based on Product-Of-Sums (POS) architecture.
(c) A CPLD consists of multiple group of PAL with programmable interconnection.
(d) A CPLD can be used to implement large logic function.

**18.** The final code after encoding data bits 1101 into 7-bit even parity Hamming Code is
(a) 1110101 (b) 1011101
(c) 1010101 (d) 0110101

**19.** The A/O gates in which an addition variable or a combination of variables can be included in the logic operation are called
(a) AOI Gates (b) Expandable Gates
(c) Variable Gates (d) Scalable Gates

**20.** The statement which is not applicable to a Moore machine
(a) Output is a function of present state only.
(b) It requires more number of states for implementing same function.
(c) Input changes do not effect the output.
(d) The characteristic equation of output $Z(t)$ can be given as $Z(t) = g\{S(t) \cdot x(t)\}$ where $S(t)$ represents present state, $x(t)$ indicates present input.

**21.** The program written below gives
MOV A, #85 H
CPL A,
ADD A, #
(a) 7BH (b) B7H
(c) 78H (d) 87H

**22.** The relationship between revolution per minute (rpm), steps per revolution (spr) and steps per second (sps) is given by

(a) $\text{sps} = \dfrac{\text{rpm} \times \text{spr}}{60}$ (b) $\text{rpm} = \dfrac{60}{\text{sps} \times \text{spr}}$

(c) $\text{rpm} = \dfrac{\text{sps} \times \text{spr}}{60}$ (d) $\text{sps} = \dfrac{60}{\text{rpms} \times \text{spr}}$

**23.** What happens if Interrupts INTO, TF0 and INT1 are activated at the same time?
(a) They are latched and kept internally.
(b) They are latched and kept externally.
(c) They are unlatched and kept internally.
(d) They are unlatched and kept externally.

**24.** In the Register Indirect addressing mode, the effective address of the datum in the base register or an index register that is specified by the instruction is

(a) $EA = \begin{Bmatrix}(AX)\\(DI)\\(SI)\end{Bmatrix}$ (b) $EA = \begin{Bmatrix}(BX)\\(DI)\\(SI)\end{Bmatrix}$

(c) $EA = \begin{Bmatrix}(CX)\\(DI)\\(SI)\end{Bmatrix}$ (d) $EA = \begin{Bmatrix}(DX)\\(DI)\\(SI)\end{Bmatrix}$

**25.** RG-59 U type transmission line has an open circuit impedance of $150\angle 25°\ \Omega$, and a short circuit impedance of $37.5\ \angle -35°\ \Omega$. The value of characteristic impedance is given by:
(a) $4\lfloor -5°\ \Omega$ (b) $75\lfloor -5°\ \Omega$
(c) $150\lfloor 25°\ \Omega$ (d) $37.5\lfloor -35°\ \Omega$

**26.** An air filled rectangular waveguide of dimension $7 \times 3.5\ cm^2$ operates in the dominant $TE_{10}$ mode. The value of phase velocity of the wave in the guide at a frequency of 3.5 GHz is given by:
(a) $3.78 \times 10^8$ m/S (b) $6.78 \times 10^5$ m/S
(c) $5.78 \times 10^8$ m/S (d) $4.78 \times 10^8$ m/S

**27.** In case of linear arrays of '$n$' isotropic point sources of equal amplitude and spacings. The expression for total electric field at a large distance in the direction '$\theta$' is given by

(a) $E = \dfrac{1+e^{jn\psi}}{1-e^{j\psi}}$ (b) $E = \dfrac{1+e^{jn\psi}}{1+e^{j\psi}}$

(c) $E = \dfrac{1-e^{j\psi}}{1+e^{nj\psi}}$ (d) $E = \dfrac{1-e^{jn\psi}}{1-e^{j\psi}}$

**28.** A sphere of radius $r_1 = 30$ cm has charge density $\left(\rho_o \dfrac{r}{r_1}\right)$ where $\rho_o = 200\ pC/m^3$. The value of total change on the sphere is given by
(a) 34 pC (b) 8.5 pC
(c) 17 pC (d) 68 pC

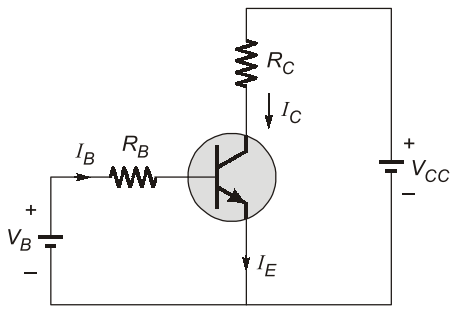
**29.** A VSB transmitter that transmits 25% of the other sideband along with wanted sideband, radiates 0.625 kW when the modulation percentage is 60%. If we want to transmit the same message by an AM transmitter then carrier power (in kW) required is
(a) 6.56 kW (b) 5.56 kW
(c) 4.56 kW (d) 7.56 kW

**30.** The term dispersion describe the process of
(a) reflecting light from a smooth surface.
(b) the process by which light is absorbed by an uneven rough surface.
(c) Light scattering.
(d) Separating light into its component frequencies.

**31.** In an FDM system, 10 channels are multiplexed. Each channel having a BW of 50 kHz. If the guard band between the channels are 1 kHz, the minimum bandwidth required for transmission is
(a) 505 kHz (b) 500 kHz
(c) 509 kHz (d) 510 kHz

**32.** The main objective of CELL in a cellular mobile system is
(a) Higher bandwidth
(b) Hand off
(c) Frequency re-use
(d) Simple modulation techniques

**33.** In the following circuit $\beta$ is in the range of 8 to 40, $R_C = 11\ \Omega$, $V_{CC} = 200$ V. $V_B = 10$ V. If the $V_{CE}$(saturation) = 1.0 V and $V_{BE}$(sat) = 1.5 V, over drive factor = 5. The value of power loss in the transistor is given by:




(a) 35.07 W (b) 23.07 W
(c) 13.07 W (d) 26.09 W

**34.** A three phase four pole induction motor is operating on an input frequency of 75 Hz and slip of 4%. If the rotor resistance of the machine is 1 $\Omega$. The torque developed by the motor is given by:

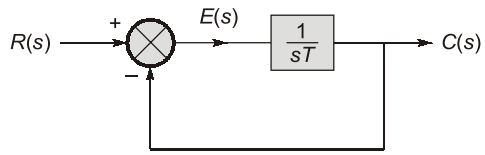
(Assume the operating voltage is 415 V, assuming stator voltage drop = 0)

(a) 6889 syn. watts (b) 7898 syn. watts
(c) 8998 syn. watts (d) 9998 syn. watts

**35.** Insertion of negative feedback in control system affects

(a) the transient response to vanish uniformly.
(b) the transient response to decay very fast.
(c) no change in transient response.
(d) the transient response decays at a slow rate.

**36.** For the following First Order System. The value of steady state error is given by




(a) 0 (zero) (b) ∞ (infinite)
(c) $(1 - e^{-t/T})$ (d) $(1 + e^{-t/T})$

**37.** A dual-slope integarting type of A/D converter has an integrating capacitor of 0.1 μF and a resistance of 100 kΩ. If the reference voltage is 2 V, and the output of the integrator is not to exceed to 10 V, the value of maximum time the reference voltage can be integrated is

(a) 10 m second (b) 50 m second
(c) 50 μ second (d) 10 μ second

**38.** The velocity transducer consists of a moving coil suspended in the magnetic field of a permanent magnet. It is not used for measurement of velocities developed in a

(a) linear manner (b) sinusoidal manner
(c) both (a) and (b) (d) discrete manner

**39.** What is not the source of Error in a Thermocouple transducer

(a) Open junction (b) Thermal conduction
(c) Galvanic action (d) Hall effect

**40.** Which is not the important characteristics of thermistors that make them extremely useful in measurement and control applications?

