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3 (Sem-5/CBCS) PHY HE 4



2024
PHYSICS

(Honours Elective)

Paper : PHY-HE-5046

(Physics of Devices and Instruments)

Full Marks : 60

Time : Three hours

**The figures in the margin indicate
full marks for the questions.**

1. Fill in the blanks : 1×7=7
- (i) Junction Field Effect Transistor (JFET) is a _____ controlled device.
 - (ii) Rectifier of a DC power supply converts a _____ input from mains to a DC output.
 - (iii) _____ filter is a passive electronic device has higher cut of frequency.
 - (iv) SiO_2 layer in an Integrated Circuit (IC) acts as a _____.
 - (v) The full form of GPIB is _____.

Contd.

(vi) The maximum value of a modulation index of an Amplitude-Modulated waveform is _____.

(vii) The process of separating message signal from the carrier signal is known as _____.

2. Give very short answers to the following questions : $2 \times 4 = 8$

(i) Give a comparison between a JFET and MOSFET device.

(ii) What is a multivibrator circuit? How many stable states exist in an astable multivibrator?

(iii) What is the role of a rectifier in a DC-regulated power supply? What are different types of rectifiers used in a regulated power supply?

(iv) What is frequency modulation? Draw a frequency-modulated waveform.

3. Answer **any three** questions from the following : $5 \times 3 = 15$

(i) What is a depletion-type MOSFET? Discuss the operation of a Depletion-type MOSFET with its input-output characteristic curve. $2+3=5$

(ii) What are load regulation and line regulation in a DC-regulated power supply?

(iii) What is lithography technique? Distinguish between optical lithography and electron-beam lithography. $2+3=5$

(iv) Discuss briefly about working principle of a phase-locked loop (PLL)

(v) Discuss the operation of a 1st order band-pass filter circuit.

(vi) What is the modulation index of an AM wave? Draw an AM wave with modulation index 0.5 and 1.0. $3+2=5$

4. Answer **any three** questions from the following : $10 \times 3 = 30$

(i) Explain RS232 communication standards. Discuss briefly about universal serial BUS and its applications. $5+5=10$

(ii) Draw the basic block diagram of a wireless communication system and discuss briefly about different blocks of the system. What is the need of modulation in a wireless communication system? Discuss briefly. $3+4+3=10$



(iii) Discuss briefly about different steps involved in the fabrication of an integrated circuit (IC). What is the importance of metallization technique used in IC fabrication and packaging?
 $6+4=10$

(iv) Write short notes on **any two** of the following : $5 \times 2 = 10$

(a) Voltage Controlled Oscillator (VCO)

(b) Parallel Communication

(c) Digital Modulation techniques

(v) Derive the expression of a drain current in an enhancement-type MOSFET.

(vi) Discuss the circuit operation for generation of an amplitude-modulated wave for a wireless communication system. What is the importance of side band frequency in AM wave? Discuss briefly about single and double side band AM-modulated waveforms.

$5+2+3=10$



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3 (Sem-5/CBCS) PHY HE 5

2024

PHYSICS

(Honours Elective)

Paper : PHY-HE-5056

(Nuclear and Particle Physics)

Full Marks : 80

Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Choose the correct answer : $1 \times 10 = 10$

(i) What is the force that binds protons and neutrons in a nucleus ?

- (a) Gravitational force
- (b) Electromagnetic force
- (c) Strong nuclear force
- (d) Weak nuclear force

Contd.

