

ENTRANCE EXAMINATIONS – 2018
(Ph.D. Admissions - January 2019 Session)

Ph.D. Electronics Science

Marks: 80

Time: 2.00 hrs

Hall Ticket no:

1. Write your Hall Ticket Number on the OMR Answer Sheet given to you. Also write the Hall Ticket Number in the Space provided above.
2. Read the following instructions carefully before answering the questions.
3. This Question paper has TWO parts: PART 'A' and PART 'B'.

Part 'A': It consists of 20 objective type questions of **TWO** marks each. There is a negative marking of **0.66** marks for every wrong answer.

Part 'B': It consists of 40 objective type questions of **ONE** mark each with no negative marking.

4. All questions are to be answered. Answers for these questions are to be entered on the OMR sheet, filling the appropriate circle against each question. For example, if the answer to a question is D, it should be marked as below:



5. No additional sheets will be provided. Rough work can be done in the question paper itself.
6. Hand over the OMR answer sheet at the end of the examination to the invigilator.
7. Mobile phones, log tables and calculators of any type are NOT permitted
8. Values of some physical constants: $V_T = 26 \text{ mV}$, $\epsilon_2 = 8.85 \times 10^{-12} \text{ F/m}$
9. This book contains 13 pages including this cover sheet.

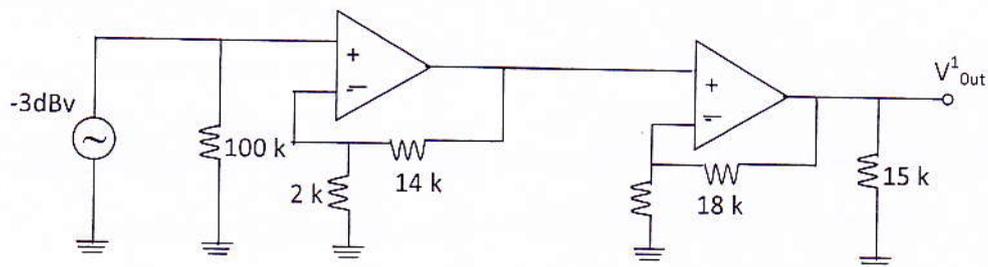
PART - A

1. In the simple linear regression, the spread around the regression line measures the
 - A. Standard error of the estimate
 - B. Standard deviation of data points
 - C. Correlation
 - D. Covariance

2. If the selling price of an article is tripled, then the profit quadruples. The profit percentage is
 - A. 75%
 - B. 100%
 - C. 200%
 - D. 300%

3. The theoretical limiting efficiency of a single crystal silicon solar cell is
 - A. 11%
 - B. 21%
 - C. 29%
 - D. 18.2%

4. What is the input impedance of the circuit shown in figure below. Assume ideal opamps.



- A. 100 K
 - B. 1.3 K
 - C. $\approx 103\text{K}$
 - D. 2 K
-
5. In order to protect the device operating on 230V rms a.c. mains supply from damage due to lightning strikes on the outdoor power supply line, which of the following is useful
 - A. A series capacitor in the live wire of the mains supply
 - B. A series inductor in the live wire of the mains supply
 - C. Good earthing of the "earth" terminal
 - D. Good earthing of the "neutral" terminal

6. Consider the data given below.

x	y
2	0.693
3	1.098
4	1.386
5	1.609

The value of y at $x=1$ is

- A. 0
 B. 0.346
 C. 0.554
 D. ∞
7. If the Resistors $R_1=(100 \pm 3) \Omega$ and $R_2 = (200 \pm 4) \Omega$ are connected in parallel, the equivalent resistance is
- A. $6.67 \pm 7 \Omega$
 B. $66.7 \pm 1.8 \Omega$
 C. $6.67 \pm 1.8 \Omega$
 D. $66.7 \pm 7 \Omega$
8. Consider the equation $y = Ax^2 + Bx$, the value of B can be determined
- A. from the slope of the graph between y and x
 B. from the slope of the graph between y and $1/x$
 C. from the x intercept of the graph between y and $1/x$
 D. from the slope of the graph between y/x and x
9. If x is the average of the two numbers m and 9, y is the average of $2m$ and 15 and z is the average of $3m$ and 18, then the average of $x, y,$ and z is
- A. $m+9$
 B. $2m+15$
 C. $3m+18$
 D. $m+7$
10. If every alternate letter of the English alphabet, starting from B is written in lowercase then "SEPTEMBER" will be written as
- A. SEPtEmBER
 B. SEptEMbEr
 C. SePTembeR
 D. SEPTEmbEr
11. Look at the series and predict the next number 8, 2, 1/2, 1/8..
- A. 1/256
 B. 1/64
 C. 1/32
 D. 8