(a) the resistance – temperature characteristic
(b) the voltage – current characteristic
(c) the current – time characteristic
(d) the power – time characteristic

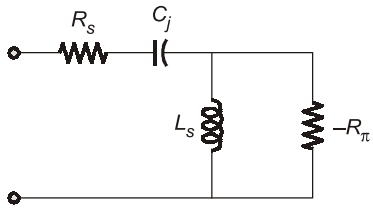
**41.** Currents in the three terminals of a transistor are mostly diffusion currents which are related by the minority carrier distribution in the base region. Which of the following statements are correct?

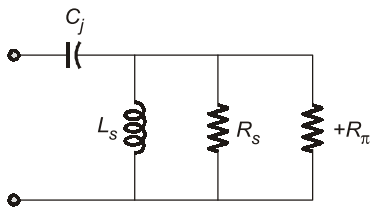
1. The applied voltages control the boundary densities through the term exp ($qV/kT$).
2. The base current is the difference between the emitter and collector currents.
3. In order to maximize emitter resistance, the emitter contact is usually made directly on top of the emitter.
4. Emitter bandgap narrowing increases current gain.
5. Emitter and collector currents are given by the minority density gradients at the junction boundaries.

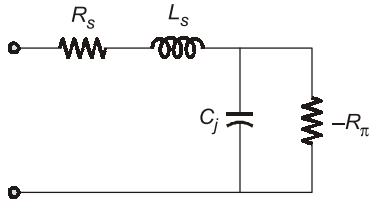
Choose the most appropriate answer from the options given below:

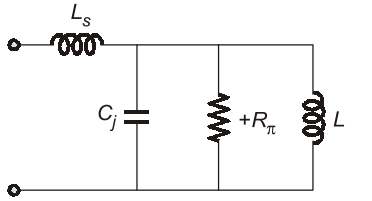
(a) 2, 3, 4 only (b) 1, 2, 5 only
(c) 3, 2, 5 only (d) 4, 5, 1 only

**42.** The small signal model of tunnel diode can be represented as

1.



2.



3.



4.


where, $R_S$ is series resistance;
$L_S$ is series inductance;
$C_j$ is junction capacitance;
$-R_\pi$ is negative resistance

Choose the most appropriate answer from the options given below:

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

**43.** In which of the following techniques beam of electrons is used as a probe and the secondary radiation is X-ray.

1. LED
2. EMP
3. TEM
4. STEM
5. EELS

Choose the correct answer from the options given below:

(a) 1 and 5 only (b) 2 and 4 only
(c) 3 and 5 only (d) 1 and 3 only

**44.** Which metals or alloys amongst the following, do not reduce $SiO_2$ and are found to have poor adhesion on $SiO_2$ surfaces.

1. W
2. Mo
3. Al
4. TinN
5. $WSi_2$

Choose the correct answer from the options given below:

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

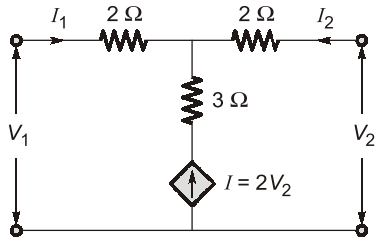
**45.** Which of the following gases commonly used in CVD are pyrophoric, toxic and flammable?

1. Phosphine
2. Argon
3. Nitrogen Oxide
4. Silane
5. Nitrogen

Choose the most appropriate answer from the options given below:

(a) 2 and 3 only (b) 3 and 5 only
(c) 2 and 5 only (d) 1 and 4 only

**46.** Consider a circuit shown in figure:




The correct values of $Y$ parameters are

1. $Y_{11} = \frac{1}{4}\mho,\ Y_{12} = -\frac{5}{4}\mho$
2. $Y_{21} = -\frac{3}{4}\mho,\ Y_{22} = -\frac{1}{4}\mho$
3. $Y_{11} = \frac{5}{4}\mho,\ Y_{12} = -\frac{1}{4}\mho$
4. $Y_{21} = -\frac{5}{4}\mho,\ Y_{22} = -\frac{1}{4}\mho$
5. $Y_{21} = -\frac{1}{4}\mho,\ Y_{22} = -\frac{3}{4}\mho$

Choose the correct answer from the options given below:

(a) 2 and 3 only (b) 1 and 4 only
(c) 1 and 5 only (d) 3 and 4 only

**47.** Which of the following statements regarding tree are correct?

1. All the links of a tree together does not constitute the complement of the corresponding tree.
2. A connected subgraph of a connected graph is a tree if there exist $(n-1)$ nodes of the group.
3. A connected subgraph of a connected graph is a tree if there exists many paths between any pair of nodes in it.
4. The number of terminal nodes or end vertices of every tree are atleast two.
5. Every connected graph has atleast one tree.

Choose the correct answer from the options given below:

(a) 1 and 2 only (b) 2 and 3 only
(c) 2 and 4 only (d) 4 and 5 only

**48.** Which of the following statements are not correct?

1. Precision rectifiers use positive feedback to compensate for the forward drop of the diodes.
2. Precision peak detector uses a capacitor to effectively lengthen the duration of the peaks.

3. Limiters may be thought of as programmable signal clippers.
4. In order to improve performance of comparators negative feedback may be used.
5. There are two basic approaches for realizing a design: (1) using Zener diodes and (2) using biased-signal diode network.

Choose the most appropriate answer the options given below:

(a) 1 and 4 only (b) 4 and 5 only
(c) 1 and 3 only (d) 2 and 4 only

**49.** The network formed by resistors and capacitors for modifying the rate of change of gain and the phase shift is called a compensating network. Which of the following statements are not correct?

1. The main purpose of a compensating network is to modify the performance of op-amp circuit over the desired frequency range.
2. There are two types of op-amps: internally compensated and externally compensated.
3. 741 C is an externally compensated op-amp while 709 C is internally compensated op-amp.
4. The phase lag and phase lead are most commonly used compensating networks in op-amps.
5. Phase lag contributes a positive phase angle and phase lead a negative phase angle.

Choose the most appropriate answer from the options given below:

(a) 2 and 3 only (b) 2 and 5 only
(c) 3 and 4 only (d) 3 and 5 only

**50.** Three major types of programmable logic are SPLD, CPLD and FPGA. Each major type have many manufacturer specific subcategories. Some statements are given below related to these programmable logic devices.

Which of the following statements are correct?

1. CPLDs have much higher capacity than SPLDs.
2. FPGAs are similar to CPLD in their internal organization.
3. Two basic classes of FPGAs are course grained and fine grained.
4. Fine grained FPGA has large logic blocks while course-gained FPGA has much smaller logic blocks.
5. FPGAs come in package and ranging less than 1000 pins.

Choose the most appropriate answer from the options given below:

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

**51.** The performance parameters of a logic family are required for better understanding. The following statements explain the characteristics of Digital logic family. Which of these statements are correct?

1. The operating speed of a logic family is determined from its propagation delay.
2. Power dissipation is inversely proportional to switching frequency and directly proportional to cycle time.
3. Fan-in is defined as maximum number of inputs for a logic gate in a particular logic family.
4. Fan-out is defined as number of dissimilar logic gates driven by a single logic gate.

Choose the most appropriate answer from the options given below:

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

**52.** In case of the parallel adder, the speed with which an addition can be performed is governed by the time required for the carriers to propagate or ripple through all the stage of the adder. Which of the following statements are correct.

1. The method of speeding up the addition process is based on additional functions of full-adder called carry generate and carry propagation.
2. The look-ahead-carry adder speeds up the process by eliminating ripple carry delay.
3. The final sum output of the $n^{th}$ stage is given by $S_n = P_n \oplus C_n$ where $P_n = A_n \oplus B_n$.
4. The final carry output of $n^{th}$ stage is given by $C_{n+1} = G_n + P_n$ where $G_n = A_n \cdot B_n$.

