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ENTRANCE EXAMINATIONS June, 2010.
QUESTION PAPER

Ph.D. (Electronics Science)

Marks: 75
Time: 2.00 hrs. Hall Ticket No.:

I. Please enter your Hall Ticket Number on the question paper and on the answer sheets without fail.

II. Read carefully the following instructions:

1. This Question Paper has Three Parts: Part-A, Part-B1 and Part-B2.
2. Part-A consists of 25 objective type questions of one mark each.
There is negative marking of 0.33 marks for every wrong answer. The marks obtained by the candidates in this part will be used for resolving tie cases.
3. Part-B consists of two sub-parts of objective type questions of 2 marks each: B1 (questions 26 to 50) and B2 (questions 51 to 75). There are no negative marks in Part B.
4. Questions in B1 are designed for candidates with an M.Sc. background
5. Questions in B2 are designed for candidates with an Engineering background
6. Candidates are, however, free to answer questions from either PART- B1 or Part- B2, irrespective of their qualifying degree.
7. Please note that in addition to marks from Part-A, marks from only one of the Parts (B1 or B2) will be considered.
8. Answers for these questions are to be marked on the OMR answer sheets using black ink pen as shown: (A) (B) ● (D)
9. Handover both the question paper booklet and OMR answer sheets at the end of the examination.
10. Calculators are permitted. Logarithmic Tables are not allowed.

This book contains 21 printed pages

Values of physical constants.
$c = 3 \times 10^{8}\ m/s$; $h = 6.63 \times 10^{-34}\ J.s$; $k_B = 1.38 \times 10^{-23}\ J/K$; $m_e = 9.1 \times 10^{-31}$ kg
$e = 1.6 \times 10^{-19}\ C$; $\mu_o = 4\pi \times 10^{-7}\ henry/m$; $\varepsilon_o = 8.85 \times 10^{-12}\ farad/m$;

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PART-A

1. The phase difference between the input and output of an integrator is

   A. 0 degree
   B. 90 degrees
   C. 360 degrees
   D. 180 degrees

2. If the gain of an Op-Amp is 104dB, then its linear gain is

   A. 104
   B. 1040
   C. 15.85×10^3
   D. 158.5×10^3

3. The cut off frequency of an active high pass filter with an input capacitance of 0.05 microfarad and a feed back resistance of 2.1 KΩ is

   A. 15 KHz
   B. 150 Hz
   C. 150 KHz
   D. 1.5 KHz

4. A positive logic two input AND gate is equivalent to a

   A. Negative logic two input OR gate
   B. Positive logic two input NAND gate
   C. Negative input XOR gate
   D. Negative logic INVERTER

5. If $F = (A\ XNOR\ B)\ XOR\ (A\ XOR\ B\ XOR\ C)$ and $A = 1$, $B = 1$, $C = 0$ then the output F will be

A. 1
B. 0
C. Don't care
D. High Impedance state

6. The dual of the Boolean expression $1.A + \overline{B}.C + 0$ is

A. $(0 + \overline{A})(B + \overline{C}).1$
B. $(1.\overline{A}) + (B.\overline{C}) + 0$
C. $(0 + A)(\overline{B} + C).1$
D. $(1 + \overline{A}) + (B + \overline{C}) + 0$

7. In a digital circuit the static power consumption is due to

A. Leakage Current
B. Switching of transistor.
C. Leakage current and Switching of transistor.
D. Heating of components

8. Match the following

Group A	Group B
P: Shift register	1: Frequency division
Q: Counter	2: Addressing memory chip
R: Decoder	3: Serial to parallel data conversion

A. P-1, Q-2, R-2
B. P-2, Q-1, R-3
C. P-3, Q-1, R-2
D. P-3, Q-2, R-1

9. If two LTI systems are cascaded and characterized by their impulse responses $h_1(n)$ and $h_2(n)$ respectively, then the LTI system $h_2(n)$ is said to be the inverse of LTI system $h_1(n)$ if

A. $h_1(n) \times h_2(n) = 1$
B. $h_2(n) / h_1(n) = 1$
C. $h_1(n) \otimes h_2(n) = 1$
D. $h_1(n) + h_2(n) = 1$

10. The computation of the N-point Discrete Fourier Transform (DFT) of a signal requires

A. N^2 complex multiplications and $N(\log_2 N)$ additions
B. $N(\log_2 N)$ complex multiplications and N complex additions
C. N(N-1) complex multiplications and N^2 complex additions
D. N^2 complex multiplications and N(N-1) complex additions

