Total number of printed pages–32

3 (Sem–6/CBCS) PHY RE 1/2/3/4/5

2023

PHYSICS

(Regular Elective)

Answer the Questions from any one Option.

OPTION – A

(Communication Electronics)

Paper : PHY–RE–6016

Full Marks : 60

Time : Three hours

OPTION – B

(Digital Signal Processing)

Paper : PHY–RE–6026

Full Marks : 60

Time : Three hours

OPTION – C

(Advanced Mathematical Physics–II)

Paper : PHY–RE–6036

Full Marks : 80

Time : Three hours

OPTION – D

(Astronomy and Astrophysics)

Paper : PHY–RE–6046

Full Marks : 80

Time : Three hours

OPTION – E

(Classical Dynamics)

Paper : PHY–RE–6056

Full Marks : 80

Time : Three hours

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

Answer ***either*** *in English* ***or*** *in Assamese.*

Contd.

OPTION–A

(Communication Electronics)

Paper : PHY–RE–6016

1. Answer the following questions : 1×7=7

তলৰ প্ৰশ্নসমূহৰ উত্তৰ কৰা ঃ

(a) Write the full form of TRAI.

TRAI ৰ অৰ্থটো সম্পূৰ্ণকৈ লিখা।

(b) How many side bands exists in Amplitude modulation ?

বিস্তাৰ কলনত কিমানটা পাৰ্শ্ব পটি থাকে?

(c) Write the full form of BPSK.

BPSK ৰ অৰ্থটো সম্পূৰ্ণকৈ লিখা।

(d) What is Geo-stationary orbit ?

ভূস্থৈতিক কক্ষপথ কি?

(e) Write the expression for bandwidth of frequency modulated spectrum.

কম্পনাংক কলিত বৰ্ণালীৰ পটিবেধৰ প্ৰকাশ ৰাশি লিখা।

(f) Write the full form of SIM.

SIM ৰ অৰ্থটো সম্পূৰ্ণকৈ লিখা।

(g) What is IMEI number of a mobile phone ?

মোবাইল ফোনৰ IMEI নম্বৰ কি?

2. Answer the following questions : 2×4=8

তলৰ প্ৰশ্নসমূহৰ উত্তৰ কৰা ঃ

(a) Give the concept of Noise.

আৰাওৰ বিষয়ে ধাৰণা দিয়া।

(b) Draw a block diagram of a communication system.

যোগাযোগ ব্যৱস্থা এটাৰ ব্লক চিত্ৰ আঁকা।

(c) What do you mean by 2G and 3G in mobile communication ? What are the ranges of frequency ?

মোবাইল যোগাযোগৰ 2G আৰু 3G মানে কি? ইহতৰ কম্পনাংকৰ পৰিসৰ কিমান?

(d) A 100*MHz* carrier wave is frequency modulated by a 10*kHz* sinusoidal modulating signal. If the maximum frequency deviation is 50*kHz*, find the modulation index.

100*MHz* বাহক তৰংগ এটাক 10*kHz* চাইন'চইডেল বার্ত্তা সংকেতৰ দ্বাৰা কম্পনাংক কলিত কৰা হ'ল। যদি কম্পনাংক সর্বোচ্চ ব্যৱধান (maximum deviation) 50*kHz*, কলন মাত্রাৰ মান নির্ণয় কৰা।

3. Answer ***any three*** of the following : 5×3=15

তলৰ *যিকোনো তিনিটাৰ* উত্তৰ কৰা ঃ

(a) Write about the electromagnetic spectrum. Which part of the electromagnetic spectrum is used for electronic communication system? 3+2=5

বিদ্যুৎ চুম্বকীয় বর্ণালীৰ বিষয়ে লিখা। বিদ্যুৎ চুম্বকীয় বর্ণালীৰ কোন অংশ ইলেকট্রনিক যোগাযোগ ব্যৱস্থাত ব্যৱহাৰ হয়?

(b) Write the advantages and disadvantages of frequency modulation in comparison to Amplitude modulation.

বিস্তাৰ কলনৰ তুলনাত কম্পনাংক কলনৰ সুবিধা আৰু অসুবিধাসমূহ লিখা।

(c) Give the idea about phase modulation.

দশা কলনৰ বিষয়ে আভাস দিয়া।

(d) Write a short note on GPS.

GPSৰ চমু টোকা লিখা।

(e) An AM broadcast station transmits 10*kW* of carrier power. If the modulation index is 0·7, find the power in each side band and the total transmitted power.

বিস্তাৰ কলিত প্রচাৰণ কেন্দ্র এটাই 10*kW* ক্ষমতাৰ বাহক তৰংগ সঞ্চালন কৰে। যদি ইয়াৰ কলন মাত্রা 0·7 হয় তেন্তে প্রত্যেক পার্শ্ব পটিৰ ক্ষমতা আৰু মুঠ সঞ্চালন ক্ষমতা নির্ণয় কৰা।

4. Answer the following questions :

তলত প্ৰশ্নসমূহৰ উত্তৰ কৰা ঃ

(a) Draw a circuit diagram of an Amplitude modulator. Explain about the generation of amplitude modulated wave. 3+7=10

বিস্তাৰ কলক এটাৰ বৰ্ত্তনী চিত্ৰ আঁকা। বিস্তাৰ কলিত তৰংগ উৎপত্তিৰ বিষয়ে ব্যাখ্যা কৰা।