Choose the correct answer from the options given below:

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

**53.** For the 40-character wide LCD, the upper address range can go as high as:

1. 0101011
2. 1000000
3. 0100111
4. 1001000
5. 1011111

Choose the most appropriate answer from the options given below:

(a) 3 only (b) 1 only
(c) 4 only (d) 2 and 5 only

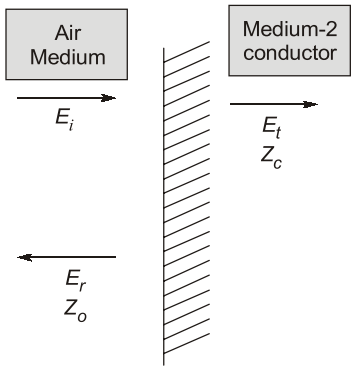
**54.** Keyboards are organised in a matrix. The CPU of 8051 accesses both rows and columns through its ports. So, it can access

1. 4 × 4 matrix of keys
2. 8 × 8 matrix of keys
3. 16 × 16 matrix of keys
4. 2 × 2 matrix of keys
5. 32 × 32 matrix of keys

Choose the most appropriate answer from the options given below:

(a) 2 only (b) 1 only
(c) 3 only (d) 4 and 5 only

**55.** For an EM wave ray traversing from air, medium 1 to a conducting medium 2. Following statements are given:




1. $E_t \simeq \frac{2Z_C}{Z_0} E_i$ 2. $E_r = \frac{Z_C - Z_0}{Z_C + Z_0} E_i$
3. $H_t \simeq 2H_i$ 4. $H_t \simeq H_i$

Which of the above are correct?

Choose the most appropriate answer from the options given below:

(a) 1, 2, 4 only (b) 1, 3, 5 only
(c) 1, 2, 5 only (d) 2, 3, 5 only

**56.** A dielectric medium has a relative permittivity $\in_r = 6$, for this the value of Index of Refraction and Phase velocity are given

1. $\eta = 6$
2. $\eta = 2.45$
3. Phase velocity = $3 \times 10^8$ m/s
4. Phase velocity = $1.22 \times 10^8$ m/s

Choose the most appropriate answer from the options given below:

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

**57.** A plane wave of frequency 2 GHz travelling in air parallel to a flat ground plane with $\vec{H}$ parallel to the ground plane losses 3 μW/m$^2$ into the ground plane having conductivity $\sigma = 10^7$ ℧/m, $\mu_r = \in_r = 1$. The following data is given

1. $E = 3.89$ V/m 2. $E = 8.98$ V/m
3. $H = 10.33$ mA/m 4. $H = 3.97$ mA/m

Choose the most appropriate answer from the options given below:

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

**58.** Which of the following statements about the matched filter in a communication receiver are correct?

1. It may produce phase error if synchronization is improper.
2. Its impulse response depends on the signal shape.
3. The characteristics of the matched filter is matched with the transmitted data.
4. It produces inter symbol interference.
5. It measures the correlation between incoming receiver message and its impulse response.

Choose the correct answer from the options given below:

(a) 2, 3, 5 only (b) 1, 2, 3 only
(c) 3, 4, 5 only (d) 1, 4, 5 only

**59.** Which of the following statements are true?

1. A parity check code can detect and correct single bit error.
2. The efficiency of Huffman code is linearly proportional to average entropy.
3. Coding increases the information rate.

4. A code dictionary with minimum distance 2 is not capable of error correct.

Choose the correct answer from the options given below:

(a) 1, 2, 4 only (b) 2, 4, 5 only
(c) 1, 3, 4 only (d) 2, 3, 4 only

**60.** Which of the following statements are correct?

1. A given source will have maximum entropy if the message produced are statistically independent.
2. As the bandwidth approaches infinity, the channel capacity becomes zero.
3. For binary transmission the baud rate is always equal to bit rate.
4. The mutual information of a channel with independent input and output is constant.
5. Nat is a unit of information.

Choose the correct answer from the options given below:

(a) 1 and 5 only (b) 1 and 2 only
(c) 3 and 5 only (d) 1, 4 and 5 only

**61.** A differential transformer

1. is a differential voltage of two secondary windings of a transformer is varied by positioning the magnetic core through externally applied force.
2. is used for pressure measurement.
3. is used for force measurement.
4. is used for displacement measurement.
5. is used for position measurement.

Choose the correct answer from the options given below:

(a) 1 only (b) 2 only
(c) 3 only (d) 1, 2, 3, 4, 5 only

**62.** The Wheatstone bridge is widely used for precision measurement of resistance:

1. from 1 Ω to few MΩ
2. very low resistance
3. 1 mΩ - 10 kΩ
4. 0.1 Ω - 100 kΩ

Choose the correct answer from the options given below:

(a) 1 only (b) 1 and 2 only
(c) 2 and 3 only (d) 4 and 5 only

**63.** The Schering bridge, one of the most important AC bridge

1. It is used for capacitance measurement.
2. It is used for phase angle measurement.
3. It is used for inductance measurement.
4. It is used for resistance measurement.
5. It is used for torque measurement.

Choose the correct answer from the options given below:

(a) 1 and 2 only (b) 3 only
(c) 4 only (d) 5 only

**64.** For the unit step response of second order system following statements are given:

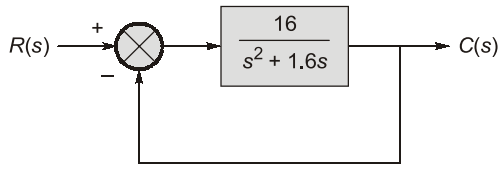
1. Delay time is the time required for the response to reach 60% of the final value in first attempt.
2. Settling time is the time required for the response to reach and stay within (2% or 5%) tolerance band of its final value.
3. Delay time is the time required for the response to reach 50% of the final value in first attempt.
4. Settling time is the time required for the response to reach and stay within 15% of the final value.

Which of the above are correct?

Choose the correct answer from the options given below:

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

**65.** A unity feedback system as shown has damping ratio of 0.8 using derivative control




Following parameters are obtained

1. Characteristic equation is $s^2 + 1.6s + 16 = 0$.
2. $\xi = 0.2$ (without derivative control).
3. $\xi = 0.8$ (without derivative control).
4. $\omega_n = 4$ rad/sec.

Choose the most appropriate answer from the options given below:

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

**66.** Match **List-I** (Volt-ampere characteristics of tunnel diode) with **List-II** (Observation):

**List-I**

**A.** At peak current $I_p$ corresponding to $V_p$

**B.** If voltage increases beyond $V_p$

**C.** When voltage is just more than valley voltage

**D.** When voltage is more than peak forward voltage

**List-II**

**1.** Resistance becomes and remains positive

**2.** Current reaches $I_p$ (peak current) and increases

**3.** $\frac{dI}{dV}$ is negative

**4.** Slope $\frac{dI}{dV}$ is zero

Choose the correct answer from the options given below:

| | A | B | C | D |
|---|---|---|---|---|
| (a) | 1 | 2 | 3 | 4 |
| (b) | 4 | 3 | 1 | 2 |
| (c) | 2 | 1 | 4 | 3 |
| (d) | 3 | 4 | 2 | 1 |

**67.** Match **List-I** (Diffusion profile measurement technique) with **List-II** (Characteristics):

**List-I**

**A.** Capacitance - voltage

**B.** Differential - conductance

**C.** Spreading resistance

**D.** RBS

**List-II**

**1.** Not suitable for diffusion studies in VLSI process when shallow junction profile are of interest.

**2.** Needs Van de graff generator

**3.** Two-point probe arrangement

**4.** Concentration near the junction space-charge region at zero bias cannot be measured

Choose the correct answer from the options given below:

| | A | B | C | D |
|---|---|---|---|---|
| (a) | 1 | 2 | 4 | 3 |
| (b) | 4 | 1 | 3 | 2 |
| (c) | 3 | 4 | 2 | 1 |
| (d) | 2 | 3 | 1 | 4 |

