No. of printed pages 02 SEAT No._____

[1283]

Sardar Patel University
Vallabh Vidyanagar
M Sc (Physics)- IV Semester Examination
PS04CPHY01 Nuclear and Particle Physics
Day and Date: Tuesday, 11 April 2017

Time: 2:00pm to 5:00pm **Max marks: 70**

Note: Symbols have the usual meaning. Use the data given below wherever required.

Data given: [M_P= 1.00759 amu, M_n= 1.00898 amu, m_e= 0.000549 amu, M(deuteron)= 2.013554 amu, M(alpha) = 4.002604 amu, 1amu = 931MeV = 1.6604 x 10-27 kg, Luminosity of sun = 3.86 x 10^{26} W, solar mass = 1.99 x 10^{30} kg]

I Choose the best possible answer from the given choices. (8x1=8)

1. The colour interaction between the Quarks are understood in terms of the exchange of
   (a) photons (b) mesons (c) gluons (d) axions
2. The binding energy per nucleon required to combine two deuterons to form alpha particle is
   (a) 22.81 MeV (b) 5.703 MeV (c) 7.07 MeV (d) 1.367 MeV
3. Ratio of the Bohr magneton (μ_B) to the Nuclear magneton (μ_N) is equal to
   (a) 1 (b) 1000 (c) 1820 (d) 931
4. The pairing energy term in the nuclear binding energy for an odd-odd nucleus is given by
   (a) $+\frac{\delta}{A^{3/4}}$ (b) $-\frac{\delta}{A^{3/4}}$ (c) $+\frac{\delta}{A^{1/3}}$ (d) $-\frac{\delta}{A^{3/2}}$
5. The four factor formula is related to
   (a) linear accelerator (b) nuclear particle detectors
   (c) a fission based nuclear reactor (d) ITER
6. The spontaneous symmetry breaking according to standard model is understood as due to the existence of
   (a) Axion fields (b) Higgs field (c) Fermion fields (d) Gauge fields
7. The As per the β- decay selection rules the β- transition $0^+ \rightarrow 0^+$ is a
   (a) Pure Gammow –Teller allowed (b) Mixed Fermi allowed transition
   (c) Mixed Gammow –Teller allowed (d) Pure Fermi allowed transition
8. According to the single particle shell model the spin parity J^P of $^{17}_{8}O$ nucleus is
   (a) $\frac{5^-}{2}$ (b) $\frac{5^+}{2}$ (c) $\frac{3^+}{2}$ (d) $\frac{1^-}{2}$

II Attempt any seven of the following short answer questions. (7x2=14)

1. Explain central and non-central forces. Give examples for both the cases.
2. Define mirror nuclei. How are they useful in the determination of the nuclear size?
3. A free neutron decays into a proton an electron and an antineutrino. Calculate the kinetic energy shared by the electron and the antineutrino assuming that the proton is at rest.
4. Explain the Geiger-Nuttal law?
5. Show that during the PPI cycle inside the Sun, on an average 6.55 MeV per proton burning is released.
6. Define Q-value of a nuclear reaction? How is it differ from the threshold energy?
7. Discuss the broad classification of elementary particles.
8. Explain gauge principle and its importance in physics very briefly.
9. Explain very briefly the Fermi allowed and Gammow-Teller allowed transitions in β-decay.

III A Explain Weizsacker's semiempirical formula for the nuclear binding energy. Using this formula define the neutron separation (S_n) and proton separation (S_P) energies. Compute them in the case of ^{16}O and ^{17}O isotopes. (6)

B Consider deuteron as a two body nuclear problem, solve the Schrödinger equation with a three dimensional square well potential and show that the probability of finding the proton and the neutron inside the potential well is just about 31% only (Given: E_B = 2.225 MeV, M= 1.67x 10^{-27}kg, b= 2.0 fm) (6)

OR

B. Discuss with sufficient details the magnetic moment of deuteron and show that the ground state of deuteron is not a pure s-state but it has a mixing of about 4% d- states [Given: g_P= 5.5856μ_N , g_n=-3.8264 μ_N , μ_d (expt.)= 0.8573 μ_N] (6)