11. The value of the definite integral $\int_0^1 \frac{y dy}{(1+y^2)}$ is

A. 1
B. (½)log2
C. π/4
D. log2

12. The expression $[x + (x^3-1)^{1/2}]^5 + [x - (x^3-1)^{1/2}]^5$ is a polynomial of degree

A. 8
B. 7
C. 6
D. 5

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13. If $e^x=y^2$ then dy/dx =
    A. (ln x)/2
    B. $e^x/2$
    C. $e^{x/2}/2$
    D. $e^{2x}/2$

14. Rutherford's experiment on scattering of alpha particles passing through thin gold foils indicates that

    A. Electrons in an atom are negatively charged
    B. Coulomb forces hold electron and nucleus in an atom
    C. Positive charge of the atom is concentrated at its nucleus
    D. Atom is a small dense positively charged nucleus surrounded by planetary electrons

15. Zeeman effect observed in the emission spectrum of a source of radiation (*e.g.* mercury) refers to

    A. Splitting of single spectral lines into 3 or more polarized components when source is placed in an electric field
    B. Electric dipole transitions in a hydrogen atom
    C. Splitting of single spectral lines into 3 or more polarized components when source is placed in a magnetic field
    D. Magnetic dipole transitions in a helium atom

16. If an electromagnetic wave is incident on a dielectric – conductor interface at a certain angle θ, then the angle between the interface and non-zero electric field E will always be

    A. 45°
    B. 0°
    C. 60°
    D. 90°

17. The current gain of a common collector amplifier is

A. $-h_{fe}$
B. -1
C. h_{fe}
D. +1

18. The radiation resistance of an antenna is

A. Resistance offered by an antenna
B. Resistance offered by free space to propagating waves
C. Coupling resistance between free space and antenna
D. Coupling resistance offered by objects in the vicinity of an antenna

19. If diamond is doped with boron then the resultant semiconductor would be

A. n-type
B. p-type
C. intrinsic
D. neither – it is an insulator

20. Holes are

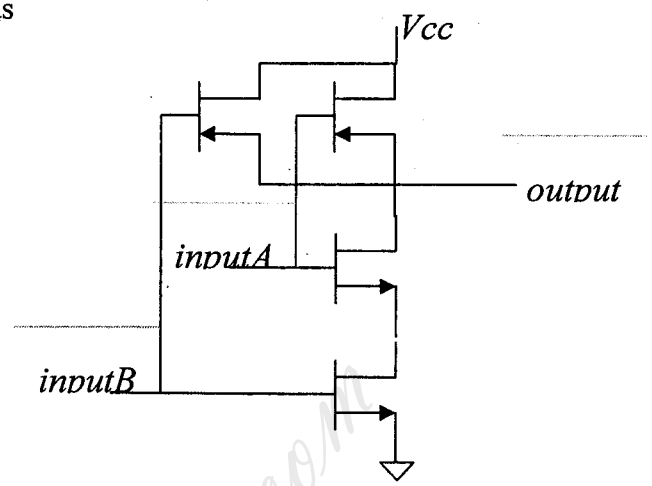
A. Pseudo particles representing conduction due to electrons of a valence band with few empty states
B. Real positively charged particles that contribute to current
C. Real negatively charged particles that contribute to current
D. Real positively charged particles that do not contribute to current.

21. The position of the Fermi level in the band gap of p-type, n-type and intrinsic semiconductors are respectively,

A. Near conduction band, near valence band and near middle of the gap respectively.
B. In the middle of the band gap in all cases.
C. Near middle of the gap, near conduction band and near valence band respectively.
D. Near valence band, near conduction and near middle of the gap respectively.

