Code No.	T – 2140

Entrance Examination for Admission to the M.Tech. Courses in the Teaching Departments, 2024

CSS

ELECTRONICS AND COMMUNICATION (OPTO ELECTRONICS AND OPTICAL COMMUNICATION)

General Instructions

1. The Question Paper is having 100 Objective Questions, each carrying one mark.
2. The answers are to be (✓) 'tick marked' **only** in the "**Response Sheet**" provided.
3. **Negative marking** : **0.25 marks** will be deducted for each wrong answer .

Time : 2 Hours **Max. Marks : 100**

To be filled in by the Candidate									
Register Number	in Figures								
	in words								

Choose appropriate answer from the options in the questions.

(100 × 1 = 100 marks)

1. The single particle density of states of a free electron gas with particle energy E is proportional to

   A. E B. $E^{1/2}$

   C. E^{2} D. $E^{2/3}$

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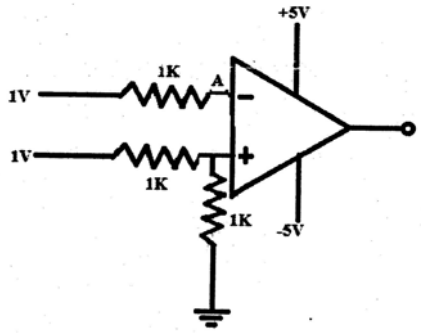
2. In the operational amplifier circuit below, the voltage at point A is



A. 1.0 V
B. 0.5 V
C. 0 V
D. –5.0 V

3. The wavelength of Ruby laser is

A. 633 nm B. 694 nm

C. 514 nm D. 532 nm

4. The number of distinct ways of placing four indistinguishable balls into five distinguishable boxes is

A. 50 B. 60

C. 70 D. 100

5. An LED operates at 1.5 V and 5 mA in forward bias. Assuming an 80% external efficiency of the LED, how many photons are emitted per second?

A. 5.0×10^{16} B. 1.5×10^{16}

C. 0.8×10^{16} D. 2.5×10^{16}

6. The basic memory element in a digital circuit consists of a

A. NAND gate B. NOR gate

C. FLIP-FLOP D. Shift register

7. Esaki diode is also known as

A. Gunn diode B. Tunnel diode

C. Laser diode D. Zener diode

8. The c/a ratio for an ideal hexagonal close packed structure is

A. $\frac{2}{\sqrt{3}}$ B. $\sqrt{8}$

C. $\sqrt{5}$ D. $\frac{\sqrt{8}}{3}$

9. Band-pass and band-reject filters can be implemented by combining a low pass and a high pass filter in series and in parallel, respectively. If the cut-off frequencies of the low pass and high pass filters are ω_0^{LP} and ω_0^{HP} respectively, the condition required implement the band-pass and band-reject filters are respectively,

A. $\omega_0^{HP} < \omega_0^{LP}$ *and* $\omega_0^{HP} < \omega_0^{LP}$ B. $\omega_0^{HP} < \omega_0^{LP}$ *and* $\omega_0^{HP} > \omega_0^{LP}$

C. $\omega_0^{HP} > \omega_0^{LP}$ *and* $\omega_0^{HP} < \omega_0^{LP}$ D. $\omega_0^{HP} > \omega_0^{LP}$ *and* $\omega_0^{HP} > \omega_0^{LP}$

