2017

(6th Semester)

PHYSICS

NINTH PAPER

(Method of Mathematical Physics—II)

(Pre-revised)

Full Marks : 75

Time : 3 hours

(PART : B—DESCRIPTIVE)

(*Marks* : 50)

The figures in the margin indicate full marks for the questions

1. *(a)* Using the definition of -function, show that

$$\frac{1}{2} \quad \sqrt{} \qquad 6$$

(b) Find the value of

$$\frac{1}{n} \quad \frac{2}{n} \quad \ldots \quad \frac{n \quad 1}{n}$$

where n is an integer. 4

Or

(a) Show that

$$(m, n) \quad \frac{(m) \quad (n)}{(m \quad n)} \qquad 5$$

(b) Prove that

$$(m) \quad m \quad \frac{1}{2} \quad \frac{\sqrt{}}{2^{2m \quad 1}} \quad (2m) \qquad 5$$

2. *(a)* Obtain Fourier series for the function

$$f(x) \quad \begin{matrix} \sin x; & 0 \quad x \\ \sin x; & x \quad 2 \end{matrix} \qquad 7$$

(b) Find the inverse sine transform of $e^{\quad n}$. 3

Or

(a) Express the function $f(x) \quad x \sin x$ in the Fourier series in the interval x . Hence, show that

$$\frac{}{4} \quad \frac{1}{2} \quad \frac{1}{1 \ 3} \quad \frac{1}{3 \ 5} \quad \frac{1}{5 \ 7} \quad \ldots \qquad 6+1$$

(b) Find the finite cosine transforms of

$$f(x) \quad \frac{}{3} \quad x \quad \frac{x^2}{2}$$

in the interval (0,). 3

3. *(a)* Find the Laplace transform of

$$f(t) \quad t^2 e^t \sin 4t$$

4

(b) Obtain the Laplace transform for half-wave rectifier wave function

$$F(t) \quad \begin{array}{l} \sin t; \quad 0 \quad t \quad - \\ 0 \quad ; \quad - \quad t \quad \frac{2}{} \end{array}$$

with period $T \quad \frac{2}{}$. 6

Or

(a) Find the inverse Laplace transform of

$$\frac{s^2 \quad 2s \quad 3}{s(s \quad 3)(s \quad 2)}$$

3

(b) Find Laplace transform of

$$f(t) \quad \begin{array}{l} a \quad \text{for} \quad 0 \quad t \quad \frac{T}{2} \\ 0 \quad \text{for} \quad \frac{T}{2} \quad t \quad T \end{array}$$

and $f(t \quad T) \quad f(t)$. 2

(c) Using Laplace transform, evaluate the integral

$$_0 \cos x^2 \, dx$$

5

4. *(a)* What do you mean by symmetry elements and symmetry operations? 2

(b) Show that the H_2O molecule belongs to the point group C_{2v}. 8

Or

(a) Show that NH_3 molecule belongs to the point group C_{3v}. 5

(b) What do you mean by representation of groups? Explain the representation of the group C_{2v}. Hence obtain the group multiplication table. 2+2+1

5. *(a)* What do you mean by DO loop? Explain the rules for writing DO loop. 1+5

(b) Write a FORTRAN program to find the mean of two numbers. 2

(c) Find the value of the expression $(A**2*2 \quad I/3 \quad 13)*J$, if $A \quad 3 \quad 0$, $B \quad 5 \quad 0$, $I \quad 8$ and $J \quad 3$. 2

Or

(a) Write a FORTRAN program to read x and n and evaluate the sum of the series $1 \quad x \quad x^2 \quad \ldots \quad x^n$. 5

(b) Write a FORTRAN program to determine the magnitude of a vector. 3

(c) Given that $A \quad 123 \quad 78$, $B \quad 84 \quad 10^{23}$, $C \quad 18 \quad 10^{35}$, $I \quad 857$, $J \quad 95$, $K \quad 1$. Write the appropriate READ statements with FORMAT statements to read A, B, C, I, J and K. 2

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Subject Code : PHY/VI/09 (PR)

Booklet No. A

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DEGREE 6th Semester
(Arts / Science / Commerce / .....) Exam., **2017**

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Paper .....

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Paper .....

Descriptive Type
Booklet No. B .....

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2 0 1 7

(6th Semester)

PHYSICS

NINTH PAPER

(Method of Mathematical Physics—II)

(Pre-revised)

(PART : A—OBJECTIVE)

(*Marks* : 25)

The figures in the margin indicate full marks for the questions

SECTION—I

(*Marks* : 10)

Tick (✓) the correct answer in the brackets provided : 1×10=10

1. The value of $\int_0^\infty e^{-t^2} dt$ is

(a) $\sqrt{\pi}$ ( )

(b) 1 ( )

(c) $\frac{\sqrt{\pi}}{2}$ ( )

(d) 0 ( )

2. The value of $\Gamma(0)$ is

(a) 1 ( )

(b) 0 ( )

(c) ∞ ( )

(d) n ( )

3. The value of $f(x)\delta(x-a)$ is

(a) 0 ( )

(b) a ( )

(c) $f(x)$ ( )

(d) $f(a)\delta(x-a)$ ( )

4. The Fourier transform of $\frac{df}{dt}$ i.e., F.T. $\left[\frac{df}{dt}\right]$ is

(a) $\frac{\omega}{\sqrt{2\pi}}\int_{-\infty}^{\infty}\frac{df}{dt}e^{-i\omega t}dt$ ( )

(b) $\sqrt{\frac{\omega}{2\pi}}\int_{-\infty}^{\infty}\frac{df}{dt}e^{i\omega t}dt$ ( )

(c) $\frac{i\omega}{\sqrt{2\pi}}\int_{-\infty}^{\infty}\frac{df}{dt}e^{-i\omega t}dt$ ( )

(d) $\frac{1}{i\omega\sqrt{2\pi}}\int_{-\infty}^{\infty}\frac{df}{dt}e^{i\omega t}dt$ ( )

5. Laplace transform of $\sqrt{t}$ is

(a) $\frac{1}{2s}\sqrt{\frac{s}{\pi}}$ ( )

(b) $\frac{s}{2}\sqrt{\frac{\pi}{s}}$ ( )

(c) $\frac{s}{2}\sqrt{\frac{s}{\pi}}$ ( )

(d) $\frac{1}{2s}\sqrt{\frac{\pi}{s}}$ ( )

6. Inverse Laplace transform of $\frac{1}{s^2 + a^2}$ is

(a) $\sin at$ ( )

(b) $\sinh at$ ( )