**68.** Match **List-I** ($h$ parameter) with **List-II** ($T$ parameter):

**List-I** **List-II**

**A.** $h_{11}$ **1.** $\frac{\Delta T}{D}$

**B.** $h_{12}$ **2.** $-\frac{1}{D}$

**C.** $h_{21}$ **3.** $\frac{B}{D}$

**D.** $h_{22}$ **4.** $\frac{C}{D}$

Choose the correct answer from the options given below:

| | A | B | C | D |
|---|---|---|---|---|
| (a) | 4 | 2 | 1 | 3 |
| (b) | 2 | 1 | 4 | 3 |
| (c) | 2 | 3 | 1 | 4 |
| (d) | 3 | 1 | 2 | 4 |

**69.** Match **List-I** (Configuration) with **List-II** (Equation of base current):

**List-I** **List-II**

**A.** Fixed bias **1.** $I_B = \frac{V_{CC} - V_{BE}}{R_B + (\beta + 1) R_E}$

**B.** Emitter bias **2.** $I_B = \frac{V_{EE} - V_{BE}}{R_B + (\beta + 1) R_E}$

**C.** Emitter follower **3.** $I_B = \frac{V_{CC} - V_{BE}}{R_B}$

**D.** Common-base **4.** $I_B = \frac{V_{EE} - V_{BE}}{R_E(\beta + 1)}$

**Codes:**

| | A | B | C | D |
|---|---|---|---|---|
| (a) | 2 | 3 | 1 | 4 |
| (b) | 2 | 3 | 4 | 1 |
| (c) | 3 | 2 | 4 | 1 |
| (d) | 3 | 1 | 2 | 4 |

**70.** Match **List-I** with **List-II**:

**List-I**

**A.** Simplest type of ADC

**B.** Fastest ADC

**C.** Slowest ADC

**D.** Most widely used ADC

**List-II**

**1.** Flash – type ADC

**2.** Dual – slope type ADC

**3.** Counter – type ADC

**4.** Successive – approximation type AD

Choose the correct answer from the options given below:

| | A | B | C | D |
|---|---|---|---|---|
| (a) | 3 | 1 | 2 | 4 |
| (b) | 2 | 4 | 1 | 3 |
| (c) | 4 | 2 | 3 | 1 |
| (d) | 3 | 4 | 2 | 1 |

**71.** Match **List-I** with **List-II**:

| List-I | List-II |
|---|---|
| **A.** Reset | **1.** 001B |
| **B.** External hardware int. 0 (INT0) | **2.** 0003 |
| **C.** Timer 0 interrupt (TF0) | **3.** 000B |
| **D.** Timer 1 interrupt (TF1) | **4.** 0000 |

Choose the correct answer from the options given below:

| | A | B | C | D |
|---|---|---|---|---|
| (a) | 4 | 2 | 3 | 1 |
| (b) | 4 | 3 | 2 | 1 |
| (c) | 3 | 2 | 4 | 1 |
| (d) | 1 | 2 | 3 | 4 |

**72.** Match **List-I** with **List-II**:

| List-I | List-II |
|---|---|
| **A.** Klystron | **1.** Slow structure |
| **B.** Transfer electron devices | **2.** Bunching |
| **C.** MESFET | **3.** Warm electrons |
| **D.** Travelling wave tube | **4.** Pinch-off |

Choose the correct answer from the options given below:

| | A | B | C | D |
|---|---|---|---|---|
| (a) | 2 | 3 | 4 | 1 |
| (b) | 1 | 3 | 2 | 4 |
| (c) | 3 | 2 | 1 | 4 |
| (d) | 4 | 3 | 2 | 1 |

**73.** Match **List-I** with **List-II**:

| List-I | List-II |
|---|---|
| **A.** DPSK | **1.** Non coherent detector |
| **B.** AM | **2.** Ratio detector |
| **C.** FM | **3.** Coherent detector |
| **D.** DSB-SC | **4.** Rectifier detector |

Choose the correct answer from the options given below:

| | A | B | C | D |
|---|---|---|---|---|
| (a) | 1 | 4 | 2 | 3 |
| (b) | 3 | 1 | 4 | 2 |
| (c) | 2 | 3 | 1 | 4 |
| (d) | 4 | 2 | 3 | 1 |

**74.** Match **List-I** with **List-II**:

For time response of a second order system

| List-I | List-II |
|---|---|
| **A.** Slower time constant | **1.** $\frac{1}{\left(\xi+\sqrt{\xi^2+1}\right)\omega_n}$ |
| **B.** Rise time | **2.** $\frac{1}{4\xi\omega_n}$ |
| **C.** Settling time | **3.** $\frac{\pi-\phi}{\omega_n-\sqrt{1-\xi^2}}$ |
| **D.** Faster time constant | **4.** $\frac{1}{\left(\xi-\sqrt{\xi^2-1}\right)\omega_n}$ |

Choose the correct answer from the options given below:

| | A | B | C | D |
|---|---|---|---|---|
| (a) | 1 | 3 | 4 | 2 |
| (b) | 2 | 3 | 4 | 1 |
| (c) | 4 | 3 | 2 | 1 |
| (d) | 3 | 4 | 1 | 2 |

**75.** Match **List-I** (Symbol) with **List-II** (Value):

| List-I | List-II |
|---|---|
| **A.** $da$ | **1.** $10^{-15}$ |
| **B.** $d$ | **2.** $10^{-1}$ |
| **C.** $f$ | **3.** $10^{-18}$ |
| **D.** $\alpha$ | **4.** 10 |

Choose the correct answer from the options given below:

| | A | B | C | D |
|---|---|---|---|---|
| (a) | 4 | 2 | 1 | 3 |
| (b) | 2 | 4 | 1 | 3 |
| (c) | 1 | 2 | 3 | 4 |
| (d) | 4 | 2 | 3 | 1 |

**76.** Arrange the following semiconductor materials on the basis of Energy-bandgap ($E_g$) from highest to lowest

**1.** ZnSe **2.** InAs **3.** CdTe
**4.** Ge **5.** InP

Choose the correct answer from the options given below:

(a) 1, 3, 2, 1, 5 (b) 3, 2, 1, 5, 4
(c) 2, 1, 4, 3, 5 (d) 1, 3, 5, 4, 2

**77.** The sequence of first to last step involved in a typical silicon gate *n*-MOS transistor is

**1.** Gate oxidation

2. Contact cuts
3. Patterning $SiO_2$ layer
4. Implant or diffusion
5. Patterning of aluminium layer

Choose the correct answer from the options given below:

(a) 3, 4, 1, 2, 5 (b) 2, 4, 1, 3, 5
(c) 3, 1, 4, 2, 5 (d) 2, 1, 4, 5, 3

**78.** Arrange the Nyquist sampling interval of the signal in descending order

1. $\sin c(300t)$
2. $\sin c(300t) + \sin c^2(300t)$
3. $\sin c(200t)$
4. $\sin c(200t) + \sin c^2(200t)$
5. $\sin c(200t) + \sin c(500t)$

Choose the correct answer from the options given below:

(a) 1, 3, 2, 4, 5 (b) 3, 4, 5, 1, 2
(c) 3, 1, 4, 5, 2 (d) 1, 5, 4, 3, 2

**79.** Compare the output signal swing of the following power amplifiers

1. Class *A* 2. Class *B*
3. Class *AB* 4. Class *C*

Choose the correct answer from the options given below:

(a) 1 > 2 > 3 > 4 (b) 4 > 3 > 2 > 1
(c) 4 > 2 > 3 > 1 (d) 1 > 3 > 2 > 4

**80.** For designing a sequential circuit, the following steps are used as general methodology

1. State Assignment and transition table
2. State diagram
3. State table
4. Realization
5. *k*-maps and minimal expressions

The sequence of these steps in order of their execution is

Choose the correct answer from the options given below:

(a) 3, 1, 2, 5, 4 (b) 5, 2, 1, 4, 3
(c) 1, 2, 5, 3, 4 (d) 2, 3, 1, 5, 4

**81.** Arrange the following addresses in ascending order of their priority

1. Address for divide error is 000H.
2. Address for one – byte interrupt instruction, INT is 000CH.
3. Address for overflow, INTO instruction is 010H.
4. Address for single step trap – TF must be set is 0004H.
5. Address for non maskable interrupt is 0008H.

