Entrance Examinations - 2020
Ph.D. (Electronics Science and Engineering)

Marks: 70
Time: 2.00 hrs   Hall Ticket no: _____

1. Write your Hall Ticket Number in 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 **1.75** marks each. **There is negative marking. Each wrong answer carries -0.5 mark.**

Part 'B: It consists of 35 objective type questions of **one** mark each. **There is no negative marking for Part 'B'.**

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:

$$\text{(A)} \quad \text{(B)} \quad \text{(C)} \quad \bullet$$

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: Planck's constant, $h = 6.6 \times 10^{-34}$ m^2kg/s, speed of light in vacuum, $c = 3 \times 10^8 m/s$, Boltzmann constant, $k_B = 1.38 \times 10^{-23}$ $m^2kgs^{-2}K^{-1}$, $V_T = k_B T/e = 26$ mV at room temperature, free space permittivity $\epsilon_o = 8.85 \times 10^{-12}$ F/m, electronic charge, $e = -1.6 \times 10^{-19}C$

9. This book contains 16 pages including this cover sheet.

PART – A

1. The percentage of healthy and infected males and females due to COVID19 in a country is shown in the figure
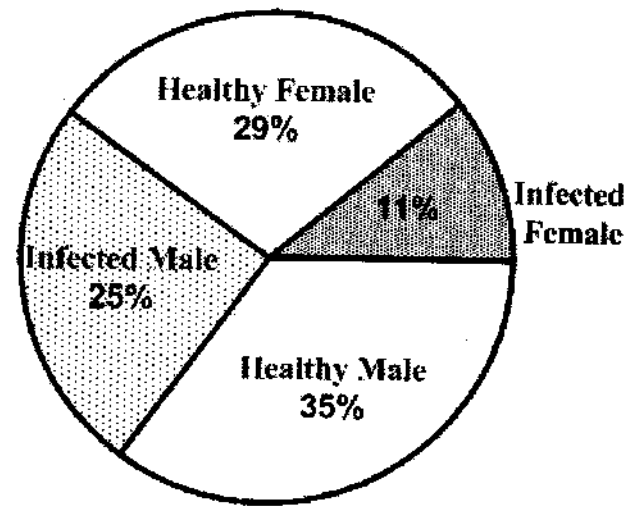
Total Number=2,50,000

What is the difference between the number of infected males and infected females?

    A. 70,000
    B. 35,000
    C. 1,700
    D. 3,500

2. In a group of nine pets, there are 5 dogs and 4 cats from which 3 pets are to be purchased. In how many different ways can the 3 pets be chosen such that at least one dog is selected?

    A. 120
    B. 84
    C. 90
    D. 80

3. The sum of the present ages of Jayati, Pooja and Suchitra is 87 years. Five years ago, their ages were in the ratio 1:2:3 respectively. What is the present age of Suchitra?

    A. 41 years
    B. 38 years
    C. 36 years
    D. 45 years

Read the following paragraph and answer question numbers 4 and 5:

Consider an n-type semiconductor with minority carrier (hole) concentration of P_{n0} at thermal equilibrium. A sample of this semiconductor is illuminated with light such that the electron-hole pairs are generated uniformly throughout the sample with uniform generation rate G_p. The sample thickness is much smaller than $1/\alpha$ where α is the absorption coefficient. The pertinent continuity equation is given by

$$\frac{dP_n}{dt} = G_p - \frac{P_n - P_{n0}}{\tau_p}$$

where P_n is the concentration of minority carriers at time t, τ_p is the minority carrier lifetime. Assume that the system has then attained steady state.

4. Which of the following options is true for steady state?

   A. $P_n - P_{n0} = 0$
   B. $P_n - P_{n0} = \infty$
   C. $P_n - P_{n0} = constant$
   D. $P_n - P_{n0} = P_{no}e^{-t/\tau_p}$

5. After the light is switched off, the minority carrier concentration will

   A. increase linearly with time
   B. decrease exponentially with time
   C. decrease linearly with time
   D. increase exponentially with time

6. The volume of a cone with a circular base of diameter 10 cm and height 18 cm is

   A. 300π cm^3
   B. 180π cm^3
   C. 45 cm^3
   D. 150π cm^3

Study the following table carefully and answer the question numbers 7 and 8

A semiconductor device manufacturing industry sold different types of devices in a country over the years as given below:

| Year	Diode	BJT	JFET	MOSFET	SCR
2015	50	20	25	300	55
2016	55	30	30	320	60
2017	60	70	35	352	70
2018	45	50	30	450	70
2019	70	80	40	500	120

7. In which of the following years, is the number of JFETs sold, as percentage of the number of SCR sold the same year, the lowest ?