10. If one of the inputs of a JK FF is high and the other is low, then the outputs Q and $\overline{Q}$

A. Oscillate between low and high in race around condition

B. Toggle and the circuit acts like a T flip flop

C. Are opposite to the inputs

D. Follow the inputs and the circuit acts like an R-S flip flop

11. If the peak output voltage of a full wave rectifier is 10 V, its dc voltage is

A. 10 V B. 7.07 V

C. 6.36 V D. 3.18 V

12. The order of magnitude of the energy gap of a typical superconductor is

A. 1 MeV B. 1 KeV

C. 1 eV D. 1 meV

13. A plane wave is represented by $A = A_o e^{ikz}$, In this equation k represents

A. Angular momentum B. Wave vector

C. Wavelength D. Frequency

14. The Boolean expression $B \cdot (A + B) + A \cdot (\vec{B} + A)$ can be realized using maximum number of

A. 1 AND gate B. 2 NAND gates

C. 1 OR gate D. 2 OR gates

15. If A and B are constant vectors, then $\nabla(\vec{A} \cdot \vec{B} \times \hat{r})$ is

A. $\vec{A} \cdot \vec{B}$ B. $\vec{A} \times \vec{B}$

C. $\hat{r}$ D. Zero

16. Which of the following vectors is orthogonal to the vector $(a\hat{i} + b\hat{j})$

A. $(-b\hat{i} + a\hat{j})$ B. $(-a\hat{i} + b\hat{j})$

C. $(-a\hat{i} - b\hat{j})$ D. $(-b\hat{i} - a\hat{j})$

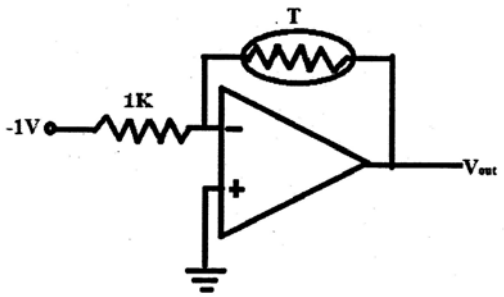
17. Silicon has diamond structure with unit cell edge a = 0.542 nm. The interatomic separation is

A. 0.112 nm
B. 0.234 nm
C. 0.383 nm
D. 0.542 nm

18. An RC network produces a phase-shift of 30°. How many such RC networks should be cascaded together and connected to a common emitter amplifier so that the final circuit behaves as an oscillator?

A. 6
B. 12
C. 9
D. 3

19. In the circuit given below, the thermistor has a resistance $3k\Omega$ at 25°C. Its resistance decreases by 150Ω per °C upon heating. The output voltage of the circuit at 30°C is



A. –3.75 V
B. –2.25 V
C. 2.25 V
D. 3.75 V

20. The following Boolean expression $Y = A\overline{B}\,\overline{C}\,\overline{D} + \overline{A}B\overline{C}D + \overline{A}\,\overline{B}\,\overline{C}D + \overline{A}\,\overline{B}CD + \overline{A}BCD + A\overline{B}\,\overline{C}D$ can be simplified to

A. $\overline{A}\,\overline{B}C + A\overline{D}$
B. $\overline{A}B\overline{C} + A\overline{D}$
C. $A\overline{B}\,\overline{C} + \overline{A}D$
D. $A\overline{B}C + \overline{A}D$

21. Input AC voltage of $V_{in} = 6\sin\omega t$ is applied across a silicon diode of $R = 30\Omega$ in series with load resistance 500Ω in a half wave rectifier circuit. The dc output current is

A. 11.3 mA
B. 10 mA
C. 10.6 mA
D. 12 mA

22. For a NaCl crystal, the cell edge a = 0.563 nm. The smallest angle at which Bragg reflection occurs corresponds to a set of plane whose indices are

A. 1 0 0 B. 1 1 0

C. 1 1 1 D. 2 0 0

23. The feedback ratio of an amplifier, which on application of a negative feedback changes the voltage gain from –250 to –100, is

A. –0.250 B. –0.025

C. –0.060 D. –0.006

24. Which of the following parameters is related to a superconductor?

A. Attenuation length B. Penetration depth

C. Skin depth D. Diffusion length

25. The velocity of orbital motion of an electron in an atom varies with the atomic number Z as

A. Z^2 B. $Z^{1/2}$

C. Z D. $1/Z$

26. Reciprocal lattice to bcc lattice is

A. fcc B. bcc

C. SC D. Oblique

27. In the diffraction pattern of bcc crystal, which of the following line is absent

A. (1 1 1) B. (2 0 0)

C. (1 1 0) D. (3 0 1)

28. In a Raman spectrum under excitation with a laser of wavelength 435.8 nm, the first Stokes line is observed at 440 nm. The corresponding Raman shift will be

A. 219 cm^{-1} B. 319 cm^{-1}

C. 200 cm^{-1} D. 110 cm^{-1}

29. For a MOD-12 counter, the FF has a propagation delay time, t_{pd} of 60 ns. The NAND gate has a t_{pd} of 25 ns. The clock frequency is

