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SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

M. Sc. (Physics) 2nd Semester ExaminationThursday, 2nd November, 2017

Time: 02:00 pm to 05:00 pm

Subject: PS02CPHY01 [Quantum Mechanics-I]

Total Marks: 70

Note: (1) Figures to the right indicate marks.

(2) Symbols have their traditional meaning.

Q:1 Attempt all of the following Multiple choice type questions. [01 mark each] [08]

- (1) $\langle \phi | \psi \rangle^* =$
- (a) $\langle \psi | \phi \rangle$ (c) $\langle \psi^* | \phi^* \rangle$
 (b) $\langle \psi | \phi \rangle^*$ (d) 1
- (2) _____ plays the role of generator of infinitesimal translations.
- (a) p_z / \hbar (c) L_z / \hbar
 (b) $\hbar L_z$ (d) $\hbar p_z$
- (3) $(\hat{B}\hat{A})^+ =$
- (a) $(\hat{B}\hat{A})^+ = A^+ + B^+$ (c) $(\hat{B}\hat{A})^+ = A^+ B$
 (b) $(\hat{B}\hat{A})^+ = A^+ B^+$ (d) $(\hat{B}\hat{A})^+ = AB^+$
- (4) The quantitative criterion for the smallness of a perturbation is given by
- (a) $|E_n - E_m| \ll |\lambda H'_{nm}|$ for all $n \neq m$ (c) $|\lambda H'_{nm}| \ll |E_n + E_m|$ for all $n \neq m$
 (b) $|E_n + E_m| \ll |\lambda H'_{nm}|$ for all $n \neq m$ (d) $|\lambda H'_{nm}| \ll |E_n - E_m|$ for all $n \neq m$
- (5) At the classical turning point
- (a) $E - V(x) > 0$ (c) $E - V(x) < 0$
 (b) $E - V(x) = 0$ (d) $E - V(x) = \infty$
- (6) If the eigen value E_n is non-degenerate, then $\nu^{(0)}$ _____ be defined uniquely.
- (a) can not (c) can
 (b) may not (d) may
- (7) At large distance from the target, the scattered particles appear radially outwards. The scattered particles are represented as _____ waves.
- (a) spiral (c) spherical
 (b) cylindrical (d) plane
- (8) A barn is equal to
- (a) 10^{-20} cm^2 (c) 10^{-30} cm^2
 (b) 10^{-28} cm^2 (d) 10^{-24} cm^2

Q:2 Answer any 7 of the following 9 questions briefly. [02 marks each] [14]

- 1 Show that the eigenvalues of a Hermitian operator are real.
- 2 Prove that any observable is always diagonal in its own representation.
- 3 Explain symmetries and conservation laws.
- 4 Write down the Hamiltonian for an anharmonic oscillator and a two dimensional harmonic oscillator.
- 5 Explain WKB approximation.
- 6 What is a trial wave function? How is it selected?
- 7 What is exchange interaction?
- 8 Write phase shift δ_l for hard sphere scattering and give its interpretation.
- 9 Explain briefly partial waves.

Q:3 (a) Explain the unitary transformation induced by rotation of coordinate system. [6]

(b) Deduce and discuss the relation $(\chi)_A = [F]_A (\psi)_A$. [6]

OR

Define Hilbert space. Show that for a continuous basis [6]

(b)
$$\langle x | \hat{p} | \psi \rangle = -i\hbar \frac{\partial \psi(x)}{\partial x}$$

Q:4 (a) What is perturbation? Derive and discuss the relation $W^{(1)} = H'_{mm}$. [6]

(b) Write note on space inversion. [6]

OR

(b) Discuss the effect of an electric field on the energy levels of the ground state and the first excited state of the Hydrogen atom. [6]

Q:5 (a) Estimate the ground state energy of a two electron atom using suitable approximation method. [6]

(b) Apply WKB approximation to evaluate bound state energy of a particle in one dimensional potential well. [6]