    A. 2015
    B. 2017
    C. 2019
    D. 2018

8. The percentage increase in the number of diodes sold in 2020 over that in 2019 is expected to be the same as the percentage increase in the number of diodes sold in 2019 over that in 2018. What is the approximate number of diodes expected to be sold in 2020?

    A. 108
    B. 95
    C. 70
    D. 45

9. The following graph represents a histogram of measurements of 2 quantities whose actual values are also indicated on the x-axis. Which of the following statements is true?
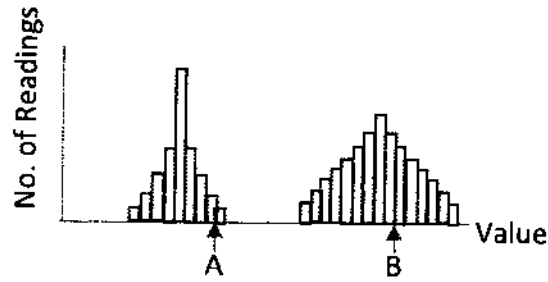
    A. Measurement of A is more precise and more accurate than that of B
    B. Measurement of A is more precise but less accurate than that of B
    C. Measurement of A is less precise and less accurate than that of B
    D. Measurement A is less precise but more accurate than that of B

10. The solution for (x,y) in the equation, $3x+(2x-y)j = 6 -3j$ is

    A. (2,7)
    B. (2,6)
    C. (4,7)
    D. (3,6)

11. The value of j^{-39} is

    A. -1
    B. -j
    C. j
    D. +1

12. The coefficient term of the x^5 term in the Maclaurin polynomial for $sin(2x)$ is

    A. 0
    B. 1.3333
    C. 0.26667
    D. 0.016667

13. If time measured for a freely falling body is $t = -v/g$, where $v = -3.8 \pm 0.3$ m/s and $g = 9.81$ m/s^2. What is the error in time?

    A. 0.05
    B. 0.3
    C. 0.02
    D. 0.03

14. A brother and a sister appear in an interview for two vacancies in a post. The probability of the brother getting selected is 1/7 and the probability of sister getting selected is 1/5. What is the probability that only one of them is selected ?

    A. 2/7
    B. 1/7
    C. 3/4
    D. 4/5

15. The power efficiency of the half wave rectifier (ratio of power in d.c. component of rectified output and total power in the rectified output) is

    A. 63.7 %
    B. 40.6 %
    C. 50 %
    D. 81.2 %

16. A certain disease has an incidence rate of 2% of the population. If a testing method has false negative rate of 10% and false positive rate of 1%. What is the conditional probability of testing positive for the disease and actually having the disease?

    A. 0.0198
    B. 0.002
    C. 0.147
    D. 0.647

17. The outcome of an experiment has p as the probability of success, q as the probability of failure and follows the binomial distribution. What is the standard deviation of the distribution, if n is the number of trials of the experiment?

A. $(np)^{1/2}$

B. $(pq)^{1/2}$

C. $(npq)^{1/2}$

D. $(np)^2$

Read the following passage and answer questions 18-20:

Marie Curie was one of the most accomplished scientists in history. Together with her husband, Pierre, she discovered radium, an element widely used for treating cancer, and studied uranium and other radioactive substances. Pierre and Marie's amicable collaboration later helped to unlock the secrets of the atom.

Marie was born in 1867 in Warsaw, Poland, where her father was a professor of physics. At an early age, she displayed a brilliant mind and a blithe personality. Her great exuberance for learning prompted her to continue with her studies after high school. She became disgruntled, however, when she learned that the university in Warsaw was closed to women. Determined to receive a higher education, she defiantly left Poland and in 1891 entered the Sorbonne, a French university, where she earned her master's degree and doctorate in physics.