A. 3.774 MHz B. 3.774 kHz

C. 4.167 MHz D. 4.167 kHz

30. Which of the following equations implies the absence of magnetic monopoles?

A. $\nabla \cdot \vec{E} = 0$ B. $\nabla \cdot \vec{B} = 0$

C. $\nabla \times \vec{B} = \mu_0 J$ D. $\nabla \times \vec{E} = 0$

31. The curl of the vector $\vec{A} = z\hat{i} + x\hat{j} + y\hat{k}$ is

A. $\hat{i} + \hat{j} + \hat{k}$ B. $\hat{i} - \hat{j} + \hat{k}$

C. $\hat{i} + \hat{j} - \hat{k}$ D. $-\left(\hat{i} + \hat{j} + \hat{k}\right)$

32. In a He-Ne laser, the laser transition takes place in

A. He only B. Ne only

C. Ne first then He D. He first then Ne

33. The spin wave functions are usually referred as

A. Scalars B. Vectors

C. Spinors D. Tensors

34. Which one of the following molecules does not show a rotational spectrum?

A. H_2 B. CO

C. HCl D. HBr

35. The clock frequency of an 8085 microprocessor is 5 MHz. If the time required to execute an instruction is $1.4\mu s$, then the number of T-states needed for executing the instruction is

A. 1 B. 6

C. 7 D. 8

36. For an LED the energy gap is 1 eV. The emission wavelength of the LED is

A. $1.24\ \mu m$ B. $0.124\ \mu m$

C. $2.48\ \mu m$ D. $0.248\,\mu m$

37. The decimal number 5.625 is equivalent to the binary number

A. 101.110 B. 101.101

C. 110.101 D. 110.110

38. The differential form of Gauss's law is

A. $\nabla \cdot \vec{B} = \frac{\rho}{\varepsilon_0}$

B. $\nabla \times \vec{B} = \frac{\rho}{\varepsilon_0}$

C. $\nabla \times \vec{E} = \frac{\rho}{\varepsilon_0}$

D. $\nabla . \vec{E} = \frac{\rho}{\varepsilon_0}$

39. A power amplifier gives 150 W output for an input of 1.5 W. The gain in dB is

A. 10

B. 20

C. 54

D. 100

40. Bohr's quantum condition is

A. $L = \frac{nh}{2\pi}$

B. $L = \frac{n\hbar}{\pi}$

C. $L = \frac{2\pi\hbar}{n}$

D. $L = \frac{\pi\hbar}{n}$

41. The gradient of a scalar is always

A. a scalar

B. a vector

C. zero

D. constant

42. The valence electrons do not directly determine the following property of a material

A. Electrical conductivity

B. Thermal conductivity

C. Shear modulus

D. Metallic lusture

43. The minimum number of NAND gates required to construct an OR gate is

A. 2

B. 4

C. 5

D. 3

44. The nature of I-V characterstic of an ideal PN diode is

A. Parabolic

B. Linear

C. Exponential

D. Zig-zag

45. The trace of a 3×3 matrix is 5. If two of its eigenvalues are 2 and 4, its third eigenvalue is

A. 9 B. –1

C. 11 D. 2

46. For the evaluation of the electric field due to a collection of charges, which of the following principle is made use of?

