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SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

M. Sc. (Physics) 2nd Semester Examination

Tuesday, 11th April, 2017

Time: 10:00 am to 01:00 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) All vectors $c|\psi\rangle, c \neq 0$, which have the same 'direction' as $|\psi\rangle$ correspond to

(a) the same physical state
(b) complete set
(c) Hilbert space
(d) complex conjugate

(2) If to any linear operator $\hat{A}$ there corresponds an adjoint $\hat{A}^+$, then for arbitrary $|\psi\rangle$ and $|\phi\rangle$

(a) $\langle\psi|\hat{A}^+|\psi\rangle = \langle\phi|\hat{A}|\phi\rangle$
(b) $\langle\psi|\hat{A}^+|\phi\rangle = \langle\phi|\hat{A}|\psi\rangle$
(c) $\langle\psi|\hat{A}|\phi\rangle = \langle\phi|\hat{A}|\psi\rangle$
(d) $\langle\psi|\hat{A}^+|\phi\rangle = \langle\phi|\hat{A}^+|\psi\rangle$

(3) In perturbation theory, W and υ are expressed as a

(a) wave function
(b) power series
(c) stationary state
(d) expectation value

(4) $\frac{p^2}{2m} + \frac{1}{2}m\omega^2 x^2$ represents the Hamiltonian of

(a) anharmonic oscillator
(b) two electron atom
(c) harmonic oscillator
(d) Helium atom

(5) The term E-V(x)=0 corresponds to

(a) classical turning point
(b) first order perturbation
(c) WKB approximation
(d) asymptotic region

(6) In the semi classical approximation

(a) $\hbar \to \infty$
(b) $\hbar \to 0$
(c) $\hbar = 0$
(d) $\hbar =$ constant

(7) The term e^{-ikr} represents

(a) incoming plane wave
(b) outgoing plane wave
(c) incoming spherical wave
(d) outgoing spherical wave

(8) In scattering experiment, the incident flux of incoming particles is given by

(a) $\hbar k/m\upsilon$ (c) $\hbar k/m^2$

(b) $\hbar^2 k^2/m$ (d) $\hbar k/m$

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

1 Define Hilbert space.
2 Show that eigenvalues of a Hermitian operator are real.
3 Show that adjoint of the adjoint of an operator is the operator itself.
4 Define perturbation. Give examples.
5 Write the Hamiltonian for (i) a two dimensional harmonic oscillator and (ii) two electrons moving in the field of a fixed nuclear charge.
6 What is WKB approximation?
7 Explain the term exchange interaction.
8 Define differential scattering cross section and total scattering cross section
9 Draw a schematic diagram of a scattering event. Explain the term elastic scattering.

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

(b) For a continuous basis, prove that $\langle x|\hat{p}|\psi\rangle = -i\hbar\frac{\partial\psi(x)}{\partial x}$. [6]

OR

(b) Explain and establish the relation $(\chi)_A = [F]_A(\psi)_A$ [6]

Q:4 (a) Explain how the problem of anharmonic oscillator could be solved by applying perturbation theory. [6]

(b) Discuss the effect of electric field on the energy levels of the ground state of Hydrogen atom i.e. Stark effect. [6]

OR

(b) Define perturbation and give example. For the non-degenerate case derive and discuss the relation $W^{(1)} = H'_{mn}$. [6]

Q:5 (a) Obtain an upper bound on the ground state energy using the variational method. What changes have to be done to apply this method to obtain the upper bound for an excited level. [6]

(b) Discuss trial function linear in variational parameters. Take $\psi(x) = A\cdot\exp(-\alpha x^2)$ as a trial wave function and calculate ground state energy of a 1-D harmonic oscillator. [6]

OR

(b) Apply WKB approximation to evaluate bound state energy of a particle in one dimensional potential well and also obtain the Bohr-Sommerfeld quantization condition. [6]

Q:6 (a) What is Born approximation? Define screened Coulomb potential and evaluate $f_B(\theta)$ for the same. [6]

(b) Write a note on validity of Born approximation. [6]

OR

(b) Interpret partial wave analysis and derive an expression for phase shift. [6]

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SARDAR PATEL UNIVERSITY

M.Sc. Physics II[nd] Semester Examination

Thursday, Date: 13/04/2017, Time: 10.00 a.m. to 01.00 p.m.