Marie was fortunate to have studied at the Sorbonne with some of the greatest scientists of her day, one of whom was Pierre Curie. Marie and Pierre were married in 1895 and spent many productive years working together in the physics laboratory. A short time after they discovered radium, Pierre was killed by a horse-drawn wagon in 1906. Marie was stunned by this horrible misfortune and endured heartbreaking anguish. Despondently she recalled their close relationship and the joy that they had shared in scientific research. The fact that she had two young daughters to raise by herself greatly increased her distress.

Curie's feeling of desolation finally began to fade when she was asked to succeed her husband as a physics professor at the Sorbonne. She was the first woman to be given a professorship at the world-famous university. In 1911 she received the Nobel Prize in chemistry for isolating radium. Although Marie Curie eventually suffered a fatal illness from her long exposure to radium, she never became disillusioned about her work. Regardless of the consequences, she had dedicated herself to science and to revealing the mysteries of the physical world.

18. When she learned that she could not attend the university in Warsaw, she felt _____.

A. annoyed

B. hopeless

C. depressed

D. worried

19. Marie _____ by leaving Poland and traveling to France to enter the Sorbonne.

    A. showed intelligence
    B. behaved irresponsibly
    C. challenged authority
    D. was distressed

20. Marie and Pierre Curie discovered radium. This means
    A. They invented radium
    B. They made one of the first man-made element
    C. They made radium through nuclear reactions
    D. They showed that it is a material hitherto unrecognized as an element

PART B

21. $u = e^{-4t}\sin 2x$ is a solution of the partial differential equation

    A. $\frac{\partial u}{\partial t} = 2\frac{\partial^2 u}{\partial x^2}$

    B. $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$

    C. $\frac{\partial u}{\partial t} = -\frac{\partial^2 u}{\partial x^2}$

    D. $\frac{\partial u}{\partial t} = -2\frac{\partial^2 u}{\partial x^2}$

22. If $\vec{f} = xy^2\hat{\imath} + x^2y^2z\hat{\jmath} - xyz^2\hat{k}$, then $div\ \vec{f}$ at (2,1,-1) is

    A. -3
    B. -7
    C. 4
    D. -5

23. If $\left(\frac{1+j}{1-j}\right)^m = 1$, then find the least positive integral value of m

    A. -4
    B. -2
    C. 2
    D. 4

24. In a simultaneous throw of a pair of dice, what is the probability of getting the total more than or equal to 8 ?

    A. 7/15
    B. 5/12
    C. 1/3
    D. 1/12

25. $\sum_{k=2}^{10}(1/2)^k$ is closest to

    A. 1.999
    B. 1.998
    C. 0.499
    D. 0.498

26. The width of the depletion layer of an ideal n-type Si/metal Schottky diode decreases

    A. with increase in donor concentration as square root of donor concentration
    B. linearly with increasing donor concentration
    C. exponentially with increasing donor concentration
    D. with increase in donor concentration as square of donor concentration

27. Consider the following statements:

    I.   BJT is a current controlled current source.
    II.   BJT is a current controlled voltage source.
    III.   FET is a voltage controlled voltage source.
    IV.   FET is a voltage controlled current source.

    Which of the following statements are correct?

    A. I, III
    B. II, III
    C. II, IV
    D. I, IV

28. What is the minimum bandgap of a semiconductor for it to be transparent to visible light (wavelength, $\lambda = 0.4$–$0.7~\mu m$) ?

    A. 1.14 eV
    B. 3.08 eV
    C. 2.24 eV
    D. 1.76 eV

29. A degenerate semi-conductor is a semi-conductor in which (T is the temperature and k is Boltzmann constant)

    A. the Fermi level is separated by $\geq 3kT$ from either conduction or valence band.
    B. there exist multiple energy levels within the conduction band.
    C. the Fermi level is at a point which is $\ll 3kT$ from either conduction or valence band.
    D. there exist mid-gap impurity levels.