22. The following circuit functions as

A. NAND
B. OR
C. AND
D. NOR



23. If a plane electromagnetic wave satisfies the equation $\frac{\partial^2 E_x}{\partial x^2} = c^2 \frac{\partial^2 E_x}{\partial t^2}$, the wave propagates in the

A. x-direction
B. z-direction
C. y- direction
D. xy- plane at an angle of 45° between the x and the z directions

24. The dominant mode in a rectangular waveguide is TE_{10}, because this mode has,

A. No attenuation
B. No cut-off
C. The highest cut- off wavelength
D. No magnetic field component

25. The scattering matrix is used to describe the behaviour of a circuit where

A. Voltage and current values at various nodes are known
B. Only power is directly measurable
C. The impedance values at various nodes are known
D. A short or open is present in the circuit

PART – B1

26. If in an Op-amp the slew rate = 2 V/microsecond, then the maximum closed loop voltage gain when the input signal varies by 0.5 V in 10 microseconds is

A. 1
B. 10
C. 40
D. 5

27. Which of the following is true for the characteristic of a master-slave JK flip flop?

A. A change in the input state immediately reflects in the output
B. A change in the output occurs only when the state of the master is affected
C. A change in the output occurs only when the state of the slave is affected
D. Both the master and slave states are simultaneously affected.

28. If the electric field intensity associated with a uniform plane electromagnetic wave travelling in a perfect dielectric medium is given by $E(z,t) = 10 \cos (2\pi \times 10^7 t - 0.1\pi z)$ volt/m, then the velocity of the travelling wave is

A. 3.00×10^8 m/sec
B. 2.00×10^7 m/sec
C. 2.00×10^8 m/sec
D. 6.28×10^7 m/sec

29. An air filled rectangular metallic waveguide has the inside dimensions of 3.0cm x 1.2cm. The impedance offered by the waveguide to the TE modes at 10GHz is

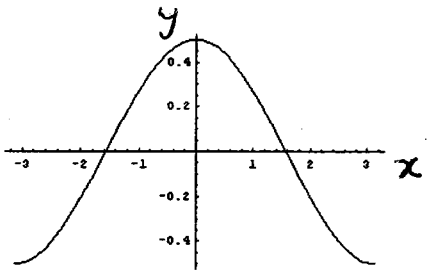
A. 377Ω
B. 37.7 Ω
C. 436 Ω
D. 872 Ω

30. Which of the following is true for the transfer function

$$H(z) = \frac{1}{(1-0.9z^{-1})(1-0.6z^{-1})}$$

A. It is stable because magnitude of each zero is less than 1
B. It is stable because magnitude of each pole is less than 1
C. It is unstable because magnitude of each zero is less than 1
D. It is unstable because magnitude of each pole is less than 1

31. The function corresponding to the graph shown below is

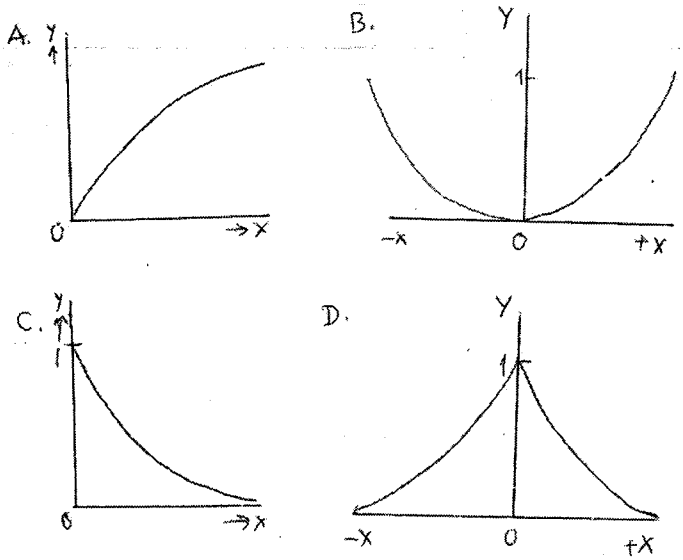


A. $y = \cos(x)/2$
B. $y = \cos(x/2)$
C. $y = \cos(2x)$
D. $y = 0.5\sin(x)$

32. Eigenvalues of $A = \begin{bmatrix} 0 & i \\ i & 0 \end{bmatrix}$ are

A. real and distinct
B. complex and coincident
C. complex and distinct
D. real and coincident

33. The graph of $y = e^{-x}$ for $-\infty < x < \infty$ is



34. Light from a discharge tube containing hydrogen atoms falls on the surface of a piece of sodium. If the kinetic energy of the fastest photoelectrons emitted from sodium is 0.73 eV and the work function of sodium is 1.82 eV, the recoil velocity of the emitting atom(at rest initially) is

A. 184 m/sec
B. 0.814 m/sec
C. 8.14 m/sec
D. 1840 m/sec

35. If a laser emits photons of energy 2.5 eV with a power of 10^{-3}W then the number of photons emitted in one second are

A. 1.0×10^{20}
B. 1.0×10^{19}
C. 1.0×10^{18}
D. 1.0×10^{21}

36. In a computer monitor, electrons approach the screen at 1.20×10^8 m/s. What is the de-Broglie wavelength of these electrons?