A. Exclusion principle B. Superposition principle

C. Combination principle D. Uncertainty principle

47. A circuit which implements AND operation is

A. AND gate B. OR gate

C. NOT gate D. NOR gate

48. In OR operation if one of inputs is '1' then output is

A. 0 B. 2

C. 4 D. 1

49. In the equation $p = \alpha E$, α is

A. Polarizibilty B. Polarization

C. A dimensionless constant D. Charge per unit area

50. Volume current density J is equivalent to

A. Current per unit volume B. Current per unit area

C. Current per unit length D. Charge per unit area

51. A volume V is enclosed by a closed surface S. The surface integral over S, given by $\oint r \cdot d\sigma$, is

A. 0 B. V

C. 4π D. 3 V

52. Internal energy of an ideal gas depends on

A. Pressure B. Volume

C. Temperature D. Molecular size

53. If energy is doubled, the wavelength of light radiation will be

A. Doubled
B. Halved
C. Same
D. One fourth

54. In a differentiator, the feedback element is a

A. Resistor
B. Capacitor
C. Zener diode
D. Voltage divider

55. The Boolean expression $\overline{\overline{AB} + \overline{A} + AB}$ is equivalent to

A. A
B. $\overline{A}$
C. 1
D. Zero

56. The flux leaving any closed surface per unit volume in a vector field $\vec{A}$ is called

A. grad $\vec{A}$
B. div $\vec{A}$
C. curl $\vec{A}$
D. flux $\vec{A}$

57. From the following type of matrix, the diagonal elements of which matrix must be pure imaginary numbers or zero

A. Skew-Hermitian
B. Symmetric
C. Hermitian
D. Skew symmetric

58. If A is a non-singular matrix of orders 5×5, then rank of A is

A. 1
B. 2
C. 3
D. 5

59. Consider a function $f(x) = x$ for $-L/2 < x < L/2$. Its expansion as a Fourier series in this interval will contain

A. Only sine terms
B. Only cosine terms
C. Only cosine terms and a constant
D. Both sine and cosine terms

60. Which of the following functions of complex variable z is analytic everywhere?

A. $\frac{1}{1-z}$
B. $|z|$
C. $z^2 - 1$
D. $\log(z)$

61. In the steady state two-dimensional heat flow on a plate, the temperature $u(x, y, t)$ is independent of t. Then the generalised heat conduction equation reduces to

A. Poisson equation in 3D
B. Laplace's equation in 2D
C. Diffusion equation in 2D
D. Wave equation in 1D

62. A microprocessor is a ———— chip integrating all the functions of a CPU of a computer.

A. multiple
B. single
C. double
D. triple

63. The purpose of the microprocessor is to control ————.

A. memory
B. switches
C. processing
D. tasks

64. The intel 8086 microprocessor is a ———— processor.

A. 8 bit
B. 16 bit
C. 32 bit
D. 4 bit

65. An electromagnetic wave propagating through vacuum is described by $E = E_0 \sin(kx - \omega t)$ and $B = B_0 \sin(kx - \omega t)$ then

A. $E_0 k = B_0 \omega$
B. $E_0 \omega = B_0 k$
C. $E_0 B_0 = \omega k$
D. $E_0 B_0 = \omega^2 k$

66. The power radiated by an electric dipole is proportional to the frequency by

A. ω
B. ω^2
C. ω^3
D. ω^4

67. If ω is the frequency of current, the skin depth is directly proportional to

A. $\frac{1}{\sqrt{\omega}}$
B. $\sqrt{\omega}$
C. ω
D. ω^2

68. The magnetic field (B) corresponding to the vector potential $A = \frac{1}{2}\mu_0 A_0 (ct - x)\hat{k}$ is

A. $\frac{1}{2}\mu_0 A_0 \hat{i}$ B. $2\mu_0 A_0 \hat{j}$

C. $\frac{1}{2}\mu_0 A_0 \hat{j}$ D. $2\mu_0 A_0 \hat{i}$

69. 10101 binary number corresponds to the decimal number

A. 31 B. 21

C. 11 D. 3

70. Holography is based on the principle of

A. Diffraction B. Interference

C. Interferometer D. Polarization

71. The power in an amplitude modulated wave having modulation 100% and carrier power is

A. 10 W B. 15 W

C. 20 W D. 25 W

72. The velocity of an electron from (E-k) curve is

A. $v = \frac{1}{\hbar}\frac{dE}{dK}$ B. $v = \hbar\frac{dE}{dK}$

C. $v = \frac{1}{\hbar}\frac{d^2E}{dK^2}$ D. $v = \hbar / \left(\frac{dE}{DK}\right)$

73. At large distances the electric field due to a quadrapole varies as

A. $\sim \frac{1}{r^3}$ B. $\sim \frac{1}{r^6}$

C. $\sim \frac{1}{r^4}$ D. $\sim \frac{1}{r^5}$

74. If $\vec{F} = x^2 z\hat{i} - 2y^3 z\hat{j} + 2y^2 z\hat{k}$, then $div\ (curl\ F)$

A. 0 B. –2

C. +2 D. –6

75. The value of the Lande g factor for a fine structure level having the quantum numbers. L = 1, J = 2 and S = 1 is

A. 11/6 B. 4/3

C. 8/3 D. 3/2

76. If ${}^{m}L_{J}$ represents the notation for the electric state of an atom, then the value of m directly enables to obtain

A. Orbital quantum number B. Spin quantum number

C. Magnetic quantum number D. Vibrational quantum number

77. A plane electromagnetic wave traveling in free space is incident normally on a material of refractive index 3/2. Assuming no absorption, its reflectivity is

A. 4% B. 16%

C. 20% D. 50%

78. The minimum kinetic energy of an electron confined within the nucleus of diameter 10^{-14} m is

A. 614.9 MeV B. 6.149 MeV

C. 0.6149 MeV D. 61.49 MeV

79. The logic expression $\overline{A}BC + \overline{A}\overline{B}C + AB\overline{C} + A\overline{B}\overline{C}$ can be simplified to