30. The bulk dopings required to fabricate a *n*-channel MOSFET and *p*-channel MOSFET on Si are, respectively,

    A. Semi-insulating
    B. *n*-type and *p*-type
    C. Intrinsic (no doping) .
    D. *p*-type and *n*-type

31. Put the following steps in a Lithographically patterned etch process, in the correct order
1.Clean substrate 2.Apply photoresist 3.Develop photoresist 4.Etch 5.Expose to UV light
6.Strip photoresist

    A. 1,2,5,3,4,6
    B. 1,2,3,4,5,6
    C. 1,2,3,5,4,6
    D. 1,2,3,6,4,5

32. The expression for the instantaneous current flowing through a coil of inductance (L) 0.1 H is given by $i_L = 2sin(314t)$ where t is the instantaneous time in seconds. The expression for the instantaneous voltage (v_L) across this coil is

    A. $0.2sin(314t - 90°)$
    B. $31.4sin(314t + 90°)$
    C. $62.8sin(314t + 90°)$
    D. $62.8sin(314t - 90°)$

33. Current flowing through the 7 kΩ resistor in the circuit shown in figure, is
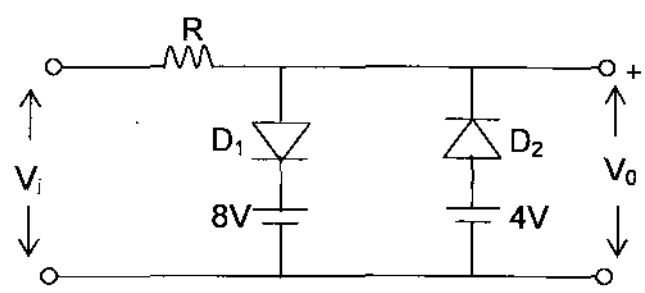
    A. 1.5 mA
    B. 2.5 mA
    C. 2 mA
    D. 3 mA
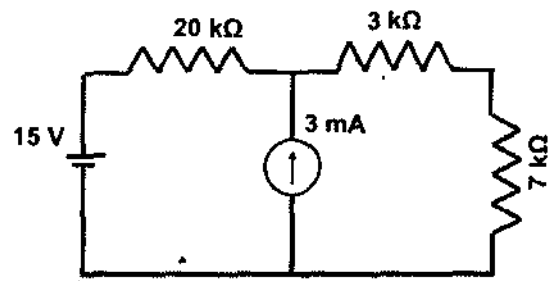
34. The stability in a phase-shift oscillator circuit, where θ is the phase shift of the feedback network and ω is the angular frequency, improves

    A. if dθ/dω increases
    B. if dθ/ dω decreases
    C. if dθ/ dω = 0
   D. if dθ/ dω <0

35. In the following circuit, if the input signal, V_i is a sine wave and the diodes are ideal, then it transmits that part of the sine wave
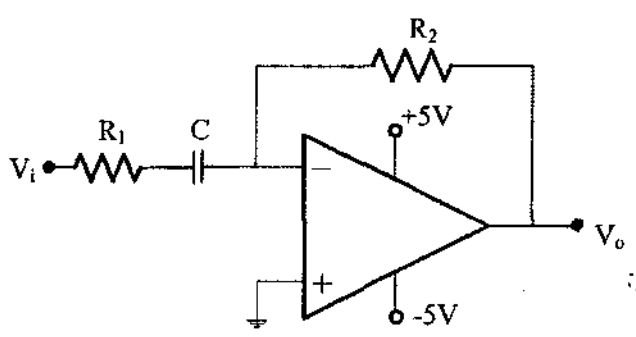

    A. which is above + 8V and below + 4V.
    B. which lies between + 4V and + 8V only.
    C. which lies above − 4V and below + 8V.
    D. which lies below + 4V and above − 8V.