IV A. Explain different types of nuclear two body exchange forces. Compute their contributions for different nuclear triplet and singlet spin states as well as different odd and even parity states. (6)

B. Discuss the nuclear shell model based on a spherical three dimensional oscillator potential. Also discuss how the introduction of the spin-orbit potential helps it to reproduce all the magic numbers. Discuss briefly the success and failures of the single particle shell model. (6)

OR

B. Discuss in detail the Gamow's theory of α- decay. Give a theoretical explanation for the wide range (10^{-6} s to 10^{10} years) of half-lives of different α- emitters. (6)

V A. Explain the basic principles of accelerators. Discuss the working of van de Graaff accelerator in detail. (6)

B. Discuss in detail the energy loss mechanisms of a heavy charged particle passing through matter. Obtain an expression for the mass stopping power. (6)

OR

B. Explain the general features of a nuclear reactor. Discuss how the nuclear reactors are classified. (6)

VI A Write short notes on the following: (6)
(i) Discuss few medical and therapeutic applications of Nuclear Physics.
(ii) Sources of energy in stars by nucleosynthesis processes.

B. What are the essential properties of QCD. Discuss two experimental evidences infavour of the existence of the colour triplet states of quarks. (6)

OR

B. Explain the various conservation laws abide by the fundamental particles in the micro world. Based on these conservation laws state whether the following reactions are allowed or forbidden. In the case of forbidden reactions indicate the quantum numbers which are not conserved: *i)* $p \rightarrow \pi^0 + e^+$ *ii)* $\Sigma^- + p \rightarrow \pi^+ + \pi^- + \pi^0$ (6)

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SEAT No._____ No. of Printed Pages : 03

[1253]

SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

M. Sc. (Physics) 4th Semester Examination

Thursday, 13th April, 2017

Time: 02:00 pm to 05:00 pm

Subject: PS04CPHY02 [Theoretical Solid State Physics]

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) Near the forbidden band the curvature of E versus k becomes
(a) positive
(b) zero
(c) negative
(d) constant

(2) The energy corresponding to a free electron is given by
(a) $h^2k/8\pi^2m$
(b) $h^2k^2/4\pi^2m$
(c) $hk^2/8\pi^2m$
(d) $h^2k^2/8\pi^2m$

(3) For a monovalent metal, the area of a Brillouin zone corresponding to a square lattice of periodicity a is given by
(a) $2\pi/a^2$
(b) $(2\pi/a)^3$
(c) $4\pi^2/a$
(d) $4\pi^2/a^2$

(4) Number of charge carriers thermally excited from valence band to conduction band is proportional to
(a) $\exp(-Ev/k_BT)$
(b) $\exp(Eg/k_BT)$
(c) $\exp(-Eg/k_BT)$
(d) $\exp(-Ec/k_BT)$

(5) In the NFE case the electron wavefunctions outside the ion core looks like
(a) plane waves
(b) highly oscillating waves
(c) tightly bound
(d) orthogonalized plane waves

(6) Explanation to theory of dHvA effect for Bloch electrons was pointed out by
(a) Landau
(b) Onsager
(c) Bloch
(d) Shoenberg

(7) The London penetration depth _____ with temperature.
(a) increases
(b) decreases
(c) remains constant
(d) levels off

(8) The critical temperature Tc of superconductors varies with the isotopic mass as

(a) $M^{\alpha}T_c = \text{constant}$ (c) $M^{\alpha}/T_c = \text{constant}$

(b) $MT_c = \text{constant}$ (d) $M^{-\alpha}T_c = \text{constant}$

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

1 Explain Umklapp scattering.

2 Explain the origin of energy gap.

3 Draw diagrams properly representing the periodic, extended and reduced zone scheme.

4 For a square lattice in two dimensions, show the first three Brillouin zones.

5 Show schematically and briefly explain how OPW's are obtained.

6 Name the experimental methods used to study the Fermi surface.

7 What is anomalous skin effect?

8 Explain fullerenes.

9 Briefly explain energy gap in a superconductor.

Q:3 (a) What is Bloch function? State and prove Bloch theorem. [6]