Choose the correct answer from the options given below:

(a) 1, 4, 5, 2, 3 (b) 1, 5, 4, 2, 3
(c) 1, 5, 2, 3, 4 (d) 1, 4, 2, 5, 3

**82.** Following materials are given

1. Nickel 2. Silicon iron
3. Silver 4. Cobalt

Arrange them in ascending order of relative permeability

Choose the correct answer from the options given below:

(a) 3, 4, 2, 1 (b) 3, 4, 1, 2
(c) 2, 4, 1, 3 (d) 3, 1, 4, 2

**83.** Arrange the bandwidth efficiency of the following *M*-ary modulation schemes in descending order

1. 8-ary PSK 2. 8-ary FSK
3. 16-ary FSK 4. 16-ary PSK
5. 4-ary FSK

Choose the correct answer from the options given below:

(a) 4, 3, 1, 2, 5 (b) 4, 5, 1, 3, 2
(c) 3, 4, 2, 1, 5 (d) 4, 1, 5, 2, 3

**84.** For a unity feedback system, open loop, gain is a complex quantity $(x + jy)$ and *M* circles are drawn for different values of '*M*'

(a) $M = 1$ (b) $M = 2$
(c) $M = 3$ (d) $M = 1.6$

**85.** Arrange the following in their order of occurrence from control grid to fluorescent screen

1. Focusing anode
2. Horizontal Deflection Plates
3. Aquadag
4. Pre-accelerating anode
5. Vertical deflection plates

Choose the correct answer from the options given below:

(a) 1, 4, 3, 2, 5 (b) 2, 3, 4, 1, 5
(c) 4, 1, 5, 2, 3 (d) 3, 2, 4, 5, 1

**86.** **Statement I:** For memory capacitors, one of the popular structure is trench capacitor to push memory densities to 64 Mbits and beyond.

**Statement II:** The sides of the trench capacitor are doped $n^+$ and the bottom of the trench has a $p^+$ region, that forms a channel – stop region to isolate adjacent capacitors.

In the light of the above statements, choose the correct answer from the options given below:

(a) Both Statement I and Statement II are true
(b) Both Statement I and Statement II are false
(c) Statement I is correct but Statement II is false
(d) Statement I is incorrect but Statement II is true

**87.** Given below are two statements: One is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

**Assertion (A):** The circuits that are quite stable and relatively insensitive to temperature variations have high stability factors.

**Reason (R):** For a particular configuration, if a change in $I_{CO}$ fails to produce a significant change in $I_C$, the stability factor will be quite small.

In the light of the above statements, choose the correct answer from the options given below:

(a) Both (A) and (R) are true and (R) is the correct explanation of (A).
(b) Both (A) and (R) are true, but (R) is not correct explanation of (A).
(c) (A) is true, but (R) is false
(d) (A) is false, but (R) is true

**88.** Given below are two statements: One is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

**Assertion (A):** In Gunn effect, when electric field is varied from zero to a threshold value. The drift velocity decreases.

**Reason (R):** Beyond the threshold electric field, if the electric field is increased. The drift velocity is decreased and the diode exhibits negative resistance.

In the light of the above statements, choose the correct answer from the options given below:

(a) Both (A) and (R) are true and (R) is the correct explanation of (A).
(b) Both (A) and (R) are true, but (R) is not correct explanation of (A).
(c) (A) is true, but (R) is false
(d) (A) is false, but (R) is true

**89.** Given below are two statements:

**Statement I:** The Hall effect sensor is induced in the magnetic core structure of the current probe.

**Statement II:** The Hall effect sensor assures that the static magnetic flux in the core is exactly zero.

In the light of the above statements, choose the correct answer from the options given below:

(a) Both Statement I and Statement II are true
(b) Both Statement I and Statement II are false
(c) Statement I is correct but Statement II is false
(d) Statement I is incorrect but Statement II is true

**90.** Given below are two statements: One is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

**Assertion (A):** The syndrome depends on both the error pattern and the transmitted code word.

**Reason (R):** All error patterns that differ by a code word have the same syndrome.

In the light of the above statements, choose the correct answer from the options given below:

(a) Both (A) and (R) are true and (R) is the correct explanation of (A).
(b) Both (A) and (R) are true, but (R) is not correct explanation of (A).
(c) (A) is true, but (R) is false
(d) (A) is false, but (R) is true

**Question Numbers: (91 to 95)**

Question Label : Comprehension

Read the Passage and Answer Question 91 – 95:

Charge Couple Device (CCD) can be used either as an image sensor or charge – transfer image sensor. Most common area images use either interline transfer or frame transfer readout architecture. The spacing between CCDs should be small for efficient charge transfer.

**91.** Which semiconductor materials are used to make Charge Couple Device (CCD)?

1. Si
2. Hg Cd Tc
3. Ta
4. In Sb

Choose the correct answer from the options given below:

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

**92.** CCDs have the following characteristics
(a) Low dark current, high – noise
(b) High – voltage operation, low – noise
(c) Poor dynamic range, low – dark current
(d) Good linearity, low – dark current

**93.** Given below are two statements:

**Statement I:** The advantage of frame – transfer readout architecture, compared to the interline, transfer is more efficient light – sensing area.

**Statement II:** For both interline transfer and frame – transfer, all columns advance their charge signals to the horizontal output register simultaneously.

In the light of the above statements, choose the correct answer from the options given below:
(a) Both Statement I and Statement II are true
(b) Both Statement I and Statement II are false
(c) Statement I is correct but Statement II is false
(d) Statement I is incorrect but Statement II is true

**94.** Given below are two statements:

**Statement I:** A line imager with dual output registers has poor read – out speed.

**Statement II:** In the frame transfer scheme, signals are shifted to a storage area away from the sensing area.

In the light of the above statements, choose the correct answer from the options given below:
(a) Both Statement I and Statement II are true
(b) Both Statement I and Statement II are false
(c) Statement I is correct but Statement II is false
(d) Statement I is incorrect but Statement II is true

**95.** **Statement I:** The three basic charge – transfer mechanism in CCD are (a) thermal diffusion, (b) self – induced drift and (c) fringing – field effect.

**Statement II:** For small amount of signal charge, self induced drift is the dominant factor and for a reasonably large charge packet; thermal diffusion is the dominant transfer mechanism.

In the light of the above statements, choose the correct answer from the options given below:
(a) Both Statement I and Statement II are true
(b) Both Statement I and Statement II are false
(c) Statement I is correct but Statement II is false
(d) Statement I is incorrect but Statement II is true

**Read the Passage and Answer Question 96 – 100:**

The ability of the oscillator circuit is to oscillate at one exact frequency is called frequency stability. The frequency of oscillation is an important criterion. Usually the circuits producing sine waves are called oscillators while those generating a square wave, triangular wave and/or sawtooth wave are called generators though both of these can be used interchangeably.