36. In the circuit shown, a Silicon transistor Q and an ideal Op-Amp are used. The output voltage (V_{out}) is
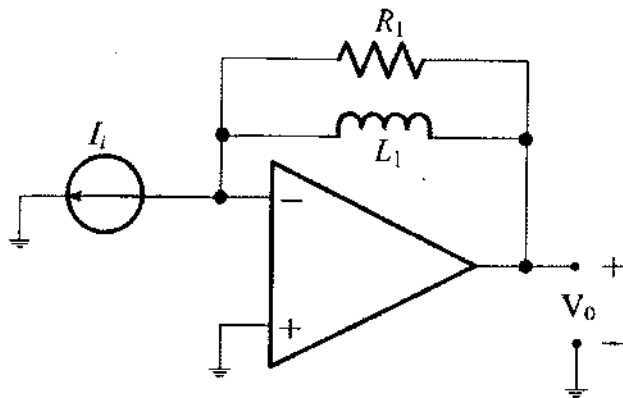
    A. −10V
    B. +10V
    C. +0.6V
    D. −0.6V
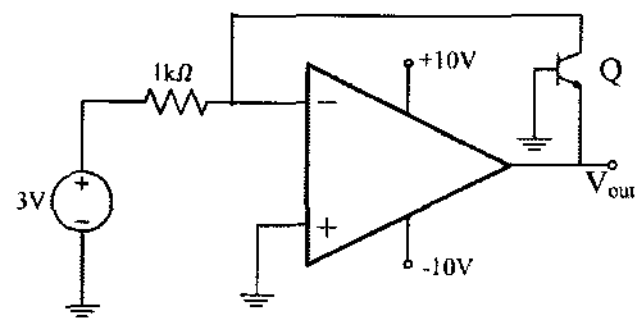
37. The function of the circuit shown is


    A. High pass filter with cut off frequency $\frac{1}{(R_1+R_2)C}$ rad/s
    B. Low pass filter with cut off frequency $\frac{1}{R_1 C}$ rad/s
    C. High pass filter with cut off frequency $\frac{1}{R_1 C}$ rad/s
    D. Low pass filter with cut off frequency $\frac{1}{(R_1+R_2)C}$ rad/s

38. The circuit shown below is a (assume the operational amplifier is ideal)

A. high pass filter
B. low pass filter
C. band stop filter
D. band pass filter

39. The simplified circuit to implement the circuit given below is

A

B

C

D
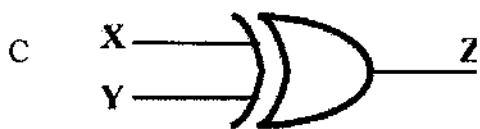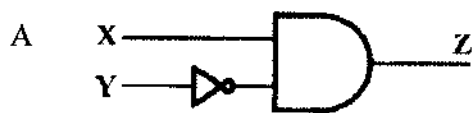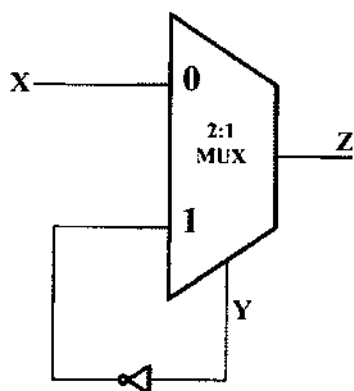
40. In the sequential circuit shown below, if the initial value of the output Q_1Q_0 is 11, then the output at Q_1Q_0 after the positive edge of 10th clock cycle is (assume that the T-flip flops are ideal)
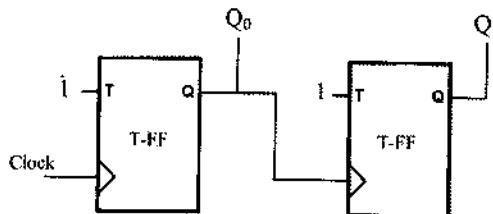
    A. 10
    B. 00
    C. 01
    D. 11

41. Consider an ideal D latch given below, the CLK1 input has time period of 25 ns with 50% duty cycle. The CLK2 is delayed by 5ns with respect to CLK1. The duty cycle at the output of Q is
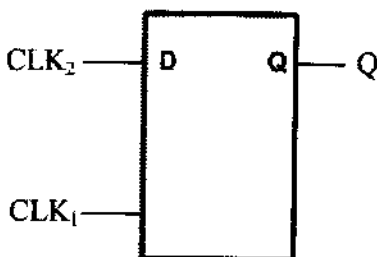
    A. 20%
    B. 30%
    C. 50%
    D. 80%

42. A five-bit adder is designed by cascading five full adders. Each full adder takes 5ns to generate the *carry* output and 20 ns to generate the *sum* output. The maximum rate of 5-bit additions of the five-bit adder per second is

    A. 8×10^6
    B. 4×10^7
    C. 1×10^7
    D. 1×10^9

43. What are the values of sign flag bit and carry flag bit in a 8085 microprocessor, after executing the following two instructions?