(b) Discuss in detail the Kronig-Penny model and describe its consequences. [6]

OR

(b) With necessary equations, discuss plasma oscillations. Derive an expression for static dielectric function, $\varepsilon(\omega) = 1 - \frac{\omega_p^2}{\omega^2}$. [6]

Q:4 (a) Discuss the classification of materials on the basis of band theory of solids. [6]

(b) Describe the Plane wave method of band structure calculation and point out its limitations. [6]

OR

(b) Discuss the empty lattice method of band structure calculation for a one dimensional crystal. [6]

Q:5 (a) Explain the levels of Bloch electrons in a uniform magnetic field and derive the relation $A(\varepsilon_\nu(k_z), k_z) = (\nu + \lambda)\Delta A$. [6]

(b) Explain briefly (i) dHvA effect (ii) Magnetoacoustic effect. [6]

OR

(b) Write a detailed note on Lindhard dielectric function. [6]

Q:6 (a) What is superconductivity? Explain in detail how superconductors are classified into type-I and type-II superconductors. [6]

(b) Write a note on Meissner effect. [6]

OR

(b) What is dc and ac Josephson effect? Explain the dc Josephson effect in detail. [6]

— X —

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SEAT No._____

SARDAR PATEL UNIVERSITY
M. Sc. (Physics), 4th Semester Examination
17th April 2017, Monday
Time: 02:00 PM TO 05:00 PM

No. of Printed Pages : 3

Subject: Applied Crystallography and Biophysics, Paper No. PS04EPHY01

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

Max Marks: 70

Que 1 Write correct answer for each of the following MCQs. **[08]**

1 Doublets on the powder photograph is due to
   a) K_α and k_β
   b) K_{α_1} and K_{α_2} radiation
   c) K and L series of spectrum
   d) Continuous radiation

2 K line is ---------- than I line
   a) Weaker and long wavelength
   b) Stronger and long wave length
   c) Both aresame intensity and wavelength
   d) weaker and short wavelength

3 In Weissenberg method metal screen is
   a) cylindrical and fixed
   b) cylindrical and translating
   c) cylindrical and oscillating
   d) cylindrical and rotate

4 The diffraction pattern in precession method is in
   a) Reciprocal lattice
   b) Direct lattice
   c) It can be in both the lattice
   d) Reciprocal to reciprocal lattice

5 During double strand formation of DNA, the guanine of the first chain pairs with ------ of the second chain.
   a) cytosin
   b) thymine
   c) adenine
   d) guanine

6 In ESR, when external magnetic field is normal to the hemeplane and parallel to the internal field then Lande's factor is
   a) 6
   b) 8
   c) 4
   d) 2

7 The Raman spectra of nucleic acids has two distinct classes of lines, one arising from the bases and other due to
   a) base-sugar
   b) base-phosphate
   c) sugar-phosphate
   d) sugar-sugar

8 The precipitant used for crystallizing proteins in aqueous solution is.
   a) polyamines
   b) polyethylene glycol
   c) metal ions
   d) salts

(1)

Que 2 **Write answers of any seven questions.** **[14]**

1 What is Goniometer head .
What are festoons for in weissenberg method?

2 Obtain the resolution for debye – scherrer camera.
Does it depend on Xray wave length ?

3 What are atomic scattering factor and structure factors.
Discuss on what are the factors it depends.

4 True absorption of Xrays by material results in Fluoresence Xray- justify.

5 What is Wilson plot?

6 α helix and β sheet secondary structure of proteins differ from each other - discuss

7 State the factors affecting crystallization of biological macromolecule

8 Differentiate between myoglobin and haemoglobin molecule. Why does myoglobin molecule show ESR absorption spectra?.

9 How can you detect the double helical structure of nucleic acid by fluorescence spectroscopy technique?

Que 3 **[a]** Discuss a technique to record diffraction from a single stationary crystal . **[06]**
What minimum tube voltage is required to produce 110 reflection? The plane makes an angle of 45 degree with the incident radiation, and the film is at 5 cm from the specimen. Calculate the distance of the laue spots from the film .