12. In Electron Beam Lithography (EBL), electron sources called Thermal Field Emission (TFE) sources are known to be capable of producing spot sizes as small as 100 Angstroms with current densities as high as $1000A/cm^2$. This makes them suitable for high-throughput, high-resolution EBL systems.
Which of the following words best describes the mechanism of the TFE source?
- A. thermal aided emission gun
 - B. thermal-aided field, emission gun
 - C. thermal-field aided emission gun
 - D. thermal-aided, field-emission gun
13. Which of the following spot sizes and current densities, respectively, can be obtained using TFE electron source, in the context of the passage in Question No. 12?
- A. < 100 Angstroms; $> 1000A/cm^2$
 - B. > 100 Angstroms; $< 1000A/cm^2$
 - C. > 100 Angstroms; $> 1000A/cm^2$
 - D. < 100 Angstroms; $< 1000A/cm^2$
14. A die is rolled twice. What is the probability of getting a sum equal to 9?
- A. $1/9$
 - B. $1/3$
 - C. $2/3$
 - D. $2/9$
15. The probability that applicant-A will get admission in December session is ' a ' and the probability that applicant-B gets admission in the same December session is ' b '. What is the probability that only one of the two get admission?
- A. $a+b-2ab$
 - B. $a-b+2ab$
 - C. $a-b-2ab$
 - D. $ab-a-b$
16. The marks in a course out of total marks 40 for 10 students = $\{10,2,38,23,38,23,21,22,24,19\}$. What is the variance of the data set?
- A. 107.2
 - B. 102.1
 - C. 104.3
 - D. 99.2
17. The reliability of a measure refers to
- A. how far we can generalise the result to the population
 - B. how far we can generalise the result of other situations
 - C. the extent to which it is free from random error
 - D. the extent to which the measure actually measures the conceptual variable

18. Two pressure gauges A and B are calibrated at 0.1% of full scale. The full scale reading of A is 50 *bar* and B is 60 *bar*. Which of the following statement is true, if the resolution is limited to two decimal places (0.01 *bar*)
- A. The accuracy of A and B are 0.01 *bar*
 - B. The accuracy of A is 0.01 *bar* and B is 0.06 *bar*
 - C. The accuracy of A and B are ± 0.05 *bar* and ± 0.06 *bar* respectively with the same resolution of 0.01 *bar*
 - D. The accuracy and resolution of A are ± 0.05 *bar* while the accuracy and resolution of B are ± 0.06 *bar*
19. A present day PC is capable of multiplying two numbers in a few
- A. Picoseconds
 - B. Nanoseconds
 - C. Microseconds
 - D. Milliseconds
20. What is "Synopsis" of a research report?
- A. It is the introduction of research report.
 - B. It is the contents of the research report.
 - C. It is the summary of the research report.
 - D. It is the total findings of the research.

PART B

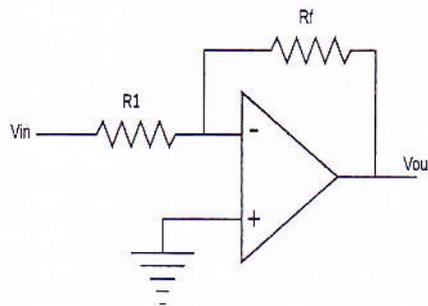
21. The general solution of $dy/dx = x + y$ is
(c is constant of integration)
- $y = \log[c(1+x+y)]$
 - $x = \ln[c(1+x+y)]$
 - $x^2 + y^2 = c$
 - $xy = y + c$
22. The Fourier transform of a signal $x(t) = te^{-at}u(t)$ is
- $j\omega/(j\omega+a)$
 - $1/[j\omega+a]^2$
 - $1/(j\omega+a)$
 - $1/(j\omega+a)^{1/2}$
23. Consider the following linear equations
- $$2x_1 + x_2 = 5$$
- $$x_1 + 2x_2 = 4$$
- then x_1 and x_2 are ..
- 6/3 , 3/3
 - 3/3 , 6/3
 - 6/4 , 3/4
 - 1/4 , 2/4
24. The Laplace transform can be used for the conversion of the function or derivative of a function from
- s domain to time domain in algebraic form
 - time domain to s domain in algebraic form
 - s domain to time domain in an integral form
 - time domain to s domain in an integral form
25. The reciprocal lattice of an *fcc* lattice is a
- fcc* lattice
 - bcc* lattice
 - hcp* lattice
 - sc* lattice
26. If n is the equilibrium concentration of electrons and p is the equilibrium concentration of holes in a semiconductor crystal, then which of the following is true for the product np at equilibrium
- It is linearly dependent on the Fermi level
 - It is exponentially dependent on the temperature
 - It is exponentially dependent on Fermi level
 - It is independent of the Fermi level