    SUB A
    SUI 01H

    A. 0,0
    B. 1,1
    C. 0,1
    D. 1,0

44. Which among the following is programmed data transfer scheme in a 8085 processor?

    I. Synchronous data transfer II. Asynchronous data transfer III. Interrupt driven data transfer IV. Direct memory access data transfer

    A. I, II and III
    B. II and III
    C. IV
    D. I and II

45. The tangential component of an electric field will be continuous at

    A. Conductor-Conductor boundary.
    B. Conductor-Dielectric boundary.
    C. Boundary between any two media.
    D. Dielectric-Dielectric boundary.

46. The depth of penetration of an electromagnetic wave in a lossy dielectric increases with increasing

    A. Conductivity.
    B. Permeability.
    C. Permittivity.
    D. Wavelength.

47. An electric field at a point on a plane is described by its potential $V = 20(r^{-1} + r^{-2})$, where r is the distance from the source to the point. The source of the field consists of

    A. A monopole.
    B. Both a monopole and a dipole.
    C. A dipole.
    D. A quadrupole.

48. A transmission line with a characteristic impedance that is purely resistive is terminated with an unknown load. The measured value of Voltage Standing Wave Ratio (VSWR) on the line is 2 and a voltage minimum point occurs at the load end. The load impedance is then

    A. Purely resistive
    B. Complex
    C. Purely capacitive
    D. Purely inductive

49. Consider a Hamming code with 2 redundant bits (m=2) and repetition code length 3 (n=3). The parity-check matrix H for this code is

    A.
$$\begin{matrix} 1 \\ 0 \\ 1 \end{matrix}$$

    B.
$$\begin{matrix} 1 & 0 & 0 \\ 1 & 0 & 1 \end{matrix}$$

    C.
$$\begin{matrix} 1 & 1 & 0 \\ 1 & 0 & 1 \end{matrix}$$

    D.
$$\begin{matrix} 1 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 \end{matrix}$$

50. $s(t)=10cos(8\pi\times10^6 t+9sin(2\pi\times10^3 t))$ is a frequency modulated (FM) voltage signal. What is the power in the FM signal across unit resistance?

    A. 40 W
    B. 200 W
    C. 100 W
    D. 50 W

51. Consider the equation $R = R_0 (1+ \alpha\ T)$ where R is the resistance of a particular metal at temperature T, R_0 the resistance at 0^0C and α is the temperature coefficient of resistance. This equation

    A. can be used to sense the temperature of an arbitrary object.
    B. can be used to sense the resistance of an arbitrary object.
    C. can be used to sense the length of an arbitrary object.
    D. cannot be used to design a sensor.

Y-65

52. If R varies with T as $R=R_0(1+\alpha T)$, then α can be extracted from

    A. x-intercept of the plot between R vs T
    B. slope of the plot between R vs T
    C. y-intercept of the plot between R vs T
    D. slope of the plot between R vs $1/T$

53. A current is passed through a metallic wire, with a temperature dependent resistance, which also forms one arm of a Wheatstone bridge. The rate at which heat is dissipated from the wire is dependent on the conductivity of the medium (air) in which it is placed. This phenomenon can be used to design a

    A. Length sensor.
    B. Temperature sensor.
    C. Pressure sensor.
    D. Volume sensor.

54. A signal, with bandwidth 1 MHz, is digitized using a 12 bit successive approximation ADC. In order to reproduce the signal most accurately from its samples, the ADC clock frequency must be greater than

    A. 24 MHz
    B. 1 MHz
    C. 2 MHz
    D. 12 MHz

55. Which of the following filters has a ripple-free frequency response?

    A. Chebyshev
    B. Inverse Chebyshev
    C. Elliptic
    D. Butterworth