Subject: PHYSICS, Paper:PS02CPHY02

Title: Elements of Experimental Physics

Instruction:

Figure to the right indicates marks.

Total Marks: 70

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

(i) In thermocouple gauge, the thermocouple is made up of _____ material.

(a) Nickel – Chromium (b) Chromel-Alumel

(c) Tungsten-Chromel (d) Nickel – Alumel

(ii) A clearance between two lobes is _____ inch is commonly used in the roots pump to create the pressure inside the chamber.

(a) 0.10 (b) 0.010 (c) 0.001 (d) 0.0001

(iii) The non-electromagnetic wave is _____.

(a) X-rays (b) Sound (c) Radio waves (d) Microwaves

(iv) In X-ray, the average value of the intensity is proportional to the _____ of the wave.

(a) square of the amplitude (b) square root of the amplitude

(c) square of the wavelength (d) square root of the wavelength

(v) The structure factor is independent of _____of the unit cell.

(a) shape only (b) size only

(c) both shape and size (d) none of the above

(vi) In TGA analysis, the current is proportional to the change in _____.

(a) temperature of sample (b) pressure of gas

(c) weight of sample (d) all of the above

(vii) If we plot cumulative frequency versus class mid-point then this curve is called _____.

(a) ogive (b) frequency of polygon (c) class frequency (d) class mark

(viii) The energy resolution obtained from ionization detectors is much better than predicted by introducing an empirical factor known as _____ factor.

(a) structure (b) Fano (c) multiplication (d) temperature

Q.2 Attempt any Seven of the followings: [14]

(i)Write the principle and draw the schematic diagram of Pirani gauge used to measure pressure in the chamber.
(ii) Using necessary diagram explain square scale method used for the calibration of McLeod gauge.
(iii) What is Bragg's law?
(iv) Mention the merit and demerit of X-ray and electron diffraction.
(v) Differentiate between differential thermal analysis and differential scanning calorimetry.
(vi) What is Camera constant?
(vii)In a manufacturing process, 75 minutes mean time is required to complete an electronic component. Randomly we have selected 25 components. If standard deviation is 10 minutes,
determine: (a) Population of mean, (b) Standard deviation of the mean and (c) Size of the sample.
The internal standard error is not to exceed 1 min.
(viii) Describe the procedure to prepare liquid scintillator.
(ix) Explain the working of cloud chamber in brief.

Q.3(a) Draw the schematic diagram of diffusion pump and explain principle, construction and the working of this pump in detail. [6]

Q.3(b) What is sputtering? With help of necessary diagram explain principle, construction and working of sputter ion pump. Also mention advantages of this pump. [6]

OR

Q.3(b) Using suitable diagram of penning gauge used to measure lower pressure created in the chamber and describe its construction and working. Also mentions its advantages and disadvantages over hot cathode ionization gauge. [6]

Q.4(a) What is elastic scattering? Explain Thomson's equation of X-ray scattering by electron. [6]

Q.4(b) Differentiate between atomic scattering factor and structure factor. Derive the necessary equation for structure factor for an orthorhombic cell. [6]

OR

Q.4(b) Establish Bragg's condition for electron diffraction. Discuss the experimental technique for electron diffraction for polycrystalline specimen. [6]

Q.5(a) Draw the schematic diagram of thermo gravimetric analyzer and explain its working, applications and uses. [6]

Q.5(b) Discuss in detail the working of X-ray fluorescence technique with diagram. Also explain its applications and limitations. [6]

OR

Q.5(b) With help of necessary diagram, describe differential thermal analysis technique and discuss its working giving an example. [6]

Q.6(a) (i)Derive the expression to calculate the best estimate of uncertainty.
(ii) Using suitable diagram describe properties of Gaussian distribution. [6]

Q.6(b) Differentiate between organic and inorganic scintillator. Why Thallium activator used in NaI crystal to prepare scintillator? Explain working of NaI (Tl) used as a scintillator. [6]

OR

Q.6(b) Write a short note on Geiger-Muller counter. [6]

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M. Sc. (Physics) (II[nd] Semester) Examination

Day: Wednesday, Date: 19/04/2017, Time: 10:00 a.m. to 01:00 p.m.