27. The leakage current across a $p-n$ junction is due to
- Minority carriers
 - Majority carriers
 - Junction capacitance
 - Low energy gap of the n type semiconductor
28. The resistivity of a material increases with temperature. The material must be
- Intrinsic semiconductor
 - Insulator
 - Metal
 - Lightly doped semiconductor
29. An electromagnetic radiation of wavelength 600 nm is incident on the surface of a dielectric film of thickness $10\text{ }\mu\text{m}$ and bandgap 4 eV . If the absorption coefficient is 100 cm^{-1} then which of the following is true?
- The radiation will get completely reflected.
 - The radiation will get completely absorbed.
 - The radiation will suffer reflection, transmission and absorption.
 - The radiation will get completely transmitted.
30. In a semiconductor where the bottom of the conduction band is at $k = 0$, an electron moves with a wave number $k = 10^9\text{ m}^{-1}$. If the effective mass of electrons in the conduction band is $0.5m_e$, then the energy of the electron measured from the bottom of the conduction band is
- 8 eV
 - 2.6 eV
 - 1.2 eV
 - 0.076 eV
31. Si is not a preferred material for fabricating LED because
- Si is a direct bandgap material.
 - Si is an indirect bandgap material.
 - Si bandgap is in the microwave region
 - Si bandgap is in the UV region.
32. The reason for the finite slope in the active region of the output characteristics of a transistor connected in common emitter configuration is (V_{CE} = Collector to emitter voltage)
- increase in the width of emitter diode's depletion region with increase in V_{CE} .
 - decrease in the width of collector diode's depletion region with increase in V_{CE} .
 - decrease in the effective width of neutral base region with increase in V_{CE} .
 - generation of excess carriers in base region by Avalanche process.

33. A PMOS transistor with node voltages at Source, Drain, Gate and Bulk equal to 1.8 V, 1.7 V, 1.2 V and 1.8 V respectively and the threshold voltage is equal to -0.5 V. What is the region in which PMOS transistor is in?

- A. Saturation
- B. Triode
- C. Cutoff
- D. Insufficient Data

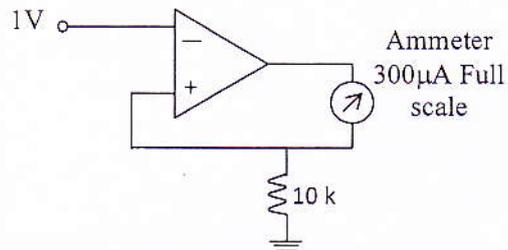
34. What is the closed loop gain of an inverting opamp with open loop gain of 10^4 , if the input series resistor (R_1) and feedback resistor (R_f) are of values $1k\Omega$ and $100k\Omega$ respectively.



- A. -99
- B. -102
- C. -101
- D. -100.5

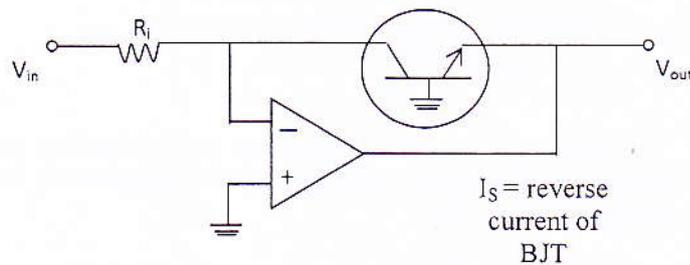
35. What is the meter deflection in the below figure, if the input voltage is 1V

- A. $50 \mu A$
- B. $300 \mu A$
- C. $100 \mu A$
- D. $150 \mu A$



36. What is the output voltage for the circuit of fig, if $V_{in} = 1V$, $R_i = 50k\Omega$ and $I_S = 30nA$. Assume $T = 300^0K$.

