+3 Sem-IV (NEP)
PHY-C-1P-8 (MAJ)

April, 2026

ANALOG SYSTEMS

Time: 3 Hrs **Full Marks: 100**

Answer all the questions.
The figures in the right hand margin indicate marks.

Part-I

1. Answer all the following questions: $(10x1 = 10)$

a. What is the position of the donor energy level with respect to the conduction band in N-type semiconductor?
b. What happens to the depletion width under forward bias?
c. What is reverse saturation current?
d. What is the ripple factor of a full-wave rectifier?
e. What is the resistance of an intrinsic semiconductor at 0 K?
f. An electric field is applied to a semiconductor. Let the number of charge carriers be ***n*** and the average drift speed be ***v***. If the temperature is increased then what will happen to both ***n*** and ***v***
g. The conduction band of a solid is partially filled at 0 K. Will it be a conductor, a semiconductor or an insulator?
h. Which transistor configuration provides highest current gain?
i. The slew rate of an ideal OP AMP is _____. (fill in the blank)
j. A p-type semiconductor is _____at 0 K but charged at higher temperatures. (fill in the blank)

Part-II

2. Answer all questions in 50 words each: $(9x2 = 18)$

a. What is Zener breakdown?
b. What is drift velocity? On which factors does drift velocity depend?
c. Why is transistor biasing necessary?
d. In Operational amplifiers what is virtual ground?
e. Why is the CE amplifier most widely used?
f. In a p-n junction, the depletion region is 400 nm wide and an electric field of $5 \times 10^5\ V\ m^{-1}$ exists in it. (i) Find the height of the potential barrier. (ii) What should be the minimum kinetic energy of a conduction electron which can diffuse from the n-side to the p-side?
g. Calculate the voltage $\mathbf{V_o}$ in the circuit of Fig-2.1.
h. Explain the operation of a non-inverting amplifier.
i. Why is LED not made of silicon or germanium?

Part-III

3. Answer any eight of the following within 250 words each: $(8x5 = 40)$

a. Why is the depletion layer formed in a PN junction?
b. An RC-coupled amplifier has a mid-frequency gain of 100. The gain is 80 at 50Hz and 100Khz. Calculate the half power frequencies.

c. How does negative feedback improve gain stability of an amplifier?

d. Discuss the principle, construction, and working of LED. Mention its advantages and applications.

e. Explain the formation of P-type and N-type semiconductors using energy band diagrams. Discuss the role of donor and acceptor impurities.

f. Find the current through the battery of the circuits shown in figure 3.1. Assume that the resistance of each diode is zero in forward bias and is infinity in reverse bias.

g. What are the readings of the ammeters A_1, and A_2, shown in figure 3.2. Neglect the resistances of the meters.

h. For the circuit shown in Fig.3.3, find: (i) the output voltage (ii) the current through zener diode.

i. Explain the concept of feedback in amplifiers. What do you mean by positive and negative feedback?

j. What is a push-pull connection? what is its primary advantage?

Part-IV

4. Answer any 4 of the following within 500 words each: $(\boldsymbol{4x8 = 32})$

a. Draw the circuit diagram of a two-stage RC-coupled CE transistor amplifier. Show how the voltage gain vary with frequency. Qualitatively explain these variations. Define the half power frequencies. (2+3+3)

b. Draw the circuit diagram for the Voltage Divider Bias of an n-p-n transistor in CE mode. Obtain expressions for its stability factors. Explain physically the why the stability of voltage devider bias circuit is better than that of a fixed bias circuit. (2+3+3)

c. Define the following terms in connection with an operational amplifier: Common-mode rejection ratio,Slew rate and closed loop gain. (4+4)

d. Derive the condition for sustained oscillations and frequency of oscillation in a colpitts oscillator.

e. Draw the circuit diagram of a full-wave rectifier with a center-tapped transformer. Draw the wave forms of the diode current and the load voltage for a sinusoidal input voltage applied to a full wave rectifier. Explain how the dc output voltage of a full-wave rectifier is improved when a capacitor filter is used. (2+3+3)