[b] The maximum number of lattice parameters of a single crystalline specimen to be determined from a single diffraction pattern – discuss a suitable technique . Discuss the merit and demerit of such method . **[06]**

OR

[b] Discuss a suitable technique to characterize polycrystalline specimen for its internal structure . **[06]**
Calculate the maximum number of diffracted lines are possible for a bcc specimen with lattice parameter of 5.00 A exposed with Cuk radiation. Is there a change if the radiation is mok radiation ?

Que 4 **[a]** Xrays are unpolarized but behave like a polarized beam- discuss. **[06]**
Discuss the role of temperature factor on scattered intensity.

[b] Discuss a suitable analytical technique to index non cubic hexagonal pattern . **[06]**

OR

[b] Derive the necessary equation to calculate the particle size from diffraction under non ideal condition . **[06]**

Que 5 **[a]** Explain primary, secondary and tertiary structure of DNA. **[06]**

[b] Explain vapour diffusion and dialysis method to crystallize the protein. **[06]**

OR

[b] Give the working principle of single crystal diffractometer. Why does it called four circle diffractometer **[06]**

Que 6 **[a]** How NMR works ? Discuss NMR applications in biophysics and medicine. **[06]**

[b] Discuss delocalization in biomolecules specifically for benzene molecule **[06]**

and explain various parameters which can be obtained applying tight binding model to it.

OR

[b] Fluorescence spectroscopy can provide information about molecular conformation and dynamics of biological molecules- explain. **[06]**

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SEAT No._____ No. of Printed Pages : 3

M.Sc. (Physics)(IVth Semester) Examination

Date : 19/04/2017, Day :Wednesday , Time : 2:00 p.m. to 5:00 p.m.

Subject : Crystal growth and imperfections in Solids, Paper No. PS04EPHY02

CBCS(choice based credit system)

Important Note : Q.1 : Multiple choice questions (MCQ) carries one mark each.

Q.2 : Short questions carries two marks each (attempt any seven out of nine)

Q.3 to Q.6 : Long questions carries 12 marks .

Total Marks : 70

Choose the appropriate options from the following in Q.1

Q.1 **(8)**

i) The number of independent variable for the layer type phase equilibrium diagram above the melting point of Pb and Al is _____ .

(a) 0 (b) 1 (c) 2 (d) 3

ii) _____ technique is used for growth of crystal without using seed crystal.

(a) Bridgman (b) Czochralski (c)Verneuil flame fusion (d) high temperature solution growth

iii) An atom located at a position that is not a normal lattice site is known as

(a) Frenkel defect (b) Schottky defect (c) dislocation (d) tilt defect

iv) M centre consist of how many adjacent F centres ?

(a) three (b) one (c) two (d) four

v) The failure that occurs in structures subjected to dynamic and fluctuating stresses is termed as

(a) Creep (b) Fatigue (c) Fracture (d) dislocation

vi) Self diffusion occurs by which mechanism

(a)vacancy (b) interstitial (c) ring (d) impurity

vii) Surface imperfections are also termed as

(a) one dimensional defect (b) zero dimensional defect (c) two dimensional defect (d) three dimensional defect

viii) The stress field of edge and screw dislocation is inversely proportional to

(a) distance from the centre of ring (b) Burger's vector (c) shear modulus (d) angle

Q.2 ***Answer any seven questions out of nine in Q.2*** **(14)**

i) Obtain the equation for stress to bend a dislocation to a radius R .

ii) Draw different cycles which represents the variation of stress with time that accounts for fatigue failures.

iii) Do edge and screw dislocations move with certain velocities in a crystal ? Justify the statement with proper diagrams.