- A. -0.1504 V
- B. -0.1684 V
- C. -0.1864 V
- D. -0.1215 V



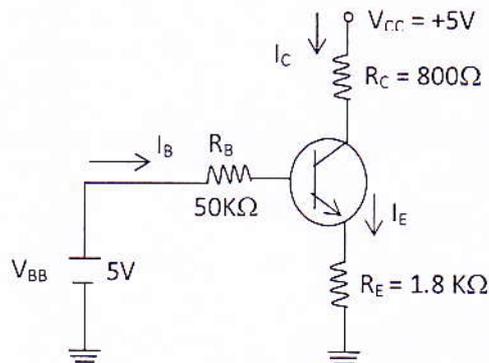
37. An amplifier high frequency response is described by the transfer function

$$A = \frac{A_0}{1 + j\omega/\omega_2} \quad \text{where in } A_0 = 1000, \omega_2 = 10^4 \text{ rad/s.}$$

The feedback factor β which will raise the upper corner frequency (ω_2) to 10^5 rad/S is,

- A. 0.009
 B. 0.001
 C. 0.010
 D. 0.011
38. Consider the transistor circuit of figure below, which has a resistance included between emitter and ground. Given $\beta = 50$. The transistor is operating in

- A. saturation region
 B. active region
 C. cutoff region
 D. indeterminate



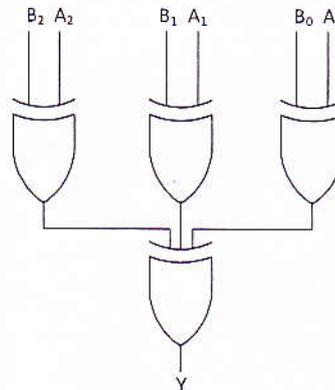
39. The wavelength of an electromagnetic wave passing through a transmission line with a phase constant of 6.28 radians/cm is
- A. 2 cm
 B. 1 cm
 C. 0.5 cm
 D. 3.14 cm
40. The length, input impedance, characteristic impedance and load impedance of a transmission line are l , Z_{in} , Z_0 and Z_L respectively. An electromagnetic wave passing through it has a wavelength $=l$, the length of the line. Then which of the following conditions is true?
- A. $Z_{in} = Z_0$
 B. $Z_{in} = Z_L^2/4$
 C. $Z_L = Z_0$
 D. $Z_{in} = Z_L$

41. The group delay of the electromagnetic wave with phase constant of 50.24 radians/cm and frequency of 4 GHz is
- A. 2 nsec/cm
 - B. 12.56 nsec/cm
 - C. 39.44 nsec/cm
 - D. 2 nsec
42. The magnitude of reflection coefficient of the electromagnetic wave passing through a transmission line where it encounters a return loss of 12 dB is
- A. 0.35
 - B. 0.55
 - C. 0.25
 - D. 0.75
43. In the Smith Chart, the coordinate of the point through which all the circles and half circles pass is
- A. (0,1)
 - B. (0,0)
 - C. (-1,0)
 - D. (1,0)
44. The input impedance of a transmission line is 20Ω when the load is open and is 5Ω when it is shorted. The characteristic impedance of the transmission line is
- A. 20Ω
 - B. 100Ω
 - C. 25Ω
 - D. 10Ω
45. In TE_{01} mode of wave propagation in a rectangular waveguide, if the smaller dimension of the cross section of waveguide is 2 cm , then the cutoff wavelength is:
- A. 4 cm
 - B. 8 cm
 - C. 1 cm
 - D. 2 cm

46. Consider the following statements:
- Pure GaAs can be made semi insulating
 - GaAs has higher charge carrier mobility than silicon
 - Pure GaAs can be made semiconducting with doping

GaAs is preferred over Silicon for making microwave monolithic integrated circuits because of