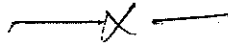
OR

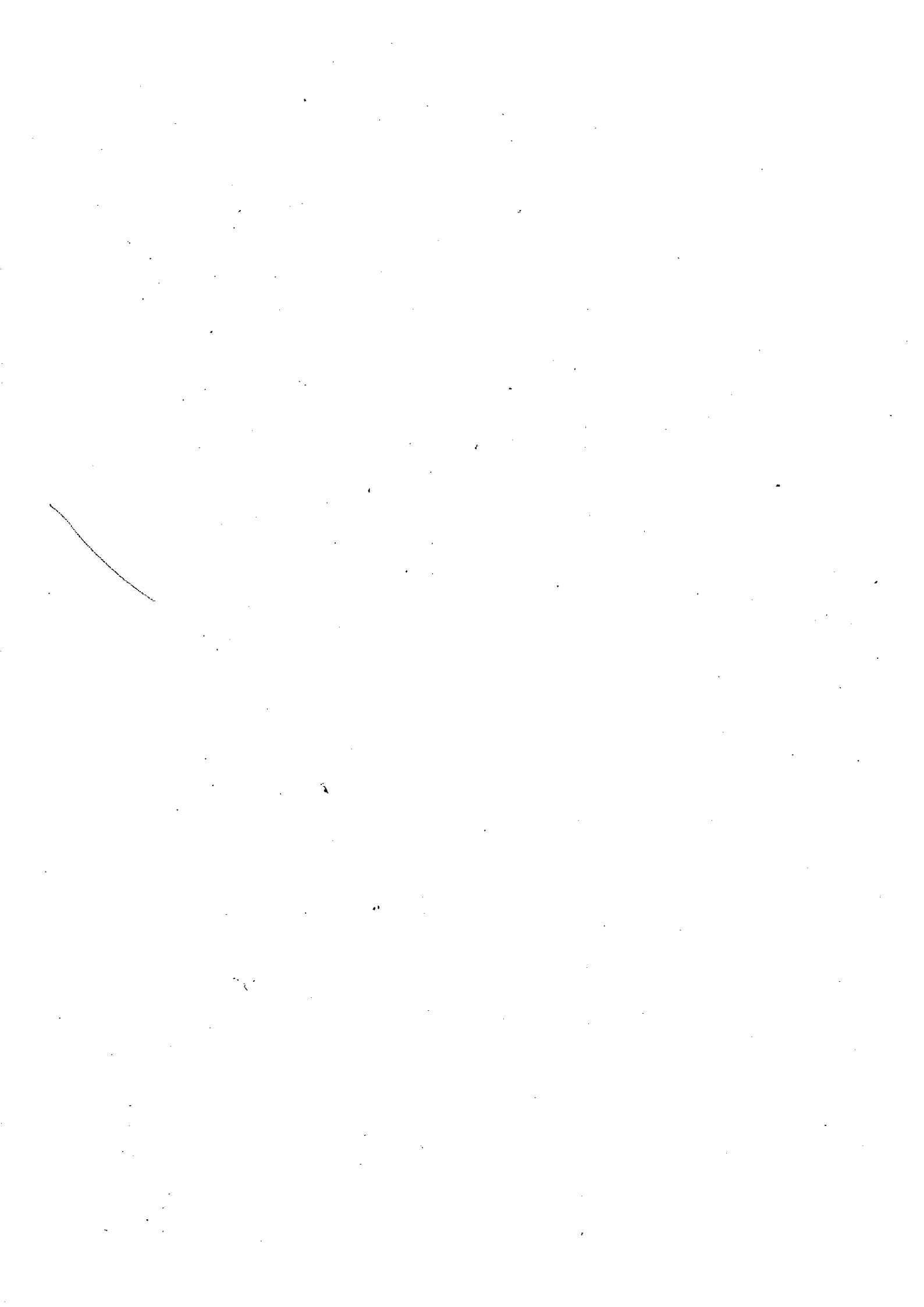
(b) On the basis of variation method explain how the problem of Hydrogen molecule can be worked out. [6]

- Q:6 (a) (i) Explain the wave mechanical picture of scattering and obtain scattering amplitude. [6]
(ii)
- (b) Explain the first Born approximation. Define screened Coulomb potential [6] and evaluate $f_B(\theta)$ for it.

OR

- (b) State and prove optical theorem. Why Born approximation violates this [6] theorem?