A. 4.31×10^{-12} m
B. 5.56×10^{-12} m
C. 6.07×10^{-12} m
D. 6.62×10^{-12} m

37. If the mobility of charge carriers in n-Germanium having a resistivity of 0.1 ohm-m at 300K is 0.38 m^2/V-s then the acceptor concentration in the sample is

A. $0.64 \times 10^{20}/m^3$
B. $1.64 \times 10^{20}/m^3$
C. $1.64 \times 10^{21}/m^3$
D. $0.64 \times 10^{18}/m^3$

38. A source follower uses a FET with a drain resistance (r_d) = 50 kilo ohms, and g_m = 0.003 mho. If the load resistance (R_s) is 500 ohms then the voltage gain A_v and the output resistance R_o are,

A. 9.32 and 500 ohms respectively
B. 0.932 and 50K-ohms respectively
C. 1 and 333 ohms respectively
D. 0.932 and 333 ohms respectively

39. If a task in a processor that operates at 50 MHz takes 2000 instructions for execution and the average number of clock cycles per instruction is 5, then the time required to execute the task is

A. 8 μsec.
B. 200 μsec.
C. 2000 μsec.
D. 10000 μsec.

40. The Ebers-Moll model is used to describe the working of a

A. JFET
B. MOSFET
C. Junction Diode
D. BJT

41. If the intercepts of a plane on the *a,b,c* axes of a crystal are ½,1, 1/3 then the Miller indices are

A. 1 2 3
B. 2 1 3
C. 3 2 1
D. ½ 1 1/3

42. If the Miller indices of a set of planes in a cubic crystal is (200) and their interplanar spacing is 2.8Å, then the lattice parameter of the crystal is

A. 2.8 Å
B. 1.4 Å
C. 7.84 Å
D. 5.6 Å

43. Which of the following is NOT true for current due to the drift of charge carriers?

A. It appears only in the presence of an applied electric field
B. Velocity of carriers is proportional to the applied electric field
C. It is proportional to the mobility of charge carriers
D. Velocity of charge carriers is proportional to the logarithmic derivative of the density of charge carriers

44. Which one of the following techniques can be used to image a surface consisting of 10 nm diameter particles?
    A. Optical microscopy
    B. Transmission electron microscopy
    C. X ray diffraction
    D. X ray photoelectron spectroscopy

45. An n-type semiconductor has a dopant density of 1 $x10^{14}$ cm^{-3}. If it has a resistivity of 10 ohm-cm, then the magnitude of the average carrier velocity in an applied electric field of 1kV/cm is

    A. 625 km/s
    B. 625 m/s
    C. 625 cm/s
    D. 6250 km/s

46. A current of 10 mA is passed through a block of a n type semiconductor with dopant concentration of 10^{13} cm^{-3} and a magnetic field of 0.1 Tesla is applied in a direction perpendicular to the current. What is the electric field developed perpendicular to both? (dimensions along magnetic field and the measured electric field are 5mm and 0.1 mm respectively).

    A. 13.5 x 10^{10} V/m
    B. 13.5 x 10^{10} V/cm
    C. 1.25 kV/cm
    D. 1.25 kV/m

47. If in a junction diode the doping in the n-region is increased by four times and the doping in the p-region is decreased by four times then the

    A. Width of depletion region in both regions will halve
    B. Width of depletion region in the n-region will decrease by 4 times and that in the p-region will increase by 4 times
    C. Width of depletion region in n-region will double and that in the p region will halve
    D. Width of depletion region in n region will halve and that in the p-region will double.

48. A material has conductivity of 10^{-2} mho/m and a relative permittivity of 4. The frequency at which the conduction current is equal to the displacement current is

    A. 45 MHz
    B. 300 MHz
    C. 90 MHz
    D. 450 MHz

49. In an n-p-n transistor if the emitter collection efficiency is 0.98 then the current gain is

    A. 98.
    B. 50
    C. 46
    D. 100.

50. A uniform plane electromagnetic wave incident normally on a plane surface of a dielectric material is reflected with a VSWR of 3. What is the percentage of incident power that is reflected?