(c) $\cos at$ ( )

(d) $\cosh at$ ( )

7. The classes of D_3 group are

(a) (*E*), (*AB*) and (*CDF*) ( )

(b) (*EA*), (*BC*) and (*DF*) ( )

(c) (*E*), (*ABC*) and (*DF*) ( )

(d) (*EAB*), (*CD*) and (*F*) ( )

8. If $l_1, l_2, \ldots$ are the dimensions of an irreducible representation of a finite group of order n, then $l_1^2 + l_2^2 + \ldots + l_n^2$ is equal to

(a) n ( )

(b) $\sqrt{n}$ ( )

(c) n^2 ( )

(d) $\frac{n(n+1)}{2}$ ( )

9. The final value of K in the DO statement DO 20 $K = 1, 10, 3$ is

(a) 1 ( )

(b) 10 ( )

(c) 3 ( )

(d) 20 ( )

10. If $I = 3$, $J = 8$ and $K = 4$, then the value of A in the following statement

$$A = 3 * J / I * K - 4 / J$$

is

(a) $\frac{1}{2}$ ( )

(b) $\frac{3}{2}$ ( )

(c) 1 ( )

(d) 0 ( )

SECTION—II

(*Marks* : 15)

Answer the following questions : 3×5=15

1. Prove that

$$\int_0^{\pi/2} \sqrt{\tan\theta}\, d\theta = \frac{\Gamma(\frac{1}{4})\Gamma(\frac{3}{4})}{2}$$

2. Find the Fourier sine transform of $f(x) = x$ such that $0 < x < 2$.

3. If $f(s)$ is the Laplace transform of $F(t)$, then show that

$$f'(s) = \frac{df}{ds} = \mathscr{L}[-tF(t)]$$

4. Show that the group formed by the set $\{1, \omega, \omega^2\}$, ω being the cube root of unity i.e., $\omega^3 = 1$, is a cyclic group of order 3 with respect to multiplication.

5. Suppose $A = 2 \cdot 5$, $B = 3 \cdot 5$, $J = 5$ and $K = 10$. What will be the value of J after the following program segment is executed :

```
      IF (2*K.LE.3*J) GO TO 50
      J = J + 1
      GO TO 60
50    J = K
60    J = J + K
```

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2017

(6th Semester)

PHYSICS

NINTH PAPER

(Mathematical Physics—II)

(Revised)

Full Marks : 75

Time : 3 hours

(PART : B—DESCRIPTIVE)

(*Marks* : 50)

The figures in the margin indicate full marks for the questions

1. *(a)* What are regular and irregular singularities of a differential equation? Explain them with examples. 1+1=2

(b) Solve the differential equation

$$2x^2y \quad xy \quad (1 \quad x^2)y \quad 0$$

by Frobenius method. 8

Or

Solve the wave equation

$$\frac{^2y}{t^2} \quad c^2 \frac{^2y}{x^2}$$

under the boundary conditions

$$y(0, t) \quad 0 ; \quad y(l, t) \quad 0$$

$$y(x, 0) \quad a \sin \frac{x}{l}$$

$$\frac{y}{t}(x, 0) \quad 0$$

10

2. *(a)* Prove that $P_n(1) \quad 1$. 3

(b) Show that

$$\int_{1}^{1} P_m(x) P_n(x) dx \quad \frac{2}{2n \quad 1} \quad _{m, n}$$

7

Or

(a) For Hermite polynomials $H_n(x)$, show that

$$2x H_n(x) \quad 2nH_{n \quad 1}(x) \quad H_{n \quad 1}(x)$$

4

(b) Show that $J_n(x)$ is the coefficient of z^n in the expansion of $e^{x/2(z \quad \frac{1}{z})}$. 6

3. *(a)* Find the Fourier series representing

$$f(x) \quad x; \ 0 \quad x \quad 2$$ 5

(b) Find the finite Fourier sine and cosine transform of $\frac{^2u}{x^2}$, where u is a function of x and t for $0 \quad x \quad l, \ t \quad 0$. 2½×2=5

Or

(a) Define finite Fourier sine transform of a function. Hence find the Fourier sine transform of $F(x) \quad x$ such that $0 \quad x \quad 2$. 2+2=4

(b) Deduce the Fourier integral for a function. 6

4. *(a)* Define Laplace transform of a function. Find the Laplace transform of *(i)* e^{at} and *(ii)* $\sin at$. 2+2+2=6

(b) Using Laplace transform, solve the differential equation

$$t\,y \ (t) \quad y \ (t) \quad ty(t) \quad 0$$

under the condition that $y(0) \quad 1$ and $y(t)$ is bounded. 4

Or

(a) Using Laplace transform, evaluate

$$_0 t^2 e^{\ t} \sin t\,dt$$ 4

(b) Find the inverse Laplace transform of

$$\frac{1}{s^2 \quad 7s \quad 12}$$ 3

(c) Using inverse Laplace transform, show that

$$_0 \cos e^{\ x^2} dx \quad \frac{1}{2}\sqrt{\ }$$ 3

5. *(a)* What do you mean by a variable in FORTRAN? What are the different types of variables in FORTRAN? State the general rules for naming a variable in FORTRAN programming. 1+2+2=5

(b) Write a FORTRAN program to calculate the magnitude of

$$\vec{A} \quad A_1\hat{i} \quad A_2\hat{j} \quad A_3\hat{k}$$ 2

(c) Explain any three FORTRAN control statements with examples. 3

Or

(a) Write a FORTRAN program to evaluate a cosine series up to n terms. 4

(b) Write a FORTRAN program to find the slope and midpoint of a line. 4

(c) Find the value of K after the following program segment is executed : 2

```
K = 0
DO 10I = 5, 25, 3
  K = K + I
  IF (K.GT.12) GO TO 15
  10 CONTINUE
  15 K = 2 * K
```

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Subject Code : PHY/VI/09 (R)

Booklet No. A

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2 0 1 7

(6th Semester)

PHYSICS

NINTH PAPER

(Mathematical Physics—II)

(Revised)

(PART : A—OBJECTIVE)

(*Marks* : 25)

The figures in the margin indicate full marks for the questions

SECTION—I

(*Marks* : 10)

Tick (✓) the correct answer in the brackets provided : 1×10=10

1. The differential equation of a circle having centre at the origin (0, 0) and radius r is

(a) $x^2 + y^2 = r^2$ ( )

(b) $x\,dx + y\,dy = 0$ ( )

(c) $y\,dx + x\,dy = 0$ ( )

(d) $x\,dx - y\,dy = 0$ ( )