- i and ii only
 - ii and iii only
 - i and iii only
 - i, ii and iii.
47. A Decoder can be used as a Demultiplexer by
- using all the input lines and enable line as data selection lines and data input line respectively.
 - using all the input lines and enable line as the data selection lines
 - by inverting the enable line and connecting it to ground.
 - by connecting three output lines of decoder as the data select lines.
48. In order to get the output $Y=0$ of the below given digital circuit, one of the correct input pair $A_2A_1A_0, B_2B_1B_0$ is

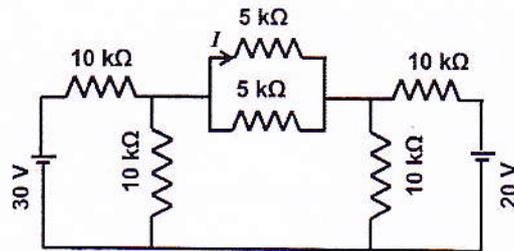


- 010,001
 - 101,001
 - 001,111
 - 101,010
49. A memory system has 6 memory chips with 12 address lines and 4 data lines. The size of the memory system is
- 12KByte
 - 24 KBte
 - 8K Kbyte
 - 4 Kbyte

50. In a 8 bit binary weighted Digital to Analog Converter, the smallest value of resistor that will limit the current drawn to 10mA from the reference supply of +5Volts is
- A. 50 Ohm
 - B. 99.6 Ohm
 - C. 500 Ohm
 - D. 996 Ohm

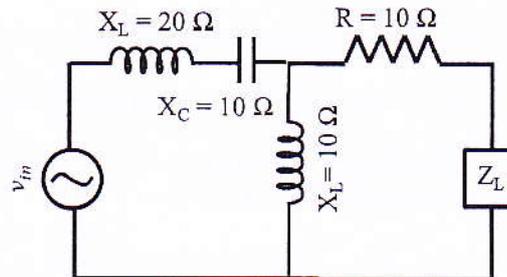
51. The current (I) flowing through the 5 k Ω resistor in the circuit shown in figure is

- A. 1 mA
- B. 0.33 mA
- C. 0.2 mA
- D. 0.16 mA



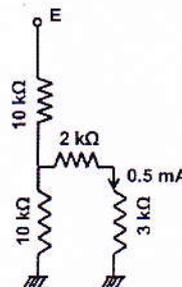
52. The value of Load impedance (Z_L) to draw maximum power from the circuit shown in figure is

- A. $10 \Omega + j5 \Omega$
- B. $10 \Omega - j5 \Omega$
- C. $j10$
- D. $(20 \Omega^2 + j10 \Omega^2) / (1 \Omega - j1 \Omega)$



53. A current of 0.5 mA is flowing through the 3 k Ω resistor in the circuit shown in the figure below. The value of the supply voltage (E) is

- A. 5 V
- B. 10 V
- C. 21.5 V
- D. insufficient data



54. The power dissipated by an a.c circuit is zero. Then which of the following statement is true?

- A. The circuit contains ideal resistive elements only.
- B. The circuit contains ideal reactive elements only.
- C. The circuit contains both resistive and reactive elements.
- D. The circuit must contain at least one non-linear element.

55. A linear, time-invariant system has a transfer function which has poles at $s = -3$ and -1 and a zero at $s = -2$ in the s -plane. The response of the system to an impulse signal $\delta(t)$ is a signal proportional to
- A. $[e^{-3t} + e^{-t}]u(t)$
 - B. $[e^{-3t} - e^{-t}]u(-t)$
 - C. $\delta(t+3) + \delta(t+1)$
 - D. $\delta(t-3) - \delta(t-1)$
56. A Linear time invariant system has an output $y(t)$ for an input $x(t)$ described by the differential equation $dy(t)/dt + 4y(t) = x(t)$. What is the response time of the system?
- A. 4
 - B. 2
 - C. 1/4
 - D. 1/2
57. Which of the following is an electron beam resist
- A. Poly methyl methacrylate
 - B. Poly vinyl alcohol
 - C. Ethylene diaminetetraacetic acid
 - D. Diazonaphthaquinone
58. Which of the following is not a clean-room compatible material
- A. Teflon
 - B. Stainless steel
 - C. Glass
 - D. Mild steel
59. Which of the following is not an anisotropic etchant for silicon
- A. KOH
 - B. EDP
 - C. HF
 - D. TMAH
60. Which of the following measurement cannot be done using a vector network analyser
- A. Return loss
 - B. Insertion loss
 - C. Phase delay
 - D. Oscillator output spectrum