**96.** Which of the following statements are not correct?
1. Rise time of triangular waveform is always equal to its fall time.
2. Sawtooth waveforms have unequal rise and fall times.
3. Triangular wave generator cannot be converted into a sawtooth wave generator.
4. Triangular wave generator can be converted into sawtooth wave generator by injecting a variable DC voltage into the inverting terminal of the integrator.

Choose the correct answer from the options given below:
(a) 3 and 4 only (b) 3 only
(c) 2 only (d) 1 and 2 only

**97.** The frequency of oscillation of a quadrature oscillator having resistance of 100 kΩ and 0.01 μF capacitor is
(a) 100 Hz (b) 159 Hz
(c) 200 Hz (d) 259 Hz

**98.** The equation of frequency of oscillation of a triangular wave generator is given as
(a) $f_0 = \frac{3R_1C_1R_2}{R_3}$ (b) $f_0 = \frac{4R_1C_1R_2}{R_3}$
(c) $f_0 = \frac{R_3}{3R_1C_1R_2}$ (d) $f_0 = \frac{R_3}{4R_1C_1R_2}$

**99.** A triangular wave generator can be formed by connecting
(a) an integrator to square wave generator
(b) a differentiator to square wave generator
(c) a differentiator to quadrature oscillator
(d) an integrator to quadrature oscillator

**100.** Square wave generator is also called
(a) one-shot multivibrator
(b) sample and hold circuit
(c) free-running multivibrator
(d) voltage-to-current converter

■■■■

## Answers UGC NET : 2020 (Exam held on 5th November, 2020)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1. (b) | 2. (d) | 3. (b) | 4. (b) | 5. (d) | 6. (d) | 7. (d) | 8. (c) | 9. (c) | 10. (a) |
| 11. (b) | 12. (b) | 13. (a) | 14. (c) | 15. (b) | 16. (c) | 17. (b) | 18. (c) | 19. (b) | 20. (d) |
| 21. (*) | 22. (a) | 23. (a) | 24. (b) | 25. (b) | 26. (a) | 27. (d) | 28. (c) | 29. (b) | 30. (d) |
| 31. (c) | 32. (c) | 33. (a) | 34. (a) | 35. (b) | 36. (*) | 37. (b) | 38. (d) | 39. (d) | 40. (d) |
| 41. (b) | 42. (c) | 43. (b) | 44. (d) | 45. (d) | 46. (c) | 47. (d) | 48. (a) | 49. (d) | 50. (d) |
| 51. (b) | 52. (c) | 53. (a) | 54. (a) | 55. (a) | 56. (c) | 57. (a) | 58. (a) | 59. (b) | 60. (c) |
| 61. (d) | 62. (a) | 63. (a) | 64. (b) | 65. (c) | 66. (b) | 67. (b) | 68. (d) | 69. (d) | 70. (a) |
| 71. (a) | 72. (a) | 73. (a) | 74. (*) | 75. (a) | 76. (d) | 77. (c) | 78. (c) | 79. (d) | 80. (d) |
| 81. (a) | 82. (a) | 83. (d) | 84. (a) | 85. (c) | 86. (a) | 87. (d) | 88. (d) | 89. (c) | 90. (d) |
| 91. (a) | 92. (d) | 93. (a) | 94. (d) | 95. (c) | 96. (a) | 97. (b) | 98. (d) | 99. (a) | 100. (c) |

## Explanations UGC NET : 2020 (Exam held on 5th November, 2020)

**1. (b)**

In hyper abrupt function of varactor diode, the sensitivity is given by

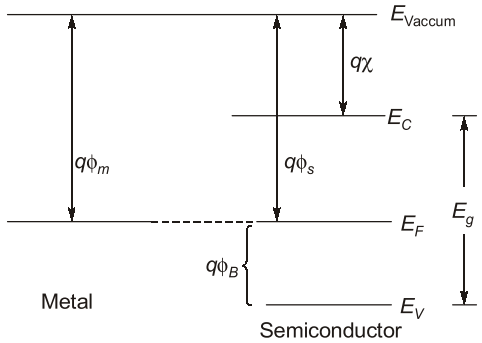
$$S = \frac{1}{m+2}$$

where, $m = -\frac{5}{3}$ given

$$\therefore \quad S = \frac{1}{\frac{-5}{3}+2} = 3$$

**2. (d)**

The metal semiconductor band diagram is given as




From the band diagram, the barrier height $q\phi_{(B_{po})}$ is given by

$$q\phi_{(B_{po})} = Eg - [E_C - E_F]$$
$$= Eg - [q\phi_s - q\chi]] \qquad ...(1)$$

For ideal metal semiconductor contact

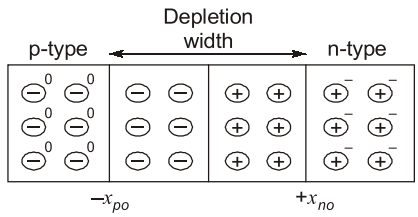
$$\phi_{ms} = 0$$
$$\therefore \quad \phi_m = \phi_s \qquad ...(2)$$
$$\therefore \quad \text{from (1) and (2)}$$
$$q\phi_{(B_{po})} = Eg - q(\phi_m - \chi)$$

**3. (b)**

The Debye length $L_D$ is a characteristic length for semiconductor and is defined as

$$L_D = \sqrt{\frac{\epsilon_s\, kT}{q^2 N}}$$

**4. (b)**




In unbiased condition, the depletion width is given by

$$W = X_{no} + X_{po}$$
$$W_p = \frac{N_D}{N_D + N_A} W$$
$$W_N = \frac{N_A}{N_A + N_D} W$$

Depletion layer width at thermal equilibrium for one-sided abrupt junction is

$$W_D = \sqrt{\frac{2\epsilon_s}{qN}\left(\psi_{bi} - \frac{2kT}{q}\right)}$$

where $\psi_{bi}$ - built in work function.

Thermal voltage is related to the temperature as,

$$V_T = \frac{kT}{q}$$

**5. (d)**

The number of ways in which a Schottky defect can occur in silicon is given by

$$= N_{C_{ns}} = \frac{N!}{N!(N-ns)!}$$

**6. (d)**

In Si-MBE system, operating condition is given as,

$$\text{MFP(cm)} = \frac{5\times10^{-3}}{\rho(\text{torr})}$$

where, MFP = Mean free path

$\rho$(torr) = system pressure

Given MFP = $5 \times 10^7$ cm

$$\therefore \quad \rho(\text{torr}) = \frac{5\times10^{-3}}{5\times10^{7}} = 10^{-10}\ \text{torr}$$

**7. (d)**

The Langmuir technique uses Langmuir probes which is metallic electrode with a well-defined geometry are used to measure the electron plasma density $n_e$, the space potential $V_{SP}$, and the electron temperature $K_BT_e$ in cold low-density plasmas.

**9. (c)**

The circuit is m-derived low pass filter. It is basically a type of electronic filter designed using the image method.

It has Rapid transition from the cut-off frequency of the pass band to a pole of attenuation just inside the stop band.

**10. (a)**

Given, $x[n] = \left(\frac{-1}{3}\right)^n u[n] - \left(\frac{1}{2}\right)^n u[-n-1]$ ...(1)

We know that

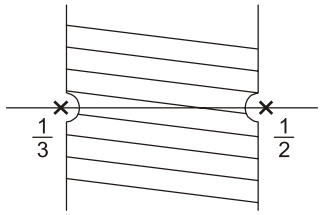
$$a^n u(n) \xrightarrow{ZT} \frac{1}{1-az^{-1}} \quad |z| > |a|$$

$$-a^n u(-n-1) \xleftrightarrow{} \frac{1}{1-az^{-1}} \quad |z| < |a|$$

$\therefore$ Using the above properties and applying *Z.T* on equation (1) we get

$$X(z) = \frac{1}{1-\left[-\frac{1}{3}\right]z^{-1}} + \frac{1}{1-\frac{1}{2}z^{-1}}$$

So, the common ROC is $\frac{1}{3} < |z| < \frac{1}{2}$




**11. (b)**

If function $f(t)$ is said to be half wave symmetry if it satisfies following condition

$f(t) = -f(t - T/2)$

where $T$ is time period of periodic signal.