2. Consider the differential equation $P_0y'' + P_1y' + P_2y = 0$, where P_0, P_1 and P_2 are polynomials in x. The point $x = a$ is an ordinary point if

(a) P_0 does not vanish for $x = a$ ( )

(b) P_0 vanishes for $x = a$ ( )

(c) P_0, P_1 and P_2 vanish for $x = a$ ( )

(d) None of the above ( )

3. Legendre polynomial $P_0(x)$ is

(a) 1 ( )

(b) x ( )

(c) $3x^2 - 1$ ( )

(d) $1 - 2x$ ( )

4. For Hermite polynomials $H_n(x)$, $H_1(x)$ is given by

(a) 1 ( )

(b) $2x$ ( )

(c) 0 ( )

(d) x ( )

5. The Fourier series of an even function contains

(a) only the cosine terms ( )

(b) only the sine terms ( )

(c) both the sine and cosine terms ( )

(d) None of the above ( )

6. The function $f(x) = x^3$ in the range $-\pi < x < \pi$ is

(a) an odd function ( )

(b) an even function ( )

(c) a numeric function ( )

(d) a delta function ( )

7. The Laplace transform of $F(t) = 1$ is

(a) 1 ( )

(b) $\frac{1}{s}$, $s > 0$ ( )

(c) s, $s > 0$ ( )

(d) $\frac{1}{s^2}$, $s > 0$ ( )

8. The inverse Laplace transform of 1 is

(a) 1 ( )

(b) $\delta(t)$ ( )

(c) $\delta(t-1)$ ( )

(d) 0 ( )

9. Which of the following is a valid variable name in FORTRAN?

(a) $A*123$ ( )

(b) $123*A$ ( )

(c) 123 A ( )

(d) A 123 ( )

10. If $A = 3$, $B = 8$ and $C = 4$, then the value of D in the statement $D = 3*B / A*C - 4$ is

(a) 12 ( )

(b) 32 ( )

(c) 30 ( )

(d) 28 ( )

SECTION—II

(*Marks* : 15)

Answer the following questions : 3×5=15

1. Find the regular singular point of the differential equation

$$2x^2y'' + 3xy' + (x^2 - 4)y = 0$$

2. Show that $J_{-n}(x) = (-1)^n J_n(x)$, where n is a positive integer.

3. Find the inverse Fourier cosine transform of $e^{-\lambda n}$.

4. Find the Laplace transform of Bessel function $J_0(x)$.

5. Write a FORTRAN program that can be used to find the factorial of a positive integer.

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2017

(6th Semester)

PHYSICS

TENTH PAPER

(Nuclear Physics—II)

(Pre-revised)

Full Marks : 75

Time : 3 hours

(PART : B—DESCRIPTIVE)

(*Marks* : 50)

The figures in the margin indicate full marks for the questions

1. *(a)* Explain the terms—binding energy, mass defect and packing fraction of nuclei. 3

(b) How does the binding energy per nucleon for light, medium and heavy nuclei vary with mass number? 3

(c) How will you classify stable nuclei according to even and odd numbers of protons and neutrons? 4

Or

Obtain semiempirical mass formula of a nucleus. 10

2. *(a)* What is the cause of alpha decay? State and explain Geiger-Nuttal law in alpha decay. 2+4=6

(b) What are radioisotopes? Write the three uses of radioisotopes. 4

Or

Write down the origin of gamma rays. Describe one method of measurement of energy of gamma rays. 5+5=10

3. *(a)* Describe the liquid-drop model of the nucleus. Point out its limitations in understanding the nuclear phenomenon. 7

(b) What is nuclear fission? Write the importance of secondary neutrons in the reaction. 3

Or

How are neutrons classified according to their kinetic energy? Write an account of the discovery, production and properties of neutron. 2+8=10

4. Describe the construction and working principle of cyclotron. Obtain the expression for maximum kinetic energy. Write down some of its limitations. 10

Or

Explain the construction and working principle of GM counter. Write the applications and its limitations. 10

5. What do you understand by mesons? Characterize different kinds of mesons. Describe how muons and pions were discovered in cosmic rays. 10

Or

What are elementary particles? How are the elementary particles classified on the basis of their masses, interaction or statistics? 2+8=10

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Subject Code : PHY/VI/10 (PR)

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2 0 1 7

(6th Semester)

PHYSICS

TENTH PAPER

(Nuclear Physics—II)

(Pre-revised)

(PART : A—OBJECTIVE)

(*Marks* : 25)

The figures in the margin indicate full marks for the questions

SECTION—A

(*Marks* : 10)

Put a Tick (✓) mark against the correct answer in the brackets provided : 1×10=10

1. The difference in the mass of the resultant nucleus and the sum of the masses of two parent nuclear particles is known as

(a) mass defect ( )

(b) solid defect ( )

(c) weight defect ( )

(d) nucleus defect ( )

2. Bohr magneton is defined as

(a) B $\frac{eh^2}{4\ m_e}$ ( )

(b) B $\frac{eh}{4\ m_e}$ ( )

(c) B $\frac{4\ m_e}{eh}$ ( )

(d) B $\frac{4\ e}{hm_e}$ ( )

3. During fission of U_1^{235}, the number of neutrons released per fission is

(a) 1·5 ( )

(b) 2 ( )

(c) 2·5 ( )

(d) 3 ( )

4. Elements undergo radioactive decay when proton number becomes greater than

(a) 50 ( )

(b) 40 ( )

(c) 83 ( )

(d) 73 ( )

5. Gamma radiation is emitted in order to

(a) excite atom ( )

(b) release excess energy from the atom ( )

(c) destabilize atom ( )

(d) stabilize atom ( )

6. Nuclear fusion releases energy when

(a) uranium splits into two fragments ( )

(b) uranium emits a neutron ( )

(c) heavy ions fuse together ( )

(d) very light nuclei fuse together ( )

7. In proportional counter, if the radius of the wire (anode) be a and that of the counter (cathode) be b, then the radial field E at a distance r is given by

(a) $E \quad \frac{Vr}{\log_e(b / a)}$ ( )

(b) $E \quad \frac{r}{V \log_e(b / a)}$ ( )

(c) $E \quad \frac{V^2}{r^2 \log_e(b / a)}$ ( )

(d) $E \quad \frac{V}{r \log_e(b / a)}$ ( )

8. In case of cyclotron, the frequency of oscillator is given by

(a) $f \quad \frac{B^2 e^2}{2\ m}$ ( )

(b) $f \quad \frac{Be}{4\ m^2}$ ( )

(c) $f \quad \frac{Be}{2\ m}$ ( )