iv) Mention important characteristics for selection of solvent for the growth of crystal from solution.

v) Define slip planes and slip directions. How many slip planes ,slip directions and slip systems are there in fcc and bcc crystals ?

vi) Draw the cooling curve of pure and binary system and calculate number of degree of freedom for each case.

vii) State Fick's first and second law of diffusion.

viii) Determine the fraction of atoms in a given solid with the energy equal to 1.5 eV at room temperature (300K) and at 1500K where Boltzmann's constant k = 8.614×10^{-5} eV/K.

ix) Explain how Knoop and Vickers microhardness tests are conducted for determining hardness of a material.

(6)

Q.3(a) Draw phase equilibrium diagram of two component systems (Say A & B) which are mutually soluble in liquid state and insoluble in solid state when 40% of component 'B' is added in component 'A'. Calculate amount of liquid and solid phase present using Lever rule. Also calculate number of independent variable for each case for condensed system using Gibb's phase rule.

Q.3(b) What is nucleation? Describe the Gibb's – Thomson equation for vapour and modified Thomson's equation for melt. **(6)**

OR

Q.3(b) If material decomposes before reaching its melting point, then which technique you will use for growing crystal . Describe this technique with schematic diagram in detail. **(6)**

Q.4(a) Show in an ionic crystal having 'N' lattice points and 'N_i 'possible interstitial positions, the number of 'n' Frenkel defects in equilibrium condition is given by **(6)**

$$n = (NN_i)^{1/2} e^{-\frac{E_i}{2kT}}$$

Q.4(b) What is dislocation? Describe edge and screw dislocation in a crystal using necessary diagram. **(6)**

OR

Q.4(b) What are stacking faults? How this fault is produced in f.c.c crystal : (a) by removing a close packed plane, (b) by inserting an extra plane and (c) by slip on a close packed plane. **(6)**

Q.5(a) Using the theory of elasticity, determine the elastic strain energy existing at the sites of edge, screw and mixed dislocations. **(6)**

Q.5(b) What are colour centres ? How they are produced in crystals ? Explain each colour centres known to you. **(6)**

OR

Q.5(b) Explain the mechanisms responsible for regenerative multiplication of dislocations with suitable diagrams. **(6)**

Q.6(a) If Boron is diffused into a thick slice of Silicon with no previous Boron in it at a temperature of 1100^0C for 2 hours. What is the depth below the surface at which the concentration is 10^{17}atoms/cm^3 if the surface concentration is 10^{18}atoms/cm^3 ? D(Boron into Silicon) = 4×10^{-13}cm^2/s at 1100^0C. **(6)**

Given :

erf Z	Z
0.8802	1.1
0.9000	X
0.9103	1.2

Q.6(b) Obtain the equation for stress raisers and write the expression for Griffith cracking criterion. Using the suitable expression solve the given problem : **(6)**
A relatively large plate of a glass is subjected to a tensile stress of 40MPa. If the specific surface energy and modulus of elasticity for this glass are 0.3J/m^2 and 69 GPa, respectively. Determine the maximum length of a surface flaw that is possible without fracture.

OR

Q.6(b) Define creep phenomena and explain it in detail with necessary diagrams. Using the Larson-Miller data for S 590 iron as 24×10^3, predict the time to rupture for a component that is subjected to a stress of 140MPa at 800^0C. **(6)**

********** THE END **********

No. of printed pages [3]

SEAT No._____

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SARDAR PATEL UNIVERSITY

M. Sc. (Physics) IV Semester Examination

Day and Date: Monday, 17th April, 2017

Time: 2.00 pm to 5.00 pm

Subject: Signal Processing and Satellite Communication

Paper No: PS04EPHY03

Total Marks: 70

Q.1 Multiple choice Questions. (8)

(1) IC 4016 is used for _____.
(a) PAM (b) PCM (c) PTM (d) PDM

(2) In optical fiber communication, the carrier frequency is around _____ Hz.
(a) 10^{14} (b) 10^{9} (c) 10^{6} (d) 10^{10}