- (ii) Nucleon is the term used for
- (a) all the light nuclei
 - (b) hydrogen nuclei
 - (c) neutrons
 - (d) protons and neutrons
- (iii) Which combination of radioactive emissions will not change the mass number of radioactive nuclei ?
- (a) Alpha and beta decays
 - (b) Alpha and gamma decays
 - (c) Alpha, beta and gamma decays
 - (d) Beta and gamma decays
- (iv) A high energy gamma ray may materialize into
- (a) a meson
 - (b) an electron and a proton
 - (c) a proton and a neutron
 - (d) an electron and a positron



- (v) Fission of a nucleus is achieved by bombarding it with
- (a) Electrons
 - (b) Protons
 - (c) Neutrons
 - (d) X-rays
- (vi) Which of the following is not a gas-filled type detector ?
- (a) Proportional counter
 - (b) G-M Counter
 - (c) Semiconductor detector
 - (d) Ionization Chamber
- (vii) Cyclotrons maintain particles in a circular path by use of
- (a) Radio frequency waves
 - (b) Magnetic fields
 - (c) Electric fields
 - (d) None of the above

(viii) What is the bottom quark also called ?

- (a) Charm quark
- (b) Bubble quark
- (c) Bilou quark
- (d) Beauty quark

(ix) Particles that cannot participate in the strong interaction are

- (a) Kaons
- (b) Baryons
- (c) Leptons
- (d) Pions

(x) Which of the following is not composed of quarks ?

- (a) Muons
- (b) Neutrons
- (c) Pions
- (d) Protons

2. Answer the following questions : $2 \times 5 = 10$

(a) What is the energy equivalent of 1 amu ?

(b) Obtain approximately the ratio of nuclear radii of ${}^{56}_{26}\text{Fe}$ and ${}^{238}_{92}\text{U}$. What is the approximate ratio of their nuclear densities ?

(c) What is the momentum of a photon of energy 1 MeV ?

(d) What are the disadvantages of linear accelerators ?

(e) Write down the quark content of protons, neutrons and pions.

3. Answer the following questions : **(any four)**
 $5 \times 4 = 20$

(a) How many α and β particles are emitted in the disintegration of ${}^{232}_{90}\text{Th}$ to the end product ${}^{208}_{82}\text{Pb}$?

(b) Two deuterons ${}^2_1\text{H}$ fuse to form a triton ${}^3_1\text{H}$ and a proton. How much energy is released ? The reaction is ${}^2_1\text{H} + {}^2_1\text{H} = {}^3_1\text{H} + {}^1_1\text{H}$.

Given that the masses of ${}^2_1\text{H}$, ${}^3_1\text{H}$ and ${}^1_1\text{H}$ are 2.014102 amu, 3.016050 amu and 1.007825 amu respectively.

(c) Write about the independent particle model. What are the limitations of the shell model ?

(d) Discuss the neutrino hypothesis in beta decay.

(e) What is the range of alpha particles ? What is Geiger-Nuttall law ?

(f) What are quarks ? Give the qualitative description of the quark model.

4. Answer the following questions : **(any four)**
 $10 \times 4 = 40$

(a) What is nuclear force ? Write the characteristics of nuclear force. Define mass defect and nuclear binding energy.
 $2 + 6 + 2 = 10$

(b) Explain the postulates of the liquid drop model. Give a simple derivation of semi-empirical mass formula. $2 + 8 = 10$

(c) What is the Q value of a nuclear reaction ? Define reaction cross-section. What are exothermic and endothermic reactions ? What are the conservation laws in nuclear reactions ?
 $1 + 2 + 2 + 5 = 10$

(d) Write *two* differences among alpha, beta and gamma rays. Discuss the theory of alpha decay.
 $3 + 7 = 10$

(e) (i) Describe in detail the principle, construction and working of a cyclotron.

(ii) Calculate the frequency of a proton cyclotron, if the magnetic field $B = 0.15$ tesla. $2 + 3 + 3 + 2 = 10$

(f) What is a scintillator detector ? What are the requirements for a good scintillator material ? Give the construction of a photomultiplier tube.
 $1 + 4 + 5 = 10$

(g) What are elementary particles ? How are they classified ? What are the baryon number and lepton number of a proton ?
 $2 + 6 + 2 = 10$

(h) Write short notes on : **(any two)**
 $5 \times 2 = 10$

(i) Binding energy curve

(ii) Gamma ray interaction through matter

- (iii) Three modes of beta decay
- (iv) Rutherford scattering
- (v) Fundamental forces of nature
- (vi) Strange particles