(d) $f \quad \frac{2\ m}{Be}$ ( )

9. Positron was discovered by C. D. Anderson in

(a) 1932 ( )

(b) 1832 ( )

(c) 1923 ( )

(d) 1823 ( )

10. The mean life of decay of muons is about

(a) 20 s ( )

(b) 2 s ( )

(c) 200 s ( )

(d) 2000 s ( )

SECTION—B

(*Marks* : 15)

Answer the following questions : 3×5=15

1. Explain the proton-electron hypothesis and proton-neutron hypothesis of nuclear composition.

2. What is the difference between -decay and *K*-capture?

3. What is radioactive series? Name the three naturally occurring radioactive series.

4. Explain the principal action of a scintillation counter.

5. Give an account of the discovery of the positron.

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2017

(6th Semester)

PHYSICS

TENTH PAPER

(Nuclear Physics—II)

(Revised)

Full Marks : 75

Time : 3 hours

(PART : B—DESCRIPTIVE)

(*Marks* : 50)

The figures in the margin indicate full marks for the questions

1. *(a)* What do you understand by mass defect and binding energy per nucleon? 2

(b) Describe graphically, how the binding energy per nucleon for light, medium and heavy nuclei vary with mass number. Explain how the energy is released when both light nuclei fuse together and a heavy nucleus undergoes fission. 6

(c) Calculate the binding energy per nucleon for -particle or He-nucleus ($_2He^4$), given masses m_p 1 007276 amu, m_n 1 008665 amu and M 4 001506 amu [1 amu = 931 MeV]. 2

Or

(a) Discuss about the nuclear stability. Hence explain the significance of magic numbers. 2+2

(b) Write down the semi-empirical mass formula of von Weizsaecker and explain the significance of various terms in it. Mention some applications of the formula. 5+1

2. *(a)* State the laws of radioactive decay and hence define the decay constant. 2+1

(b) Prove that the decay constant of a substance is the reciprocal of the time after which the number of nuclei falls to $\frac{1}{e}$ of its original value. 5

(c) Calculate the half-life and mean life of a substance whose decay constant is 4 28 10 ^{4} per year. 2

Or

(a) State and explain Geiger-Nuttall law. 4

(b) What is beta decay? Discuss the energy spectrum curve from beta decay. Explain how Pauli's neutrino hypothesis accounts for the continuous beta-ray spectra. 6

3. *(a)* What do you mean by '*Q*-value' and 'threshold energy' of a nuclear reaction? 2+2

(b) For a nuclear reaction $a\ X\ Y\ b$, where X and Y are target and product nuclei respectively, and a and b are the bombarding and outgoing particles, obtain an expression for *Q*-value and threshold energy. 6

Or

(a) Discuss the terms related to nuclear fission : 3

(i) Chain reaction

(ii) Critical mass

(iii) Multiplication factor

(b) Discuss how nuclear fusion reaction enables energy generation inside stars. (State the detailed steps of either *p-p* cycle or *C-N* cycle.) 4

(c) Explain the differences between nuclear fission and nuclear fusion by using suitable examples of these reactions. 3

4. Describe the construction and working principle of a cyclotron with neat diagram. What are its limitations and how these are resolved? 7+3

Or

Describe the construction and principle of a GM counter and explain its operations. What do you mean by the 'counter efficiency' and 'dead time' of a GM counter? 8+2

5. *(a)* Discuss primary and secondary cosmic rays. 4

(b) Explain the terms in detail : 3+3

(i) Latitude effect

(ii) Altitude effect in cosmic rays

Or

(a) Mention four fundamental interactions found in nature. What are the corresponding force carriers or exchange particles for these interactions? 2+2

(b) What do you mean by 'hadrons'? How are they further classified? Give examples of each type of hadrons and mention their quark structures. 1+1+2

(c) Based on the conservation of quantum numbers, mention whether the following reaction can occur or not : 2

$$p \quad p \quad n \quad p$$

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Subject Code : PHY/VI/10 (R)

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2 0 1 7

(6th Semester)

PHYSICS

TENTH PAPER

(Nuclear Physics—II)

(Revised)

(PART : A—OBJECTIVE)

(*Marks* : 25)

The figures in the margin indicate full marks for the questions

SECTION—I

(*Marks* : 10)

Tick (✓) the correct answer in the brackets provided : 1×10=10

1. Which of the following nuclei are isobars?

(a) $_{14}Si^{28}$, $_{14}Si^{29}$ ( )

(b) $_{8}O^{16}$, $_{7}N^{16}$ ( )

(c) $_{6}C^{14}$, $_{8}O^{16}$ ( )

(d) None of the above ( )

2. The radius of $_2He^4$ is 2·24 fm. Hence the radius of $_{99}Es^{256}$ is

(a) 4·48 fm ( )

(b) 6·72 fm ( )

(c) 8·96 fm ( )

(d) 11·20 fm ( )

3. When $_{29}Cu^{64}$ emits a positron, the resultant nucleus is

(a) $_{28}Ni^{64}$ ( )

(b) $_{29}Cu^{63}$ ( )

(c) $_{30}Zn^{64}$ ( )

(d) $_{28}Ni^{63}$ ( )

4. When $_5B^{11}$ is bombarded with proton, it is artificially transmuted to $_4Be^8$. The outgoing particle is

(a) proton ( )

(b) deuteron ( )

(c) neutron ( )

(d) α-particle ( )

5. Nuclear isomers are the nuclei having

(a) different charge numbers ( )

(b) different mass numbers ( )

(c) different nuclear energy states ( )

(d) All of the above ( )

6. Controlled thermonuclear reaction may be possible in

(a) International Thermonuclear Energy Reactor (ITER) ( )

(b) nuclear reactor ( )

(c) atom bomb ( )

(d) hydrogen bomb ( )

7. In a linear accelerator, the tubes must have lengths proportional to

(a) 1 : 2 : 3 : 4 ... ( )

(b) $1 : \sqrt{2} : \sqrt{3} : \sqrt{4}$ ... ( )

(c) 1 : 4 : 9 : 16 ... ( )

(d) 1 : 1 : 1 : 1 ... ( )

8. According to standard model of particle physics, the fundamental matter particles are

(a) quarks and leptons ( )

(b) leptons and mesons ( )

(c) quarks and gluons ( )

(d) leptons and baryons ( )

9. Which of the following instruments is not a radiation detector?

(a) Ionisation chamber ( )

(b) Proportional counter ( )

(c) Cloud chamber ( )

(d) Electron synchrotron ( )