(3) In cellular telephone network, the shape of each cell is _____.
(a) circular (b) hexagonal (c) rectangular (d) triangular

(4) In satellite communication, the propagation delay in signal transmission is _____.
(a) 600μs (b) 600ms (c) 600ns (d) 600s

(5) If the output stage in a transmitter is _____, the modulation is known as high level modulation.
(a) Collector (b) Emitter (c) Base (d) None of them

(6) What is the importance of single side band technique?
(a) Reduces the transmission power (b) Easy to produce
(c) No carrier wave is required (d) No modulating wave is required

(7) In Television system, the continuous motion of picture is due to the principal of _____ of vision.
(a) Persistence (b) Perception (c) Sensitivity (d) Color

(8) In amplitude modulation, the side band power equation is _____.
(a) $\frac{m^2}{4}\frac{V_c^2}{2R}$ (b) $\frac{m^2}{4}\frac{V_c^2}{R^2}$ (c) $\frac{m^2}{2}\frac{V_c^2}{4R^2}$ (d) $\frac{m^2}{2}\frac{V_c^2}{R^2}$

Q.2 Short questions (Attempt any seven) (14)

(1) Write down the structure of IMEI number. Indicate the TAC, remainder of TAC and check digit.
(2) What is the significance of companding?
(3) Give a difference between TDM and FDM.
(4) Mention different types of MODEMS. What is a basic difference between them?
(5) Why the frequency of uplink is always higher than that of a downlink?
(6) Discuss in short the basic reactance modulator for generation of frequency modulation.
(7) Discuss the Phase Modulation (PM) method and its modulation index.

(8) Calculate the percentage power saving when the carrier and one of the sidebands are suppressed in an AM wave modulated to a depth of (a) 100 percent and (b) 50 percent.

(9) Discuss the difference between Tuned Radio Frequency (TRF) and Super heterodyne receiver.

Q.3 (a) What is a communication system? Draw the basic block diagram of communication system and explain each block in detail. Why modulation is required in communication system? (6)

(b) Explain amplitude modulation (AM) and derive the frequency equation of AM using carrier and modulating wave sine wave equations. Define its modulation index. Derive power relations in the AM wave. (6)

OR

(b) List various sources of random noise and impulse noise external to a receiver. How can some of them be avoided or minimized? What is the strongest source of extraterrestrial noise? (6)

Q.4 (a) With schematic circuit diagram and waveforms, explain Grid-Modulated Class C amplifier for generation of amplitude modulated (AM) wave. (6)

(b) With schematic circuit diagram, mathematically discuss in details Balanced Modulator for generation of SSB signal. (6)

OR

(b) With the help of block diagram of transmitter and receiver, describe the basic monochrome television system. Explain how television is capable of displaying complete moving pictures, despite the fact that at any instant of time, only a tiny portion of the picture tube screen is active. (6)

Q.5 (a) Draw the block diagram of satellite transponder. Explain the significance and operation of each block. (6)

(b) What is PCM? Why it is known as digital modulation process? Using necessary example, explain the quantization of signal in PCM. Why the pulsating waveform is considered as digital output? (6)

OR

(b) Which are the synchronization techniques used in MODEM? Discuss in detail the asynchronous synchronization technique with necessary byte structure. (6)

Q.6 (a) Draw the structure of cell in cellular technology. Describe in detail the cellular telephone communication in detail. (6)

(b) With the help of necessary example, explain the IMEI number and its identification method. (6)

OR

(b) What are GSM and CDMA? Differentiate between GSM and CDMA. Mention the advantages and disadvantages of GSM and CDMA. (6)

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SEAT No._____ No. of Printed Pages : 2

[66]

SARDAR PATEL UNIVERSITY

M.Sc. (PHYSICS) (IVth Semester) Examination

Wednesday, 19th April, 2017 2:00 pm to 5:00 pm

Course No.: PS04EPHY04: Advanced Solid State Electronic Devices

All questions are compulsory.