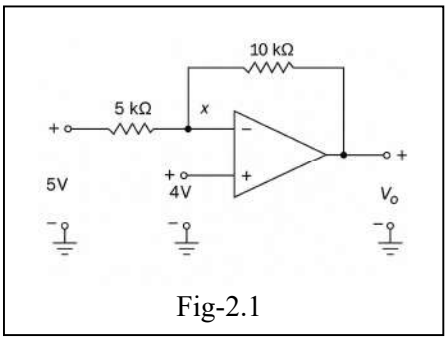

Fig-2.1

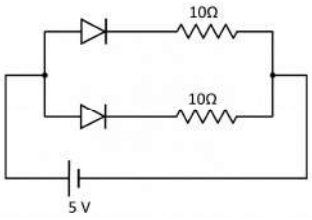

Fig-3.1

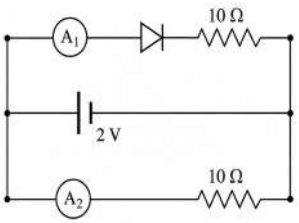

Fig-3.2

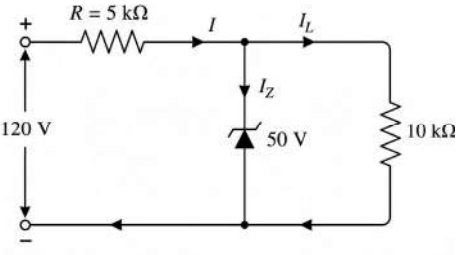

Fig-3.3

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+3 Sem-IV (NEP)
PHY-C-1P-9 (MAJ)

APRIL, 2026

BASIC INSTRUMENTATION

Time: 3 Hrs **Full Marks: 100**

Answer all the questions.
The figures in the right hand margin indicate marks.

Part-I

1. Answer all the following questions: $(\mathbf{10x1 = 10})$

i. The percentage error in measuring 100 V with an uncertainty of ±0.5 V is:
(a) 0.05% (c) 5%
(b) 0.5% (d) 50%

ii. An ideal voltmeter should have:
(a) Zero resistance (c) Very low resistance
(b) Infinite resistance (d) Variable resistance

iii. Precision without accuracy indicates:
(a) Presence of systematic error (c) No error exists
(b) Presence of random error only (d) Perfect measurement

iv. In a CRO, the sawtooth waveform is generated by:
(a) Trigger circuit (c) Time-base generator
(b) Vertical amplifier (d) Power supply

v. A true RMS voltmeter measures
(a) average value (c) RMS value`
(b) instantaneous value (d) peak value

vi. The waveform not normally generated directly by a function generator is:
(a) Sine wave (c) Triangular wave
(b) Square wave (d) Sawtooth wave

vii. The unit of deflection sensitivity of a CRO is:
(a) V/cm (c) A/cm
(b) cm/V (d) Hz/cm

viii. Digital instruments display readings in:
(a) Pointer scale (c) Graph form
(b) Numeric form (d) Analog form

ix. Quantization error is associated with:
(a) Analog meters (c) CRO
(b) Digital meters (d) Signal generators

x. Loading effect in a voltmeter can be avoided by
(a) using an accurate and precise instrument (c) using a high sensitivity voltmeter
(b) using a low sensitivity voltmeter (d) using high voltage range

Part-II

2. Answer all questions in 50 words each: $(9x2 = 18)$

i. Distinguish between accuracy and precision with suitable examples.
ii. Why is high input impedance desirable in a voltmeter?
iii. What is the significance of input impedance in an electronic voltmeter?
iv. Why are AC millivoltmeters used instead of ordinary voltmeters for low AC voltages?
v. Define deflection sensitivity of a CRO.
vi. How is frequency measured using a CRO?
vii. Define pulse width and duty cycle.
viii. Distinguish between a pulse generator and a function generator.
ix. What is quantization error in digital measurements?

Part-III

3. Answer any eight of the following within 250 words each: $(8x5 = 40)$

i. Define sensitivity of an instrument. How does it affect measurement?
ii. Why is synchronization necessary in a CRO?
iii. Explain the working principle of a low-frequency signal generator.
iv. Define sensitivity of voltmeters. What is the significance of sensitivity in voltmeters?
v. Explain with the help of a diagram the various sections of a multimeter.
vi. Explain the operation of a basic digital multimeter.
vii. Explain the working principle of a digital frequency meter.
viii. State the function of a delay line used in the vertical section of an oscilloscope.
ix. Write a short-note on the use of a Cathode Ray Oscilloscope.
x. How can you measure the frequency of a signal voltage by means of a CRO.

Part-IV

4. Answer any 4 of the following within 500 words each: $(4x8 = 32)$

i. Explain the construction, working principle, specifications, advantages, limitations, and applications of a multimeter. Describe how it measures DC voltage, DC current, AC voltage, and resistance.
ii. Draw the block diagram and explain the operation of a Function Generator. Describe the generation of sine, square, and triangular waveforms. Discuss its specifications and applications.
iii. Draw the block diagram of an Electronic Voltmeter and explain its working. Discuss the advantages of electronic voltmeters over conventional multimeters with respect to sensitivity, accuracy, and input impedance.
iv. Draw a neat diagram of a cathode ray tube and explain its working principle. Explain how time-base is obtained in a cathode ray oscillograph.
v. Explain the working of a CRO in detail. Describe how voltage, frequency, current, and phase difference can be measured using a CRO. Discuss the use of Lissajous figures in phase measurement.