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No. of printed pages: 02

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SARDAR PATEL UNIVERSITY
M.Sc. Physics IInd Semester Examination
Day & Date : Monday & 06/11/2017
Time: 02:00 p.m. to 05:00 p.m.
Subject: PHYSICS, Subject Code:PS02CPHY02
Title: Elements of Experimental Physics

Instruction:

Figure to the right indicate marks.

Total Marks: 70

Q.1 Write answer of all questions by showing your choice against the question number. [8]

- (1) _____ material is used to measure the pressure in McLeod gauge.
(a) Lead (b) Titanium (c) iron (d) mercury
- (2) In roots pump, the clearance between lobes is _____ inch is commonly used.
(a) 0.0001 (b) 0.001 (c) 0.01 (d) 0.1
- (3) X-ray consist of :
(a) negatively charged particles (b) electromagnetic radiation
(c) positively charged particles (d) a stream of neutrons
- (4) The Bragg's law for diffraction in crystalline material is:
(a) $n\lambda = -2d\sin\theta$ (b) $n\lambda = 2d/\sin\theta$ (c) $n\lambda = \sin\theta/2d$ (d) $n\lambda = 2d\sin\theta$
- (5) X-rays are produced when an element of high atomic weight is bombarded by high energy _____.
(a) Protons (b) photons (c) neutrons (d) electrons
- (6) The short wavelength limit of X-rays depend on
(a) Nature of target (b) potential difference across the X-ray tube
(c) nature of the filament used (d) none of these
- (7) The energy resolution obtained from ionization detectors is much better than predicted by introducing an empirical factor known as _____ Factor.
(a) Structure (b) Multiplicity (c) Fano (d) Temperature
- (8) The number of observations are falling within each class is called class frequency.
(a) class mark (b) class frequency (c) class boundary (d) class interval

Q.2 Attempt any Seven of the followings:

[14]

- (i) Draw schematic diagram of thermocouple gauge and write principle of this gauge.
- (ii) Mention factors need to minimize the errors in measured values of pressure using McLeod gauge.
- (iii) How X-rays are produce?

- (iv) What do you mean by coherent scattering?
- (v) Describe X-ray photo-electron spectroscopy in brief.
- (vi) What are the important thermal parameters obtained from thermogravimetric analysis?
- (vii) What is histogram? Mention important requirements of histogram.
- (viii) Differentiate between discrete quantity and continuous distributed quantity with example.
- (ix) Describe the procedure to prepare liquid scintillator.

- Q.3(a) Draw schematic diagram of molecular drag pump and describe its working in detail. Also mention its advantages. [6]
- Q.3(b) What is sputtering? Explain the principle, construction, working and advantages of sputter on pump using necessary diagram. [6]
- OR
- Q.3(b) Differentiate between hot and cold cathode ionization gauge. Describe working hot cathode ionization gauge used for measurement of lower pressure. [6]
- Q.4(a) What is scattering? Using necessary diagram explain in detail scattering by an electron. [6]
- Q.4(b) Describe slow neutron scattering in solid in detail. [6]
- OR
- Q.4(b) With help of suitable diagram explain principle, construction and working of Transmission Electron Microscope in detail. [6]
- Q.5(a) What is phosphorescence? Describe construction and working of instrument used for the phosphorescence measurements using necessary diagram. [6]
- Q.5(b) Write a note on X-ray fluorescence spectroscopy. [6]
- OR
- Q.5(b) Discuss the intensity of photoluminescence is related to the concentration in detail. [6]
- Q.6(a) Distinguish between organic and inorganic scintillator. Describe NaI(Tl) scintillator in detail using necessary diagram. [6]
- Q.6(b) (i) Prove that arithmetic mean is the best estimated true value of the data. [3]
- (ii) A company manufactures 80 resistors and the resistance of resistor is given below:
Resistance (ohms) 93-95, 96-98, 99 -101, 102-104 & 105-107
of resistor 4, 15, 33, 21, & 7 respectively.
Determine : arithmetic mean, median value and modal value using above given data. [3]
- OR
- Q.6(b) Describe detailed working of ionization chamber and the proportional counter. [6]

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No. of Printed Pages : 2

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SARDAR PATEL UNIVERSITY
M. Sc. Physics IInd – Semester Examination
Wednesday, Date: 08-11-2017 Time: 2:00 p.m. to 5:00 p.m.
Course No: PS02CPHY03
Subject: Electrodynamics and Plasma Physics

Note: Symbols have their usual meaning.