Total Marks:70

Q.1 Multiple choice questions. **(8)**

(i) Which of the following does not affect the operating speed of BJT
(a) Gummel number **(b)** Base width
(c) Emitter doping **(d)** Collector width

(ii) Cross doping is a serious problem in _____heterojunction devices.
(a) Si - Ge **(b)** GaAs - InP **(c)** Si - GaP **(d)** CdSe - ZnSe

(iii) In which of the following FETs, the high frequency limiting factor related to ionized impurity scattering problem is resolved?
(a) MESFET **(b)** MOSFET **(c)** MODFET **(d)** JFET

(iv) Which of the following structure leads to the lowest channel length?
(a) MESFET **(b)** MOSFET **(c)** MODFET **(d)** HMOS

(v) CMOS works as _____.
(a) Amplifier **(b)** Inverter **(c)** Attenuator **(d)** None.

(vi) In accumulation mode of MOS capacitor with p-type semiconductor, the hole density increases _____.
(a) within semiconductor **(b)** within oxide layer
(c) within semiconductor away from interface
(d) near semiconductor-oxide interface within semiconductor

(vii) The leakage current in ____ diode is large.
(a) PIN **(b)** P-N **(c)** Heterojunction **(d)** Avalanche

(viii) The LED constructed using GaP emits ____ light.
(a) yellow **(b)** green **(c)** red **(d)** blue

Q.2 Short answer questions.(Attempt any seven) **(14)**

(a) Calculate the band gap shrinkage in case of a Si based BJT having donor concentration of $5x10^{18}$ in the emitter region at room temperature(300 K) and at 77K.

(b) Sketch the velocity – field characteristics in case of Si and GaAs and discuss how the differences are exploited for high frequency applications.

(c) Sketch the energy band diagram of BJT and HBT showing significant differences between the two structures.

(d) What is channel length modulation? Mention the parameters that control it.

(e) What are MMIC and OEIC? How Si is ruled out for these applications?

(f) Why MOS capacitor operates in inversion mode when the metal is given positive bias with respect to p-semiconductor?

(g) Mention important effects observed in short channel MOSFETs and describe any two in brief. **P.T.O.**

(h) Differentiate between P-N junction and avalanche photodiodes.
(i) Explain the significance of intrinsic layer in PIN diode.

Q.3(a) Mention differences between JFET and MODFET and discuss key motivations for MODFET structure. (6)

(b) Discuss different silicon and non-silicon based advanced devices mentioning their advantages relying on material and fabrication technology along with the frequency limitations. (6)

OR

(b) Mention approximations made to explain the V-I characteristics of MESFET and derive the expression for drain current in terms of drain-source voltage, material and device dimension parameters. (6)

Q.4(a) Explain the use of MOS structure in CCD application. (6)

(b) Describe the charge control model for MODFET and establish relation for sheet charge density developed in the spacer region. (6)

OR

(b) Discuss in detail about following advanced MOS devices (6)
(i) HMOS and
(ii) SIMOX based MOSFET.

Q.5(a) Differentiate between enhancement and depletion modes of MOSFET operation and discuss in detail the operation of depletion mode MOSFET. (6)

(b) With the help of equivalent circuit of a MOS capacitor establish an equation for its total capacitance. Using necessary C-V characteristics, explain the variation of capacitance in different modes of MOS capacitor. (6)

OR

(b) Sketch a circuit diagram of CMOS and describe its working for the applied digital input voltages. Also show how power dissipation in CMOS is very low. (6)

Q.6(a) What is a photoconductive cell? Discuss the process of light detection in photoconductive cell and calculate the wavelength of the maximum of incident light if the energy band gap of semiconductor is 1.35 Å. (6)

(b) Using a necessary structural diagram, explain in detail the mechanism of light emission in P-N junction LED. (6)

OR

(b) What is a difference between spontaneous and stimulated emission of radiation? Describe operating principle and characteristics of semiconductor laser. (6)

XXXXXXXXXX