Hence, if Fourier series expansion of a periodic function with half wave symmetry contains only odd harmonics.

**12. (b)**

$$FT[x(n)] = X(e^{j\omega}) = \sum_{n=-\infty}^{\infty} x(n)\, e^{-j\omega n}$$

We know that

$$x^*[n] \xleftrightarrow{FT} X^*(e^{-j\omega}) = X_1(\omega)$$

then,

$$x^*[-n] \xleftrightarrow{FT} X_1^*(e^{-j\omega}) = X^*[e^{-j(-\omega)}]$$

$$= X^*[e^{j\omega}]$$

**13. (a)**

Given, slew rate $SR$ = 0.5 V/$\mu$ sec

Peak value of undistored sine wave are 10 V and 1 V.

The slew rate for sinusoidal input is given by

$$SR = 2\pi \times f \times V$$

where $f$ is maximum frequency and $V$ is peak voltage.

For $V = 10$ V peak

$$\because \quad f_{max} = \frac{SR}{2\pi V}$$

$$= \frac{0.5 \times 10^6}{2\pi \times 10} = 7957.74 \text{ Hz}$$

$$\therefore \quad f_{max} = 8 \text{ kHz}$$

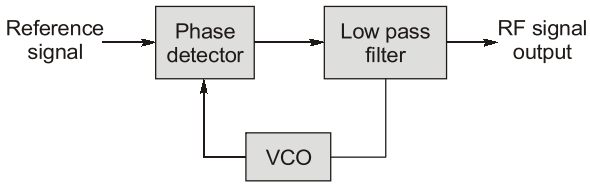
For $V = 1$ V peak

$$f_{max} = \frac{SR}{2\pi V} = \frac{0.5 \times 10^6}{2\pi \times 1} = 79557.4747$$

$$\therefore \quad f_{max} = 80 \text{ kHz}$$

**14. (c)**

The phase-locked loop (PLL) consists of VCO (Voltage controlled oscillator), phase detector and low-pass filter.




**15. (b)**

Relation between $T_j$ and $T_A$ is given as

$$T_j = T_A + [R_{\theta JA} \times P_D]$$

$R_{\theta JA}$ = Total thermal resistance i.e. function to ambient thermal resistance.

$$R_{\theta JA} = \theta_{JC} + \theta_{CS} + \theta_{SA}$$

$$\therefore \quad P_D = \frac{T_j - T_A}{R_{\theta JA}} = \frac{T_j - T_A}{\theta_{JC} + \theta_{CS} + \theta_{SA}}$$

**16. (c)**

$$V_{ref} = (\text{Resolution}) \times \left( \begin{matrix} \text{Decimal equivalent} \\ \text{of binary data} \end{matrix} \right)$$

$$V_{ref} = \left( \frac{V_{fs}}{2^n - 1} \right) \times (2^{n-1} + 2^{n-2} + \ldots + 2^1 + 2^0)$$

$$\therefore \quad V_{ref} = 2^n [V_{fs}] / 2^n - 1$$

$$\therefore \quad V_{fs} = \frac{2^n - 1}{2^n} V_{ref}$$

$$\therefore \quad V_{fs} = V_{ref} \left( 1 - \frac{1}{2^n} \right)$$

**17. (b)**

CPLD

1. It is a logic device that consists of multiple SPLD's interconnected on a single chip and also consists of multiple group of PAL with programmable interconnection.
2. It is used to implement large logic function.

**18. (c)**

Given data bits = 1101

So, $d_1 = 1$

$d_2 = 1$

$d_3 = 0$

$d_4 = 1$

and for (7,4) Hamming code there are three parity bit i.e., $P_1\ P_2\ P_3$

So, $P_1 = d_1 \oplus d_2 \oplus d_4 = 1 \oplus 1 \oplus 1 = 1$

$P_2 = d_1 \oplus d_4 \oplus d_3 = 1 \oplus 1 \oplus 0 = 0$

$P_3 = d_2 \oplus d_4 \oplus d_3 = 1 \oplus 1 \oplus 0 = 0$

$\therefore$ The final code is in format of

| $P_1$ | $P_2$ | $d_1$ | $P_3$ | $d_2$ | $d_3$ | $d_4$ |
|---|---|---|---|---|---|---|
| 1 | 0 | 1 | 0 | 1 | 0 | 1 |

**20. (d)**

The characteristic equation of output given in (d) option.

$Z(t) = g\{s(t) \cdot x(t)\}$ where $s(t)$ represent present state, $x(t)$ indicate present input is false because the output depend on present state as well as present input but in Moore machine o/p is only function of present state.

**21. (*)**

MOV A, #85H ; A ← 85H

CPL A ; Complement each bit

ADD A, # {This is not valid instruction}

So, there is error in question.

**22. (a)**

$$\frac{\text{rpm} \times \text{spr}}{60} = \frac{\text{rev}}{\text{min}} \times \frac{\text{steps}}{\text{rev}} \times \frac{1}{60}$$

$$\therefore \quad \text{SPS} = \frac{rpm \times spr}{60}$$

**23. (a)**

8051 microcontroller has 5 interrupt signals, i.e., 1NTO, TF0, 1NT1, TF1, RT/T1

Each interrupt can be enabled or disabled by setting bits of IE register and the whole interrupt system can be disabled by clearing the EA bits of the same register.

**24. (b)**

In register indirect addressing mode, the operand's offset is placed in any one of the registers BX, BP, SI and DI as specified in the instruction.

**25. (b)**

The characteristic impedance is given by

$$Z_0 = \sqrt{Z_{sc}Z_{oc}}$$

where, $Z_{sc}$ = Short circuit impedance

$Z_{oc}$ = Open circuit impedance

Given, $Z_{oc} = 15° \angle 25° \ \Omega$

and $Z_{SC} = 37.5 \angle -35° \ \Omega$

$$\therefore \quad Z = \sqrt{150 \times 37.5 \angle (25° - 30°)}$$

$$= \sqrt{150 \times \frac{75}{2} \angle -10°}$$

$$Z = \sqrt{75 \times 75} \angle -5°$$

$$Z = 75 \angle -5° \ \Omega$$

**26. (a)**

The phase velocity is given by,

$$V_p = \frac{C}{\sqrt{1-\left(\frac{f_c}{f}\right)^2}}$$

where,

$f_c$ = cut-off frequency $= \frac{C}{2a} = \frac{3 \times 10^8}{2 \times 7 \times 10^{-2}}$

$$f_c = 2.142 \text{ GHz}$$

frequency of operation ($f$) = 3.5 GHz

$$\therefore \quad V_p = \frac{3 \times 10^8}{\sqrt{1-\left(\frac{2.142}{3.5}\right)^2}}$$

$$V_p = 3.78 \times 10^8 \text{ m/sec}$$

**28. (c)**

Given, $r_1 = 30$ cm

$\rho_0 = 20$ pc/m$^3$

$$\rho_v = \frac{\rho_r}{r_1}$$

By using Gauss law,

$$Q = \int_V \rho_v dv$$

$$Q = \int_0^{2\pi}\int_0^{\pi}\int_0^{r} \frac{\rho_o}{r_1} r^2 \sin\theta \, dr \, d\theta \, d\phi$$

$$Q = \frac{\rho_0}{r_1}\int_0^{2\pi} d\phi \int_0^{\pi} \sin\theta \, d\theta \int_0^{r_1} r^3 dr$$

$$Q = \frac{\rho_0}{r_1}[2\pi] \cdot [-\cos\theta]_0^{\pi}\left[\frac{r^4}{4}\right]_0^{r_1}$$

$$Q = \frac{2\pi\rho_0}{r_1}[2]\left[\frac{r_1^4}{4}\right]$$

$$Q = \pi\rho_0 r_1^3$$

$$\therefore \quad Q = \pi \times 200 \times [30 \times 10^{-2}]^3$$

$$Q = 16.964 \text{ pC}$$

$$Q \cong 17 \text{ pC}$$

**29. (b)**

The power relation in VSB modulation is given by

$$P_t = \frac{\mu^2}{4}P_c + F\left[\frac{\mu^2}{4}P_c\right]$$

where $\mu$ = modulation index

$F$ = represents a fraction = 0.25

$\therefore$ Given, $P_t = 0.625$

$\mu = 0.6$

$$\therefore \quad 0.625 = \frac{(0.6)^2}{4}P_c[1+0.25]$$

$$\therefore \quad P_c = 5.50 \text{ kW}$$

**30. (d)**

Dispersion is defined as separating light into its component frequencies.