10. The isotopic spin I is related to multiplet number M as

(a) $M = 2I + 1$ ( )

(b) $M = I + 1$ ( )

(c) $M = 2I - 1$ ( )

(d) $M = I - 1$ ( )

SECTION—II

(*Marks* : 15)

Answer the following questions : 3×5=15

1. What do you mean by nuclear density? Show that it is constant for all nuclei.

2. What do you mean by radioactive dating? Discuss the carbon dating technique.

3. Mention some of the basic properties of neutrons and their classifications.

4. Write a short note on proportional counter.

5. Based on quark structure, show that proton has charge +1, π^- has charge –1 and neutron has no charge.

★★★

2017

(6th Semester)

PHYSICS

ELEVENTH PAPER

(Electromagnetic Theory)

(Pre-Revised)

Full Marks : 55

Time : 2½ hours

(PART : B—DESCRIPTIVE)

(*Marks* : 35)

The figures in the margin indicate full marks for the questions

1. *(a)* Give the statement of Faraday's laws of electromagnet. 1

(b) Starting from Maxwell's equations, show that the electric field satisfies the following differential equation in a homogeneous medium containing charges and currents :

$$^2\vec{E} \quad \frac{^2\vec{E}}{t^2} \quad \frac{\vec{E}}{t}$$

Here the notations in the equation have their usual meanings. 3

(c) What is displacement current? Prove that the displacement current in the direction of a parallel-plate capacitor is equal to the conduction current in the connecting loads. 1+2=3

Or

(a) Derive the Maxwell's equation

$$\rightarrow \quad \vec{H} \quad \vec{J} \quad \frac{\vec{D}}{t}$$

where $\vec{D}$ is electric displacement and $\vec{J}$ is the current density. 4

(b) Using Maxwell's equations, discuss the boundary conditions satisfied by the magnetic field vector at the interface between two different media. 3

2. *(a)* Derive the general equation for electromagnetic wave equation in free space and hence show that the propagation of electric and magnetic fields are in phase. 2+2=4

(b) Define the transverse nature of electromagnetic waves and explain its orthogonality. 2+1=3

Or

(a) Derive the necessary equation to define the Poynting vector and also explain the Poynting theorem. 2+2=4

(b) Define the electromagnetic momentum and express it in its vector form. 2+1=3

3. *(a)* Discuss the reflection and refraction of electromagnetic wave by considering the oblique incidence at the boundary. 2½+2½=5

(b) Explain in brief the polarization of electromagnetic wave. 2

Or

(a) What is the total internal reflection of an e.m. wave? Show that the wave is totally reflected back at total internal reflection. 3+1=4

(b) What are skin depth and the skin effect in an electromagnetic wave? 3

4. *(a)* What are the scalar and vector potentials in e.m. waves? Show that the electromagnetic potentials satisfy the wave equation. 1+3=4

(b) Derive the Poisson's equation using vector potential with the current density. 3

Or

Discuss the transformation of electromagnetic wave by using Lorentz gauge transformation and explain how the Lorentz gauge is used to explain the wave theory. 4+3=7

5. Deduce the total power radiated from an oscillating dipole

$$\langle P_E \rangle \quad \frac{1}{4 \quad 0} \quad \frac{p_0 \quad ^4}{3c^2}$$

where p_0 is the amplitude of electric dipole, the frequency of oscillating dipole and c the velocity of light 7

Or

Explain Rayleigh scattering of electromagnetic radiation and thus derive the expression for the scattering cross section

$$\frac{\quad 2}{\quad 0} \quad T$$

where the symbols used have their usual meanings. 7

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Subject Code : PHY/VI/11 (PR)

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Descriptive Type

Booklet No. B .....

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2 0 1 7

(6th Semester)

PHYSICS

ELEVENTH PAPER

(Electromagnetic Theory)

(Pre-Revised)

(PART : A—OBJECTIVE)

(*Marks* : 20)

The figures in the margin indicate full marks for the questions

SECTION—I

(*Marks* : 5)

Put a Tick ☑ mark against the correct answer in the box provided : 1×5=5

1. The integral form of Maxwell's equation originated from Faraday's law of electromagnetic induction is

(a) $\vec{D}\ \bar{d}s \quad {}_{v}dV$ ☐

(b) $\vec{B}\ \bar{d}s \quad 0$ ☐

(c) $\circ_{c} \vec{H}\ \bar{d}l \quad \vec{I}_{c}\ \bar{d}s \quad \frac{\vec{D}}{t}\ \bar{d}s$ ☐

(d) $\circ_{c} \vec{E}\ \bar{d}l \quad \frac{\vec{B}}{t}\ \bar{d}s$ ☐

2. The intrinsic impedance of electromagnetic wave is

(a) $\frac{0}{k}$ ☐

(b) $\frac{_0 k}{}$ ☐

(c) $\frac{0}{k}$ ☐

(d) $\frac{_0 k}{}$ ☐

where the symbols used have their usual meanings.

3. For normal incidence of an e.m. wave from media 1 to 2, the ratio of transmitted intensity to the incidence intensity is

(a) $R_n \quad \frac{n_2 \quad n_1}{n_2 \quad n_1}^{2}$ ☐

(b) $R_n \quad \frac{n_1}{n_2 \quad n_1}^{2}$ ☐

(c) $R_n \quad \frac{n_2 \quad n_1}{n_2 \quad n_1}^{2}$ ☐

(d) $R_n \quad \frac{n_2}{n_2 \quad n_1}^{2}$ ☐

where n_1 and n_2 are the refractive indices of the dielectric media 1 and 2 respectively.

4. For any e.m. wave, the dispersion relation gives the relation between the

(a) wave number k and velocity of the wave v ☐

(b) wave number k and frequency ☐

(c) velocity of the wave v and intensity i ☐

(d) wave number k and intensity i ☐

5. The energy radiated by an oscillating electric dipole is represented by

(a) $\vec{S} \quad \frac{1}{0}(\vec{E} \quad \vec{B})$ ☐

(b) $\vec{S} \quad \frac{1}{}(\vec{E} \quad \vec{B})$ ☐

(c) $\vec{S} \quad \frac{1}{}(\vec{E} \quad \vec{B})$ ☐

(d) $\vec{S} \quad \frac{1}{0}(\vec{E} \quad \vec{B})$ ☐

SECTION—II

(*Marks* : 15)

Give very short answers to the following questions : 3×5=15

1. If e.m. wave is propagated in a material media, show that the Maxwell's equations for curl B becomes

$$\rightarrow \vec{B} \qquad \vec{J}_f \rightarrow \vec{M} \frac{\vec{P}}{t} \frac{1}{c^2}\frac{\vec{E}}{t}$$

where the notations in the equation have their usual meanings.