Course No. PS02EPHY01 (Analog and Digital Electronics)

CBCS (choice based credit system)

Important Note: Q.1: Eight multiple choice questions (MCQ) carry one mark each.
Q.2: Short answer questions carry two marks each (attempt any seven out of nine).
Q.3 to Q.6: Long answer questions carry 12 marks each.

Total Marks: 70

Q1 1 The emitter firing potential V_P in UJT is given as? Where; V_{BB} is voltage between Base-1 and Base-2; V_D is forward voltage drop of the emitter-base and η is intrinsic stand-off ratio.

(a) $\eta V_{BB} + V_D$ (b) $\eta V_{BB} - V_D$
(c) $V_{BB} + \eta V_D$ (d) $V_{BB} - \eta V_D$

2 The fill factor of solar cell is given by _____. If I_{sc} is short circuit current and V_{oc} is open circuit voltage; I_m is maximum current and V_m is maximum voltage delivered by solar cell.

(a) $I_{sc}V_{oc}/I_mV_m$ (b) $I_mV_m/I_{sc}V_{oc}$
(c) $I_{sc}V_m/I_mV_{oc}$ (d) $I_mV_{oc}/I_{sc}V_m$

3 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

4 In a Schmitt Trigger, if V_{ut} and V_{lt} is needed to be fixed at $\pm 3V$, what should be the values of R_1 and R_2, if $\pm V_{sat} = \pm 12V$.

(a) $R_1 = 10\ k\Omega$ and $R_2 = 10\ k\Omega$ (b) $R_1 = 10\ k\Omega$ and $R_2 = 20\ k\Omega$
(c) $R_1 = 10\ k\Omega$ and $R_2 = 40\ k\Omega$ (d) $R_1 = 10\ k\Omega$ and $R_2 = 30\ k\Omega$

5 A decoder is a logic circuit whose input is _____

(a) decimal digits (b) binary coded numbers
(c) both a and b (d) none of them

6 Which of the following counter is a fastest counter?

(a) 4-bit ripple counter with positive edge triggering (b) 4-bit Ring counter
(c) 4-bit ripple counter with negative edge triggering (d) 4-bit synchronous Up-counter

7 A percentage resolution of a 10 bit DAC is _____%.

(a) 1.58 (b) 0.542 (c) 0.097 (d) 0.024

8 Which of the following is a fastest A/D converter?

(a) successive approximation type (b) tracking type
(c) dual slope type (d) counter type

Q2 1 What is reverse recovery time of a diode? How can it be overcome?

2 With necessary circuit diagram and waveform explain series noise clipper.

3 Why phototransitor is more sensitive than photodiode?

4 Using IC-741 construct an inverting comparator? Draw its circuit diagram and input-output waveform.

5 With block diagram and I-V characteristic write a brief note on TRIAC.

6 What are encoder circuits?

7 Compare basic characteristic features of synchronous and asynchronous counters.

8 Give classification of semiconductor memory.

9 Write specification of data bus and address bus of Intel-8085 microprocessor. Also mention how they are shared.

Q3 (a) Discuss in detail by drawing input-output waveform the diode clamper circuits. Draw and discuss the circuit diagram to clamp output at approximately +2V minimum (lower level of wave form at approximately +2V) along with input and output wave forms. 6

(b) Draw and explain with neat diagram the construction and working of silicon control rectifier (SCR). Draw its equivalent circuit using transistors and explain the OFF and ON state conditions? 6

OR

(b) Discuss with neat diagram the construction of uni-junction transistor (UJT). Draw the equivalent circuit diagram and explain the UJT static emitter characteristic. 6

Q4 (a) Discuss in details with block diagram timer IC-555. Describe the use of IC-555 as monostable multivibrator. 6

(b) Draw neat diagram and discuss the principle and working of PLL IC565. 6

OR

(b) Explain in detail the Karnaugh mapping. 6

Q5 (a) Describe the operation of following arithmetic circuits: 6
(i) Full-Adder (ii) Comparator

(b) Explain the working of 3-line to 8-line decoder IC-74LS138 with the help of logic diagram and truth table. What is the use of enable input in a decoder? 6

OR

(b) Explain the operation of Multiplexer and De-Multiplexer circuits and mention their 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 counter 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 use of ALU and Internal registers. 6

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