**31. (c)**

Given, Number of channel(n) = 10

B.W of each channel ($f_m$) = 50 kHz

Guard BW (G) = 1 kHz

In FDM,

Minimum bandwidth = $nf_m + (n-1)G$

required for transmission

$= 10 \times 50 + 9 \times 1$

$= 509$ kHz

**32. (c)**

Frequency reuse is the main objective of CELL in a cellular mobile system.

**33. (a)**

Since $V_{BE(sat)} > V_{CE(sat)}$

Therefore transistor is in saturation region.

From the give circuit,

$$I_C = \frac{V_{CC} - V_{CE(sat)}}{R_C} = \frac{200 - 1}{11} = 18.09 \text{ A}$$

and, $I_C = \beta I_{BS}$

Saturation base current,

$$I_{BS} = \frac{18.09}{8} = 2.26 \text{ A}$$

Due to overdrive factor

$$I_B = I_{BS} \times \text{ODF} = 2.26 \times 5 = 11.3 \text{ A}$$

Now, power loss

$$P = V_{BE} I_B + V_{CE} I_C$$

$$P = (11.3 \times 1.5) + (1 \times 18.09)$$

$$P = 35.04 \text{ Watts}$$

**34. (a)**

We know that,

The torque per phase under running condition is given by,

$$\frac{T_r}{\text{phase}} = \frac{SE_2^2 R_2}{R_2^2 + (SX_2)^2}$$

$$\frac{T_r}{\text{phase}} = \frac{0.04 \times (415)^2 \times 1}{1^2} \quad [\because X_2 = 0\ \Omega]$$

$$\frac{T_r}{\text{phase}} = 6889 \text{ syn. watts}$$

**35. (b)**

Effect of negative feedback.

1. If reduces the overall gain of the system with the degree of reduction being related to the open-loop gain.
2. It reduces distortion noise, sensitivity to external change, as well as improves the system bandwidth and input and output impedance.
3. It stabilizes the control system by counteracting the changes due to any reason.

**36. (*)**

Incomplete question

$$e_{ss} = \lim_{s \to 0} \frac{sR(s)}{1 + G(s)H(s)}$$

For $e_{ss}$ (steady state error) there should be information of input signal $R(s)$.

**37. (b)**

For dual-slope integrating type A/D converter the output voltage is given as

$$V_{0_{max}} = \frac{V_{ref}}{RC} t$$

Given, $V_{0_{max}} = 10 \text{ V}$

$V_{ref} = 2 \text{ V}$

$R = 100 \text{ k}\Omega$

$C = 0.1 \ \mu\text{F}$

$$\therefore \quad t = \frac{V_{0_{max}} RC}{V_{ref}}$$

$$= \frac{10 \times 0.1 \times 10^{-6} \times 100 \times 10^3}{2}$$

$$t = 50 \text{ msec}$$

**39. (d)**

The common causes for error in thermocouple are

1. Inherent variation in alloys.
2. Temperature variations around the reference function.
3. Thermocouple ageing
4. Thermocouple grounded at more than one location.
5. Selecting the wrong type of thermocouple on transmitter.
6. Problems related to thermocouple extension wire.

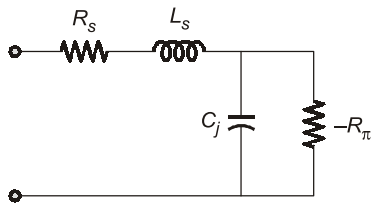
**40. (d)**

The important characteristics of thermistors are

1. The voltage – current characteristic
2. the current - time characteristic
3. the resistance - temperature characteristic

**42. (c)**

The small signal model of tunnel diode




$R_s$ = Series resistance

$L_s$ = Series inductance

$C_j$ = Junction capacitance

$-R_\pi$ = negative resistance

**43. (b)**

In EMP and STEM techniques beam of electrons is used as a probe and the secondary radiation in X-ray.

**45. (d)**

- CVD stands for chemical vapor deposition. It is a process used to produce this films of semiconductor materials.
- The deposition of required materials is obtained by exposing the substrate to the volatile precursors which decompose on the surface of the substrate to produce the deposit.

**46. (c)**

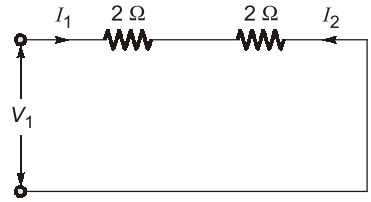
The Y parameter for the two port network is

$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

$$Y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2 = 0}$$

$$Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2 = 0}$$

So, we make $V_2 = 0$, so $I = 2\ V_2 = 0$



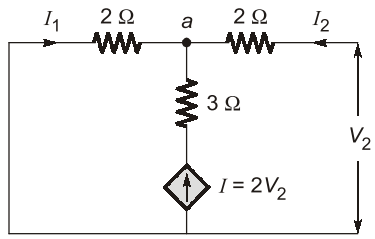

$\therefore \quad I_1 = -I_2$

$V_1 = 4I_1$

So, $Y_{11} = \frac{1}{4}\mho$ and $Y_{21} = \frac{-1}{4}\mho$

Now, we will calculate $Y_{12}$ and $Y_{22}$

So make $Y = 0$




KCL at A

$-I_1 - 2V_2 - I_2 = 0$

$I_1 + 2V_2 + I_2 = 0 \quad \ldots(1)$

$$\frac{V_a}{2} - 2V_2 + \frac{V_a - V_2}{2} = 0$$

$$V_a = \frac{5}{2}V_2$$

$$I_1 = -\frac{V_a}{2} = \frac{-5}{4}V_2$$

$$\frac{V_a - V_2}{2} = -I_2 = \frac{(5/2)V_2 - V_2}{2}$$

$$-I_2 = +\frac{3}{4}V_2$$

$$-I_2 = \frac{-5}{4}\Omega$$

$$Y_{12} = \frac{-5}{4}\mho$$

$$Y_{22} = \frac{-3}{4}\mho$$

**47. (d)**

- All the links of a tree constitute the complement of the corresponding tree. Thus, statement (1) is wrong.
- A tree contains all the nodes of the graph. Thus, statement (2) is also wrong.
- Every tree has at least two terminal nodes. Thus, statement (4) is correct.
- Every connected graph has atleast one tree. Thus, statement (5) is also correct.

**48. (a)**

- Precision rectifier do not uses positive feedback.
- In comparators both positive or negative feedback is used for improving performance.

**49. (d)**

Op-amps are both internally and externally compensated to avoid unintentional creation of positive feedback, which will cause the amplifier to oscillate and to improve the bandwidth of the signal pole system.

**51. (b)**

The propagation delay is the parameters that is used to determine the operating speed of the logic family.

It is defined as the average transition delay for the signal to propagate from the input to output when the binary input signal changes its value.