2. Define the radiation pressure and give the relation with intensity of e.m. wave.

3. State and explain Brewster's law in electromagnetic waves.

4. Explain the non-uniqueness of the magnetic and scalar potentials.

5. What are retarded potentials and retarded times in an electromagnetic wave?

★★★

2017

(6th Semester)

PHYSICS

ELEVENTH PAPER

(Electromagnetic Theory)

(Revised)

Full Marks : 55

Time : 2½ hours

(PART : B—DESCRIPTIVE)

(*Marks* : 35)

The figures in the margin indicate full marks for the questions

1. Using Maxwell's electromagnetic field equations, deduce the wave equations satisfied by the electric field vector and the magnetic field vector in free space. Obtain their plane wave solution and hence show that electromagnetic waves are transverse in nature. 3+2+2=7

Or

Define Poynting vector. Deduce theoretically Poynting theorem for the flow of energy in an electromagnetic field. 2+5=7

2. Derive Fresnel equations for reflection and refraction of electromagnetic waves at a plane boundary separating two media when the incident wave is polarized with E vector parallel to the plane of incidence. Find the angle of incidence for which there is no reflected wave. What is this angle called? 5+1+1=7

Or

Discuss the propagation of plane electromagnetic waves in conducting medium and hence explain why plane wave cannot propagate in it without attenuation. 6+1=7

3. What are the electromagnetic potentials? Establish the non-uniqueness of electromagnetic potentials. What do you mean by gauge transformation? 3+3+1=7

Or

What do you mean by Coulomb gauge and Lorentz gauge? Show that the scalar potential satisfies Poisson's equation and hence explain the origin of transverse gauge. 3+3+1=7

4. *(a)* Draw the equivalent circuit of an op-amp. Write down the characteristics of an ideal op-amp. 3

(b) Using op-amp, design an inverting amplifier and obtain the expression for voltage gain. 4

Or

Draw the circuit diagram of integrator and differentiator using op-amp. Obtain the expression for output voltage in both the cases. 3+2+2=7

5. *(a)* What are universal gates and why are they so called? Draw their logic symbols and write their truth table. 1+3=4

(b) Construct a logic circuit whose output is given by the Boolean expression $(A \quad B)\ \overline{AB}$. 3

Or

(a) State and prove De Morgan's theorem. 3

(b) Write the truth table and draw the digital circuit of full adder. 4

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Subject Code : PHY/VI/11 (R)

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2 0 1 7

(6th Semester)

PHYSICS

ELEVENTH PAPER

(Electromagnetic Theory)

(Revised)

(PART : A—OBJECTIVE)

(*Marks* : 20)

The figures in the margin indicate full marks for the questions

SECTION—I

(*Marks* : 5)

Tick (✓) the correct answer in the brackets provided : 1×5=5

1. For a plane wave of angular frequency ω and propagation vector $\vec{k}$ propagating in the medium, Maxwell's equations reduce to

(a) $\vec{k}\cdot\vec{E}=0,\ \vec{k}\cdot\vec{H}=0,\quad \vec{k}\times\vec{E}=-\mu\omega\vec{H},\ \vec{k}\times\vec{H}=\varepsilon\omega\vec{H}$ ( )

(b) $\vec{k}\cdot\vec{E}=0,\ \vec{k}\cdot\vec{H}=0,\quad \vec{k}\times\vec{E}=\mu\omega\vec{H},\ \vec{k}\times\vec{H}=\varepsilon\omega\vec{H}$ ( )

(c) $\vec{k}\cdot\vec{E}=0,\ \vec{k}\cdot\vec{H}=0,\quad \vec{k}\times\vec{E}=\varepsilon\omega\vec{H},\ \vec{k}\times\vec{H}=-\mu\omega\vec{H}$ ( )

(d) $\vec{k}\cdot\vec{E}=0,\ \vec{k}\cdot\vec{H}=0,\quad \vec{k}\times\vec{E}=\mu\omega\vec{H},\ \vec{k}\times\vec{H}=-\varepsilon\omega\vec{H}$ ( )

2. When a plane electromagnetic wave enters from one medium into another, which of the following quantity remains unchanged?

(a) Frequency ( )

(b) Electric field amplitude ( )

(c) Wavelength ( )

(d) Velocity ( )

3. Unlike electrostatics in electrodynamics, we cannot write

(a) $\vec{B} = \vec{\nabla} \times \vec{A}$ ( )

(b) $\vec{\nabla} \times \vec{E} = 0$ ( )

(c) $\vec{\nabla} \times \vec{E} \neq 0$ ( )

(d) $\vec{\nabla} \cdot \vec{B} = 0$ ( )

4. The common mode rejection ratio of an ideal diff-amp is

(a) zero ( )

(b) infinity ( )

(c) less than unity ( )

(d) greater than unity ( )

5. The 2's complement of 1000_2 is

(a) 0111 ( )

(b) 0101 ( )

(c) 1000 ( )

(d) 0001 ( )

SECTION—II

(*Marks* : 15)

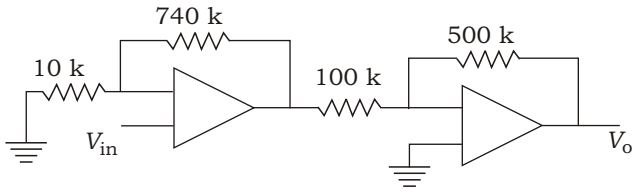
Give very short answers to the following questions : 3×5=15

1. What do you mean by momentum and radiation pressure of an electromagnetic wave?

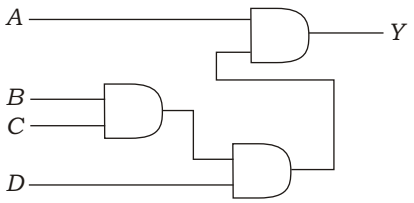
2. The constitutive parameters of aluminium are given by $\mu_r = 1$, $\varepsilon_r = 1$, $\mu_0 = 4\pi \times 10^{-7}$ H/m and $\sigma = 3 \cdot 54 \times 10^7$ mho/m. Find the frequency for which the skin depth of aluminium is 0·01 mm.