    A. 10%
    B. 50%
    C. 25%
    D. 75%

PART - B2

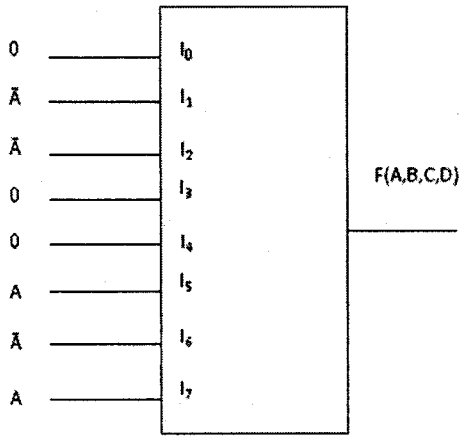
51. If in an Op-amp the slew rate = 2 V/microsecond, then the maximum closed loop voltage gain when the input signal varies by 0.5 V in 10 microseconds is

A. 1
B. 10
C. 5
D. 40

52. Which of the following is true for the characteristic of a master-slave JK flip flop

A. A change in the input state immediately reflects in the output
B. A change in the output occurs only when the state of the slave is affected
C. Both the master and slave states are simultaneously affected.
D. A change in the output occurs only when the state of the master is affected

53. The output *F (A,B,C,D)* of the 8:1 MUX given below is



A. $F = \Sigma(1,2,6,13,15)$
B. $F = \Sigma(1,2,6,7,13)$
C. $F = \Sigma(1,3,6,7,8)$
D. $F = \Sigma(1,3,5,6,9,11)$

54. If the output *y(n)* and input *x(n)* of a system in time domain are characterized by

$y(n) = x(n/L)$ *for* $n=0,\pm L,\pm 2L,\pm 3L....$
$= 0$ otherwise

then in the frequency domain, the output is

A. $Y(e^{j\omega}) = X(e^{jL\omega})/L$
B. $Y(e^{j\omega}) = LX(e^{j\omega})$
C. $Y(e^{j\omega}) = X(e^{j\omega/L})$
D. $Y(e^{j\omega}) = X(e^{jL\omega})$

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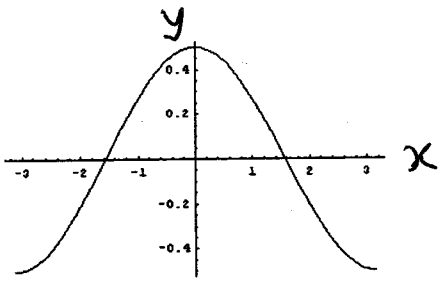
55. Which of the following is true for the transfer function

$$H(z) = \frac{1}{(1-0.9z^{-1})(1-0.6z^{-1})}$$

A. It is stable because magnitude of each zero is less than 1
B. It is unstable because magnitude of each zero is less than 1
C. It is stable because magnitude of each pole is less than 1
D. It is stable because magnitude of each pole is less than 1

56. The function corresponding to the graph shown below is



A. $y = \cos(x/2)$
B. $y = \cos(2x)$
C. $y = \cos(x)/2$
D. $y = 0.5\sin(x)$

57. Eigenvalues of $A = \begin{bmatrix} 0 & i \\ i & 0 \end{bmatrix}$ are

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B. complex and distinct
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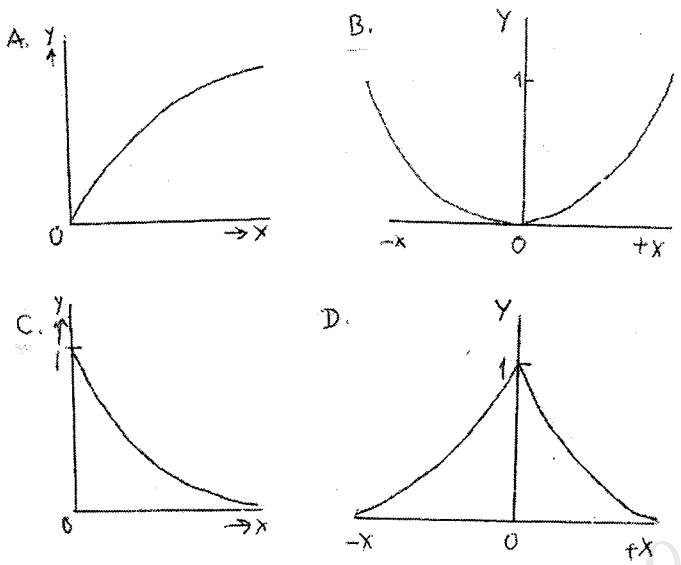
58. The graph of $y = e^{-x}$ for $-\infty < x < \infty$ is