Total Marks: 70

Q.1 Select the best possible answer from the choices given below each questions. (8)

- (1) Maxwell corrected Amperes law so as to satisfy the
 - (a) Continuity equation for moving charges
 - (b) Displacement current law
 - (c) Biot-Savart's law
 - (d) Faraday's law
- (2) The nonexistence of magnetic monopole can be inferred from the equation given by
 - (a) $\nabla \times E = 0$
 - (b) $\nabla \cdot B = 0$
 - (c) $\nabla \cdot E = 0$
 - (d) $\nabla \times H = 0$
- (3) All metals appear opaque in the optical wavelength is attributed to
 - (a) Brewster effect
 - (b) Polarization effect
 - (c) Skin effect
 - (d) Diamagnetic effect
- (4) Hollow wave guides propagate only ----- modes of electromagnetic waves.
 - (a) TE
 - (b) TM
 - (c) TEM
 - (d) HE
- (5) For a rectangular waveguide the dominant mode of EM transmission is
 - (a) TE_{11}
 - (b) TM_{11}
 - (c) TEM_{11}
 - (d) TE_{10}
- (6) An Antenna located in a town is a source of radio waves. How much time does the signal take to reach another town 12,000 km away from the antenna?
 - (a) 40ms
 - (b) 30 μ s
 - (c) 50 ms
 - (d) 25 μ s
- (7) The radiation emitted by a relativistically moving charge particle in circular orbit is known as
 - (a) Alpha radiation
 - (b) Cerenkov radiation
 - (c) Bremstrahlung radiation
 - (d) Synchrotron radiation
- (8) ITER is an experimental multinational facility related to
 - (a) Fast breeder reactor
 - (b) Accelerator for Hadron therapy
 - (c) Nuclear Fusion energy
 - (d) Hydrogen Bomb for defence purpose

(1)

C.P.T.O.)

Q.2 Answer any seven questions. All questions carry 2 marks each

(7x2=14)

- (1) Write the four Maxwell's equations in differential form.
- (2) Derive the dispersion relation for an electromagnetic wave in a conducting medium.
- (3) State Poynting theorem and explain its physical meaning.
- (4) What is retarded time? Where is it used?
- (5) What is Brewster angle? Explain.
- (6) Explain the basic difference between Bremsstrahlung and Cerenkov radiations.
- (7) Explain the physical meaning of Landau damping.
- (8) Discuss briefly the Lawson criterion.
- (9) Explain briefly the formation of Sheaths in plasma.

Q.3(a) Derive the boundary conditions satisfied by the electromagnetic field components at the interface of two dielectric media. (6)

(b) Derive an expression for the Maxwell's stress tensor. (6)

OR

(b) Derive the Fresnel's equations for the case of polarization in the plane of incidence of a plane electromagnetic wave at oblique incidence. (6)

Q.4(a) Discuss the different modes of electromagnetic wave propagation. Illustrate the electromagnetic wave propagation through a rectangular wave guide for TE mode and identify the dominant mode of propagation. (6)

(b) A plane wave travelling in the +z direction in free space is incident normally at $z=0$ on a conducting medium for which $\sigma = 61.7 \text{ MS/m}$. The free space \mathbf{E} wave having a frequency of 1.5 MHz and magnitude 1.0 V/m is given by $\mathbf{E}(\mathbf{0}, t) = 1.0 \sin(2\pi f t) \mathbf{a}_y$. Find $\mathbf{H}(z, t)$ for $z > 0$. (6)

OR

(b) Discuss a center-fed linear dipole antenna and obtain the power radiated by the antenna. (6)

Q.5(a) Derive the time dependent generalized Coulomb's law from the retarded potentials. (6)

(b) What is Landau damping? Derive its dispersion relation. Give the Physical meaning of Landau damping. (6)

OR

(b) Compute the electric and magnetic fields of a point charge moving with a constant velocity. (6)

Q.6(a) Discuss in detail the problems related to controlled fusion. (6)

(b) Explain the necessity for sheaths in plasma devices and derive the Bohm - Sheath criterion. (6)

OR

(b) Write short notes on i) Acoustic shock waves ii) Ponderomotive force. (6)

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SEAT No. _____

No. of Printed Pages : 02

SARDAR PATEL UNIVERSITY
M. Sc. (Physics) (IInd Semester) Examination
Day: Friday, Date: 10/11/2017, Time: 02:00 p.m. to 05:00 p.m.
Course No. PS02EPHY01 (Analog and Digital Electronics)

All questions are compulsory.