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+3 Sem-IV (NEP)
PHY-C-1P-10 (MAJ)

APRIL, 2026

NUCLEAR AND PARTICLE PHYSICS

Time: 3 Hrs **Full Marks: 100**

Answer all the questions.
The figures in the right hand margin indicate marks.

Part-I

1. Answer all the following questions: $(\mathbf{10x1 = 10})$

i. The Landé g-factor for a pure orbital motion is:
(a) 0 (b) 1 (c) 2 (d) 1.5

ii. The Stern–Gerlach experiment provided direct evidence for:
(a) Nuclear spin (c) Nuclear spin and space quantization
(b) Electron spin and space quantization (d) Only space quantization

iii. The normal Zeeman effect occurs when electron spin is:
(a) Considered (b) Ignored (c) Maximum (d) Quantized

iv. The nucleus having maximum binding energy per nucleon is approximately:
(a) Uranium (b) Hydrogen (c) Iron (d) Helium

v. During radioactive decay, the quantity that remains constant is:
(a) Mass number and charge together (c) Number of undecayed nuclei
(b) Decay constant (d) Activity

vi. Nuclear forces saturate because nucleons interact mainly with:
(a) All nucleons equally (b) Nearest neighbours (c) Protons only (d) Neutrons only

vii. Which interaction does not conserve strangeness?
(a) Strong interaction (c) Weak interaction
(b) Electromagnetic interaction (d) Nuclear interaction

viii. Electron belongs to the family of:
(a) Mesons (b) Baryons (c) Leptons (d) Hadrons

ix. The pion ($\boldsymbol{\pi^+}$) quark composition is:
(a) $u\bar{d}$ (b) $d\bar{u}$ (c) uud (d) udd

x. Which conservation law is violated in weak interactions but conserved in strong and electromagnetic interactions?
(a) Charge (b) Baryon number (c) Strangeness (d) Energy

Part-II

2. Answer all questions in 50 words each: $(\mathbf{9x2 = 18})$

i. Compare Zeeman Effect and Stark Effect with suitable examples.
ii. Calculate the ratio of momenta of a proton and neutron having the same de Broglie wavelength.
iii. Estimate the $\boldsymbol{A}$ value and identify the nucleus if its radius is given to be 3.6 fm.
iv. What is packing fraction?
v. Give two achievements of nuclear shell model.

vi. In the following radioactive series, write down the atomic number and mass number of **B, C, D, E**.

$$^{238}_{90}\mathbf{A} \xrightarrow{\alpha} \mathbf{B} \xrightarrow{\beta} \mathbf{C} \xrightarrow{\alpha} \mathbf{D} \xrightarrow{\beta} \mathbf{E}$$

vii. Complete these nuclear reactions:

$$^{9}_{4}\mathbf{Be} + {}^{4}_{2}\mathbf{He} \rightarrow 3{}^{4}_{2}\mathbf{He} + ?\,,$$

$$^{79}_{35}\mathbf{Br} + {}^{2}_{1}\mathbf{H} \rightarrow ? + 2{}^{1}_{0}\mathbf{n}$$

viii. A positive pion collides with a proton and two protons plus another particle are created. What is the other particle ?

ix. Why must the quarks in a hadron have different colors?

Part-III

3. Answer any eight of the following within 250 words each: $(\mathbf{8x5 = 40})$

i. Explain the concept of space quantization. Describe how the Stern–Gerlach experiment provided experimental evidence for space quantization and electron spin.

ii. Explain meson or Yukawa theory of nuclear forces.

iii. The half-life of ^{24}Na is 15.0 h. How long does it take for 80 percent of a sample of this nuclide to decay? use log(2)=0.30103

iv. Derive $KE_\alpha = {}^{(A-4)Q}/_{A}$, for the kinetic energy of the alpha particle released in the decay of a nucleus of mass number A. Assume that the ratio ${}^{M_\alpha}/_{M_d}$ between the mass of an alpha particle and the mass of the daughter is $\approx {}^{4}/_{A-4}$.

v. Explain the Normal Zeeman Effect with suitable energy level diagrams and spectral line splitting.

vi. Use single particle shell model to predict the ground state spin and parity of $^{40}_{18}\mathbf{Ar}$.

vii. Explain the Quark Model and discuss how it accounts for the classification of hadrons.

viii. A hydrogen atom is in the 4p state. To what state or states can it go by radiating a photon in an allowed transition? Calculate the wavelengths of these emitted photons

ix. Write a note on Nuclear reaction cross-section.

x. Explain the Vector Atom Model. Discuss the coupling of orbital and spin angular momenta in atoms.