59. A band limited signal is sampled at the Nyquist rate. The original signal can be recovered by passing the sampled signal through

A. An ideal low-pass filter with appropriate bandwidth
B. An RC filter
C. A band pass filter
D. A PLL

60. If a laser emits photons of energy 2.5 eV with a power of 10^{-3}W then the number of photons emitted in one second are

A. 1.0×10^{20}
B. 1.0×10^{19}
C. 1.0×10^{18}
D. 1.0×10^{21}

61. In a computer monitor, electrons approach the screen at 1.20×10^8 m/s. What is the de Broglie wavelength of these electrons?

A. 4.31×10^{-12} m
B. 6.62×10^{-12} m
C. 5.56×10^{-12} m
D. 6.07×10^{-12} m

62. A transmission line is distortion- less if (where R, G, L and C are resistance, conductance, Inductance and capacitance per unit length respectively)

A. RL = 1/GC
B. RL=GC
C. LG=RC
D. RG=LC

63. A source follower uses a FET with a drain resistance (r_d) = 50 kilo ohms, and g_m = 0.003 mho. If the load resistance (R_s) is 500 ohms then the voltage gain A_v and the output resistance R_o are,

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B. BJT
C. MOSFET
D. Junction Diode

66. If the intercepts of a plane on the *a,b,c* axes of a crystal are ½,1, 1/3 then the Miller indices are

A. 1 2 3
B. 2 1 3
C. 3 2 1
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67. If the Miller indices of a set of planes in a cubic crystal is (200) and their interplanar spacing is 2.8Å, then the lattice parameter of the crystal is

A. 2.8 Å
B. 1.4 Å
C. 7.84 Å
D. 5.6 Å

68. Which of the following is NOT true for current due to the drift of charge carriers

A. Velocity of charge carriers is proportional to the logarithmic derivative of the density of charge carriers
B. It appears only in the presence of an applied electric field
C. Velocity of carriers is proportional to the applied electric field
D. It is proportional to the mobility of charge carriers

69. For a transmission line, the attenuation is given as 0.3dB/km. After 10km, the power available will be what fraction of input power?

A. 1/2
B. ¼
C. 1/10
D. 1/3

70. An n-type semiconductor has a dopant density of 1 x10^{14} cm^{-3}. If it has a resistivity of 10 ohm-cm, then the magnitude of the average carrier velocity in an applied electric field of 1kV/cm is

A. 625 m/s
B. 625 cm/s
C. 625 km/s
D. 6250 km/s

71. A current of 10 mA is passed through a block of a n type semiconductor with dopant concentration of 10^{13} cm^{-3} and a magnetic field of 0.1 Tesla is applied in a direction perpendicular to the current. What is the electric field developed perpendicular to both? (dimensions along magnetic field and the measured electric field are 5mm and 0.1 mm respectively).

A. 13.5 x 10^{10} V/m
B. 1.25 kV/m
C. 13.5 x 10^{10} V/cm
D. 1.25 kV/cm

72. If in a junction diode the doping in the n-region is increased by four times and the doping in the p-region is decreased by 4 times then the

A. Width of depletion region in n region will halve and that in the p-region will double.
B. Width of depletion region in both regions will halve
C. Width of depletion region in the n-region will decrease by 4 times and that in the p-region will increase by 4 times
D. Width of depletion region in n region will double and that in the p region will halve

73. In an n-p-n transistor if the emitter collection efficiency is 0.98 then the current gain is

A. 98.
B. 46
C. 50
D. 100.

74. If the dc output voltage with no load attached to power supply is 200 V and it is 150 V at full load then the percentage of voltage regulation is

A. 33%
B. 25%.
C. 50%
D. 75%.

75. A video transmission system transmits 625 picture frames per second. Each frame consists of a 400 x 400 pixel grid with 64 intensity level per pixel. The data rate of the system is

A. 6.8 Gbps
B. 16 Mbps
C. 100 Mbps
D. 680 Mbps

END OF QUESTION PAPER