Total Marks: 70
(8)

Q1 Multiple choice questions

- (i) Which of the following devices can be used to construct a relaxation oscillator circuit?
(a) SCR (b) Photodiode (c) UJT (d) IC-555
- (ii) The efficiency of a PN-junction solar cell is a function of
(a) Dimension of solar cell (b) Weight of solar cell
(c) Barrier potential of PN junction (d) None
- (iii) In IC-555, what lies between Pin-1 (Ground) and Pin-8 (+V_{CC}).
(a) inverter as buffer (b) two transistors
(c) potential divider circuit (d) none of them
- (iv) Which of the following devices exhibits highest input impedance?
(a) SCR (b) IC-741 (c) Phototransistor (d) UJT
- (v) A decoder is a logic circuit whose input is _____.
(a) decimal digits (b) binary numbers
(c) both a and b (d) none of them
- (vi) The Gray code equivalent of binary number 1001 is _____.
(a) 1010 (b) 1100 (c) 1001 (d) 1101
- (vii) A percentage resolution of a 12 bit DAC is _____.
(a) 1.58 (b) 0.542 (c) 0.097 (d) 0.024
- (viii) Which of the following Analog to Digital converters has a good compromise between speed and accuracy for A/D conversion?
(a) Successive approximation type (b) Tracking type
(c) Dual slope type (d) Counter type

Q2 Short answer question (Attempt any seven)

(14)

- (i) Define reverse recovery time of a diode and mention the factors on which it depends.
- (ii) With necessary circuit diagram and waveform explain series noise clipper.
- (iii) Justify the statement, "phototransistor is more sensitive than photodiode".
- (iv) Construct a comparator circuit using IC-741 and show its input-output waveforms.
- (v) Sketch and explain the V-I characteristics of TRIAC.
- (vi) What is a decoder circuit? Mention its applications.
- (vii) Why synchronous counters are faster than asynchronous counters? Also mention limitations of synchronous counters.
- (viii) Give classification of semiconductor memory.
- (ix) Discuss about the organization of internal registers of Intel-8085 microprocessor.

(P.T.O.)

- Q3 (a) Write a short note on LED. (6)
- (b) What is silicon control rectifier (SCR)? With the help of neat diagram and equivalent circuit explain its operation. (6)

OR

- (b) Explain how a photovoltaic PN-junction solar cell works? Describe its characteristics in the fourth quadrant and discuss different characterizing parameters. (6)
- Q4 (a) Sketch the block diagram of a timer IC-555 and explain its functioning. Also write equations for charging time and discharging time of an external capacitor and derive the relation for output frequency for a mono-stable multi-vibrator circuit using IC-555. Is it possible to obtain a square wave at the output terminal? (6)
- (b) With the help of a neat diagram explain the working principle of a PLL IC565. Mention few of its chief applications. (6)

OR

- (b) Explain how a Karnaugh mapping is used to reduce a Boolean expression taking a suitable example of a four variable map. (6)
- Q5 (a) Describe the operation of following arithmetic circuits: (6)
- (i) Full-Subtractor (ii) Comparator
- (b) Explain the working of a decoder with the help of logic diagram and truth table. What are its applications? (6)

OR

- (b) Explain the operation of Multiplexer circuit and mention its applications. (6)
- Q6 (a) Sketch the block diagram of 4-bit DAC using a binary counter and explain its operation with the help of output waveform. Also discuss specification parameters of a DAC. (6)
- (b) Describe the operation of a successive approximation type Analog to Digital Converter using its logic diagram and output waveform. (6)

OR

- (b) Sketch the block diagram of Intel-8085 microprocessor and describe the working of ALU and Data/Address bus. (6)

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