A. A XOR C B. A AND $\overline{C}$

C. 0 D. 1

80. An amplifier has a gain of 300. When negative feedback is applied, the gain is reduced to 240, then the feedback ratio is

A. 5/4 B. 1/1200

C. 60 D. –1/300

81. The Lagrangian for a charged particle in an electromagnetic field is given by

A. $T - e\varphi + (e/c)A.v$

B. $T + e\varphi + (e/c)A.v$

C. $T + e\varphi - (e/c)A.v$

D. $T - e\varphi - (e/c)A.v$

82. A photon has a spin of

A. 2

B. 1/2

C. 1

D. 0

83. The Bragg reflections from bcc structure are distinguished if the Miller indices $[h\ k\ 1]$ are such that

A. $h + k =$ even

B. $h + k + 1 =$ odd

C. $h + k + 1 =$ even

D. $h + k =$ odd

84. The value of integral $\int_{-\infty}^{\infty} \frac{1}{x^2 + 1} dx$ is

A. $-\pi$

B. $+\pi$

C. 0

D. Indeterminate

85. The number of independent components for a general electromagnetic field tensor is

A. 4

B. 6

C. 8

D. 9

86. If $\vec{F} = x^2 z\hat{i} - 2y^3 zj + 2y^2 z\hat{k}$, div (curl F)

A. 0

B. –2

C. +2

D. –6

87. How does the momentum of a photon change if the wavelength is halved?

A. Doubles

B. Quadruples

C. Stays the same

D. Is cut to one-half

88. A signal of frequency 10k Hz is being digitalized by an A/D converter. A possible sampling time which can be used is

A. $100\,\mu s$ B. $40\,\mu s$

C. $60\,\mu s$ D. $200\,\mu s$

89. If the analog input to an 8-bit successive approximation ADC is increased from 1.0 V to 2.0 V, then the conversion time will

A. Remain unchanged B. Double

C. Decrease to half its original value D. Increase four times

90. Far away from any of the resonance frequencies of a medium, the real part of the dielectric permittivity is

A. Always independent of frequency

B. Monotonically decreasing with frequency

C. Monotonically increasing with frequency

D. A non-monotonic function of frequency

91. For a three-dimensional crystal having N primitive unit cells with a basis of p atoms, the number of optical branches is

A. 3 B. $3p$

C. $3p-3$ D. $3N-3p$

92. Which one of the following CANNOT be explained by considering a harmonic approximation for the lattice vibrations in solids?

A. Deby's T^3 law B. Dulong Petit's law

C. Optical branches in lattices D. Thermal expansion

93. A 2×4 decoder with an enable input can function as a

A. 4×1 multiplexer B. 1×4 demultiplexer

C. 4×2 encoder D. 4×2 priority encoder

94. The relative magnetic permeability of a type-I super conductor is

A. 0 B. –1

C. 2π D. 3π

95. A Zener diode with an operating voltage of 10 V at 25°C has a positive temperature coefficient of 0.07% per °C of the operating voltage. The operating voltage of this Zener diode at 125°C is

A. 12.0 V
B. 11.7 V
C. 10.7 V
D. 9.3 V

96. Which of the following gates can be used as a parity checker?

A. an OR gate
B. a NOR gate
C. an exclusive OR (XOR) gate
D. an AND gate

97. A plane electromagnetic wave traveling in free space is incident normally on a glass plate of refractive index 3/2. If there is no absorption by the glass, its reflectivity is

A. 4%
B. 16%
C. 20%
D. 50%

98. An unpolarized light wave is incident from air on a glass surface at the Brewster angle. The angle between the reflected and the refracted wave is

A. 0°
B. 45°
C. 90°
D. 120°

99. A 3×3 matrix has elements such that its trace is 11 and its determinant is 36. The eigenvalues of the matrix are all known to be positive integers. The largest eigenvalues of the matrix is

A. 18
B. 12
C. 9
D. 6

100. An op-amp based Voltage follower

A. is useful for converting a low impedance source into a high impedance source
B. is useful for converting a high impedance source into a low impedance source
C. has infinitely high closed loop output impedance
D. has infinitely high closed loop gain

ANSWER SHEET

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

ROUGH WORK

ROUGH WORK

ROUGH WORK