3. Express Lorentz force equation in terms of the scalar and vector potentials of electromagnetic field.

4. Find the output of the circuit given below :



5. After finding the Boolean equation for the circuit shown in the figure below, compute the output if $A = 1,\ B = 0,\ C = 1,\ D = 0$:



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2017

(6th Semester)

PHYSICS

TWELFTH (A) PAPER

(Solid-State Physics—II)

(Pre-revised)

Full Marks : 55

Time : 2½ hours

(PART : B—DESCRIPTIVE)

(*Marks* : 35)

The figures in the margin indicate full marks for the questions

1. Derive the dispersion relation for the vibrations of a one-dimensional monatomic lattice. Deduce the expression for the phase and group velocities from the dispersion relation. 4+3=7

Or

Considering the vibrations of diatomic linear lattice, derive the expressions for the frequency of acoustic and optical branches of vibrations. Draw the dispersion curves for the two branches of vibrations. 5+2=7

2. Derive the expression for paramagnetic susceptibility of a solid and hence derive the Curie's law. 5+2=7

Or

What are ferromagnetic domains? Write about the contributing factors in the total internal energy of the domain structure in a ferromagnetic material. 2+5=7

3. Evaluate the local field acting at an atom in the dielectric and derive the Clausius-Mossotti relation. 3+4=7

Or

What do you mean by polarizability? Discuss the classical theory of electronic polarizability. 7

4. What are the basic assumptions in Kronig-Penney model? Discuss the Kronig-Penney model for the motion of an electron in a linear lattice. 2+5=7

Or

How do the energy bands originate in solids? Explain the classification of solids in terms of energy bands. What are direct and indirect transitions? 2+3+2=7

5. Derive the London's equations and obtain an expression for London's penetration depth. 5+2=7

Or

What are Cooper pairs and coherence length? Explain how the superconducting energy gap varies with temperature. 2+2+3=7

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Subject Code : PHY/VI/12 (a) (PR)

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2017

(6th Semester)

PHYSICS

TWELFTH (A) PAPER

(Solid-State Physics—II)

(Pre-revised)

(PART : A—OBJECTIVE)

(*Marks* : 20)

The figures in the margin indicate full marks for the questions

SECTION—I

(*Marks* : 5)

Put a Tick (✓) mark against the correct answer in the brackets provided : 1×5=5

1. The phase velocity of the vibrational waves in an elastic media is given by

(a) $V_p = \sqrt{\frac{C}{\rho}}$ ( )

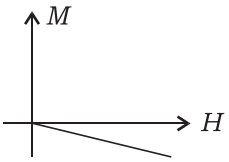
(b) $V_p = \frac{\rho}{C}$ ( )

(c) $V_p = \sqrt{\frac{\rho}{C}}$ ( )

(d) $V_p = \frac{\rho}{C^2}$ ( )

where C is the elastic constant and ρ is the density of the medium.

2. The susceptibility of diamagnetic material corresponds with

(a) 

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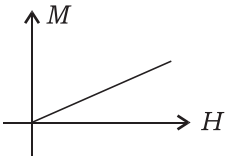
(b) 

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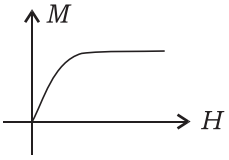
(c) 

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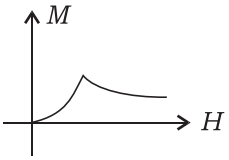
(d) 

( )

3. The relation between dielectric constant and electric susceptibility is given by

(a) $\varepsilon_r + 1 = \chi$ ( )

(b) $\varepsilon_r - 1 = \chi$ ( )

(c) $\varepsilon_r = 1 / \chi$ ( )

(d) $\varepsilon_r = \chi - 2$ ( )

where the symbols have their usual meanings.

4. The effective mass of an electron in an energy band is given by

(a) $m^* = \dfrac{\hbar}{\dfrac{d^2E}{dk^2}}$ ( )

(b) $m^* = \dfrac{\hbar^2}{\dfrac{d^2E}{dk^2}}$ ( )

(c) $m^* = \dfrac{\hbar^2}{\dfrac{dE}{dk}}$ ( )

(d) $m^* = \hbar \cdot \dfrac{dE}{dk}$ ( )

5. The magnetic flux density inside a metal in the superconducting state is always

(a) zero ( )

(b) highest ( )

(c) same as in the non-superconducting state ( )

(d) low ( )

SECTION—B

(*Marks* : 15)

Give short answers of the following questions : 3×5=15

1. What are phonons? Write the wave vector conservation law for inelastic collision.

2. What are the differences between diamagnetic, paramagnetic and ferromagnetic materials?

3. What are normal and anomalous dispersions?

4. Explain the concept of holes.

5. What is the isotope effect of superconductors?

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2017

(6th Semester)

PHYSICS

TWELFTH (A) PAPER

(Solid-State Physics—II)

(Revised)

Full Marks : 55

Time : 2½ hours

(PART : B—DESCRIPTIVE)

(*Marks* : 35)

The figures in the margin indicate full marks for the questions

1. Discuss the lattice vibration of one-dimensional monatomic chain of linear atom and show that the condition at the boundary of the first Brillouin zone is equivalent to Bragg reflection of X-ray. 5+2=7

Or

Obtain the dispersion relation for the case of vibration of one-dimensional diatomic chain of linear atom. Find the value of wave vector for the optical and acoustic branches as $k \to 0$. 6+1=7

2. Describe the classical theory of diamagnetism and obtain the expression for susceptibility. 5+2=7

Or

Discuss the Weiss theory of ferromagnetism and obtain Curie-Weiss law. 5+2=7

3. What is depolarization field? Obtain the expression for local electric field at an atom in dielectric material. 1+6=7

Or

Discuss the classical theory of electronic polarizability and obtain Clausius-Mosotti relation. 4+3=7

4. Discuss the Kronig-Penney model for the motion of an electron in a periodic potential. 7

Or

Discuss the concept of effective mass of an electron. Explain how electron in a crystal can behave dynamically like a particle with variable mass. 5+2=7

5. Derive the London equations and find an expression for London penetration depth. 5+2=7

Or

(a) Define superconductivity. What are type I and type II superconductors? 1+4=5

(b) Briefly explain isotope effect of superconducting material. 2

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Subject Code : PHY/VI/12 (a) (R)

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2 0 1 7

(6th Semester)

PHYSICS

TWELFTH (A) PAPER

(Solid-State Physics—II)

(Revised)

(PART : A—OBJECTIVE)

(*Marks* : 20)

The figures in the margin indicate full marks for the questions

SECTION—A

(*Marks* : 5)

Put a Tick (✓) mark against the correct answer in the brackets provided : 1×5=5

1. The forbidden frequency of solids disappears at k / $2a$, if

(a) m M ( )

(b) m M ( )

(c) m M ( )

(d) mM 1 ( )

where the m's are masses of atoms of one-dimensional diatomic linear chain, a being the nearest neighbor distance.