Part-IV

4. Answer any 4 of the following within 500 words each: $(\mathbf{4x8 = 32})$

i. What is semiempirical mass formula? Explain the significance of various terms. (2+6)

ii. Describe briefly the following intrinsic quantum numbers in connection with elementary particles:
(a) Isospin (b) Hypercharge (c) Strangeness (d)Decay process of mesons. (2+2+2+2)

iii. Describe the Shell Model of the nucleus. Explain the origin and significance of magic numbers. (6+2)

iv. Explain Gamow's theory of alpha decay and discuss quantum tunnelling in alpha emission.

v. What is L-S coupling? Deduce the various interaction energy terms for L-S coupling.

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+3 Sem-IV(NEP)
PHY-C-3P-2 (MIN)

April, 2026

ANALOG SYSTEMS CORE-III

Time: 3 Hrs **Full Marks: 100**

Answer all the questions.
The figures in the right hand margin indicate marks.

Part-I

1. Answer all the following questions: $(\mathbf{10x1 = 10})$

i. The current in a reverse-biased PN junction is mainly due to :
(a) Majority carriers (c)Holes only
(b) Minority carriers (d) Electrons only

ii. The depletion region contains:
(a) Free electrons only (c) Mobile charge carriers
(b) Free holes only (d) Immobile ions

iii. A capacitor filter is connected:
(a) In series with load (c) Across source
(b) In parallel with load (d) Across transformer

iv. Photodiodes are generally operated under:
(a) Forward bias (c) Zero bias only
(b) Reverse bias (d) Saturation

v. In active region:
(a) Both junctions forward biased (c) E-B forward, C-B reverse
(b) Both reverse biased (d) E-B reverse, C-B forward

vi. An RC-coupled amplifier provides maximum gain in:
(a) Low-frequency region (c) High-frequency region
(b) Mid-frequency region (d) Audio distortion region

vii. The ideal op-amp has:
(a) Infinite input impedance (c) Infinite output impedance
(b) Zero input impedance (d) Finite gain

viii. The parameter $\mathbf{h_{fe}}$ represents:
(a) Input resistance (c) Forward current gain
(b) Reverse voltage gain (d) Output conductance

ix. The donor impurity level in an N-type semiconductor lies:
(a) Near valence band (c) Near conduction band
(b) Mid-gap (d) Below valence band

x. A Zener diode is normally operated in:
(a) Forward bias (c) Cut-off
(b) Reverse breakdown (d) Saturation

Part-II

2. Answer all questions in 50 words each: $(\mathbf{9x2 = 18})$

i. Define the static resistance and dynamic resistance of a p-n diode.

ii. What is a transistor ?

iii. Draw the common-base input and output characteristics of a transistor.

iv. What is a load line ? Explain its significance.
v. Draw the circuit diagram of a common-emitter transistor amplifier.
vi. What are advantages of the h-parameters ?
vii. What are the advantages of using OP AMPs ?
viii. Discuss the use of an OP AMP as an inverting amplifier.
ix. Draw the circuit diagram of a Colpitts oscillator.

Part-III

3. Answer any eight of the following within 250 words each: $(\mathbf{8x5 = 40})$

i. How does a barrier field appear across a p-n junction ?
ii. Draw the characteristic curve of a forward biased p-n junction and explain its nature.
iii. Explain with circuit diagram the use of a Zener diode as voltage regulator.
iv. What is a filter as used with a rectifier ? Explain its function.
v. For a p-n-p transistor in CE mode, $\beta = 100$.What is the value of α? If $\mathbf{I_{CO}= 10\mu A}$, what is the collector current for an emitter current of 2mA
vi. Draw the circuit diagram for fixed-bias considering an n-p-n transistor in the CE configuration.
vii. For the h-parameters of a transistor, show that $\boldsymbol{h_{fb} = -\frac{h_{fe}}{1+h_{fe}}}$
viii. Explain with a circuit diagram the operation of a push-pull power amplifier.
ix. Explain the concept of feedback in amplifiers. What do you mean by positive and negative feedback ?
x. What is a push-pull connection ? what is its primary advantage ?

Part-IV

4. Answer any 4 of the following within 500 words each: $(\mathbf{4x8 = 32})$

i. Write notes on: (i) solar cell and (ii) photo diode (4+4)
ii. For a full-wave rectifier , calculate (i) the dc load current (ii)the ripple factor (iii) the efficiency of rectification (2+3+3)
iii. Explain the current amplification factors α and β for CB and CE configurations, respectively. Obtain a relation between them . (3+3+2)
iv. Draw and label the circuit diagram of a small-signal single-stage low-frequency transistor amplifier in the CE mode. Using the h-parameters , obtain expressions for current gain, input resistance and voltage gain. (2+2+2+2)
v. Write a note on the use of an OP AMP as a differentiator and an integrator. (4+4)

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