2. If the susceptibility of a material is independent of temperature, then it is

(a) ferromagnetic ( )

(b) paramagnetic ( )

(c) diamagnetic ( )

(d) antiferromagnetic ( )

3. Bloch theorem is applicable to

(a) constant potential ( )

(b) periodic potential ( )

(c) infinite potential ( )

(d) free electrons ( )

4. Spontaneous polarization takes place due to

(a) atoms ( )

(b) free electrons ( )

(c) permanent dipoles ( )

(d) ions ( )

5. The formation of Cooper pair according to BCS theory is the exchange of virtual phonons between two electrons through

(a) spin-orbit interaction ( )

(b) lattice deformation ( )

(c) magnetic field ( )

(d) Auger effect ( )

SECTION—B

(*Marks* : 15)

Answer the following questions : 3×5=15

1. What are phonons? Write the wave vector conservation law for inelastic collision of photons accompanied by creation and also absorption of phonons.

2. What is crystal anisotropy energy? What is its role in the formation of ferromagnetic domain?

3. What are the different polarization processes? On what factor does the contribution of a particular process of polarization of dielectric depend?

4. Explain how beryllium with electronic configuration $1s^2 2s^2$ is an electrical conductor using energy band concept.

5. What is coherence length? What is the effect of presence of impurities in a superconductor on the coherence length?

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2017

(6th Semester)

PHYSICS

TWELFTH (B) PAPER

(Advanced Electronics)

Full Marks : 55

Time : 2½ hours

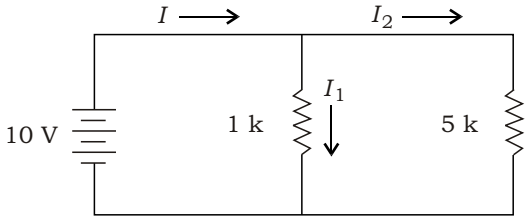
(PART : B—DESCRIPTIVE)

(*Marks* : 35)

The figures in the margin indicate full marks for the questions

1. *(a)* Draw the circuit diagram for Wien's bridge and obtain the two balance conditions. 5

(b) Consider the circuit shown below :



Calculate the currents I, I_1 and I_2. 2

Or

(a) Draw a typical current vs. voltage characteristic curve for a *p-n* junction diode and explain qualitatively its main features. 4

(b) What are load line and Q-point of a *p-n* junction diode? For a basic diode circuit containing one voltage source, series resistance and a diode, draw the characteristic curve showing *Q*-point. 3

2. With the help of appropriate circuit diagram, explain the working principle of a half-wave rectifier and obtain its efficiency. Also calculate the ripple factor of the half-wave rectifier. 3+2+2=7

Or

What is Zener diode? Describe with diagram the use of Zener diode as voltage regulator for both load and line fluctuations. 1+3+3=7

3. What do you understand by transistor biasing? Describe voltage divider bias method in detail. Explain how stabilization of operating point is achieved by this method. 7

Or

With a neat circuit diagram, explain the working of RC coupled amplifier. Draw and explain its frequency response curve. 7

4. What is Barkhausen criterion for oscillation? Draw the circuit diagram of Colpitts' oscillator. Explain how Barkhausen conditions are satisfied. 7

Or

Draw a neat circuit diagram of monostable multivibrator and discuss its working. 7

5. What is the difference between a JFET and a bipolar transistor? Explain the construction and working of a JFET. 7

Or

A carrier wave is amplitude modulated at audio frequency. Deduce an expression to show that two sidebands are produced. What is the relative power in each sideband carrier when modulation coefficient is 0·5? 7

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Subject Code : PHY/VI/12 (b)

Booklet No. A

Date Stamp .....

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To be filled in by the Candidate

DEGREE 6th Semester
(Arts / Science / Commerce / .....) Exam., **2017**

Subject .....

Paper .....

INSTRUCTIONS TO CANDIDATES

1. **The Booklet No. of this script should be quoted in the answer script meant for descriptive type questions and vice versa.**
2. **This paper should be ANSWERED FIRST and submitted within** *45 minutes* **of the commencement of the Examination.**
3. **While answering the questions of this booklet, any cutting, erasing, over-writing or furnishing more than one answer is prohibited. Any rough work, if required, should be done only on the main Answer Book. Instructions given in each question should be followed for answering that question only.**

To be filled in by the Candidate

DEGREE 6th Semester
(Arts / Science / Commerce / .....) Exam., **2017**

Roll No. .....

Regn. No. .....

Subject .....

Paper .....

Descriptive Type

Booklet No. B .....

Signature of Scrutiniser(s)

Signature of Examiner(s)

Signature of Invigilator(s)

2 0 1 7

(6th Semester)

PHYSICS

TWELFTH (B) PAPER

(Advanced Electronics)

(PART : A—OBJECTIVE)

(*Marks* : 20)

The figures in the margin indicate full marks for the questions

SECTION—I

(*Marks* : 5)

Choose the correct answer by putting a Tick (✓) mark in the brackets provided for it : 1×5=5

1. Conductivity of an intrinsic semiconductor is ($_e$ = mobility of electrons, $_h$ = mobility of holes, n = electron density, h = hole density)

(a) $ne_e \quad pe_h$ ( )

(b) $ne_e \quad pe_h$ ( )

(c) ne_e ( )

(d) pe_h ( )

2. Which of the following statements is true?

(a) Emitter in a transistor is always in reverse biased. ( )

(b) Emitter is lightly doped and very thin. ( )

(c) Emitter-base junction is always forward biased. ( )

(d) Collector is the middle section in a transistor. ( )

3. If temperature changes, *h* parameters of a transistor

(a) may or may not change ( )

(b) do not change ( )

(c) also change ( )

(d) become infinitely large ( )

4. An oscillator differs from an amplifier because it

(a) has more gain ( )

(b) requires no input signal ( )

(c) requires no d.c. supply ( )

(d) always has the same input ( )

5. As the modulation level is increased, the carrier power

(a) is increased ( )

(b) remains the same ( )

(c) is decreased ( )

(d) reduces to zero ( )

SECTION—II

(*Marks* : 15)

Give very short answers to the following questions : 3×5=15

1. What do you mean by drift velocity and mobility of an electron?

2. What are tunnel diode and LED?

3. What are class A and class B amplifiers? Explain their differences in operation.

4. What do you understand by gain, stability, distortion and noise?

5. Write a brief note on demodulation of AM wave using diode detector.

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