Or / নাইবা

What do you mean by multiplexing? Write short notes on TDM and FDM. 2+4+4=10

মাল্টিপ্লেকচিং মানে কি? TDM আৰু FDM ৰ চমু টোকা লিখা।

(b) Draw a simple block diagram of a digital communication system. Explain the function of each block. 2+8=10

সাংখ্যিক যোগাযোগ ব্যৱস্থাৰ সাধাৰণ ব্লক চিত্ৰ অংকণ কৰা। প্ৰত্যেক ব্লকৰ কাৰ্য্য ব্যাখ্যা কৰা।

Or / নাইবা

What are the essential sections of a satellite communication system? Mention the advantages and disadvantages of satellite communication. 5+5=10

উপগ্ৰহ যোগাযোগ ব্যৱস্থাৰ দৰকাৰী খণ্ডসমূহ কি? উপগ্ৰহ যোগাযোগ ব্যৱস্থাৰ সুবিধা আৰু অসুবিধাসমূহ উল্লেখ কৰা।

(c) What do you mean by mobile communication? Explain the architecture of mobile communication network. 2+8=10

মোবাইল যোগাযোগ মানে কি? মোবাইল যোগাযোগ নেট্ৱৰ্কৰ গঠন ব্যাখ্যা কৰা।

Or / নাইবা

Write short notes on FSK and PSK. 5+5=10

FSK আৰু PSK ৰ চমু টোকা লিখা।

OPTION–B

(Digital Signal Processing)

Paper : PHY–RE–6026

1. Give short answer of the following questions : 1×7=7

   (a) What is the power of a energy signal ?

   (b) What is the result of convolution of two equal length rectangles ?

   (c) Fill in the blank :

   The LTI systems are always considered with respect to the _____ .

   (d) If the DTFT $t(\omega)$ is a complex function of ω, then write down its expression.

   (e) What is the basic concept of FIR filter ?

   (f) Mention whether the statement is true ***or*** false :

   A signal is not said to be periodic if $(t) = x(t+T)$, where T is the fundamental time period.

   (g) Write down the name of *two* types of digital filter.

2. Briefly answer the following questions : 2×4=8

   (a) Define IIR filter.

   (b) What do you mean by DTFT ?

   (c) Write down *two* basic characteristics of FIR filter.

   (d) Write down *two* basic characteristics of infinite impulse response (IIR).

3. Answer ***any three*** of the following questions : 5×3=15

   (a) Define static and dynamic system. If $y(t) = 2x(t) + 3x(t-3)$, here $x(t)$ is input $y(t)$ is output signal for present value of $t = 0$, show that system is dynamic.

   (b) State and explain linear property and time shifting property of Z-transform.

   (c) Define Inverse Discrete Time Fourier Transform (IDTFT), find the IDTFT of $x(\omega)$ where $x(\omega) = e^{-j\omega}$ for $-\pi \le \omega \le \pi$.

(d) Discuss addition and subtraction of amplitude of signal with proper examples.

(e) Discuss continuous and discrete convolution.

(f) Define FFT and DFT briefly.

4. Answer ***any three*** of the following questions : 10×3=30

(a) Define convolution of system. Discuss about shifting and scaling property of LTI system. If $x(t)$, $y(t)$ and $h(t)$ is the input, output and impulse signal of LTI system then express the differentiation of output. 2+4+4=10

(b) What do you mean by IIR filter ? What is the basic technique of transforming IIR digital filter from analog filter ? Mention the *three* basic classification of transformation of analog to digital IIR filter. Describe in short the bilinear Z-transform. 2+2+3+3=10

(c) What do you mean by signal ? Describe briefly about two types of basic signal. What are the differences between analog and digital signal ? Write the relation between signal and system. 1+4+3+2=10

(d) Establish a relation between trigonometric and exponential Fourier series.

(e) Describe in brief about ROC of LTI system. Write down its properties briefly. 4+6=10

(f) Write short notes on : 5+5=10

(i) Sampling and

(ii) Quantization

OPTION–C

(Advanced Mathematical Physics–II)

Paper : PHY–RE–6036

1. Answer the following questions : $1\times10=10$

তলৰ প্ৰশ্নবোৰৰ উত্তৰ দিয়া ঃ

(a) What is functional?

ফলনক কি?

(b) The degrees of freedom for two masses joined by a rigid rod are

দৃঢ় দণ্ডৰ দ্বাৰা যুক্ত দুটা ভৰৰ স্বাধীনতাৰ মাত্ৰা হ'ব

(i) 3

(ii) 2

(iii) 6

(iv) 5

(c) What are canonical pair of variables?

বিহিত যুগ্ম চলৰাশিবিলাক কি?

(d) Is the relation R "x as a divisor of y" symmetric?

সম্বন্ধ R "x হয় yৰ বিভেদক" প্ৰতিসম নেকি?

(e) If $A=\{a, b, c\}$ and $B=\{l, m, n\}$ are two sets, form a one-one onto mapping.

যদি $A=\{a, b, c\}$ আৰু $B=\{l, m, n\}$ দুটা সংহতি হয় তেনেহলে এটাকৈ আচ্ছাদক মানচিত্ৰণ গঠন কৰা।

(f) Fill in the blank :

খালী ঠাই পূৰ্ণ কৰা ঃ

In a Poisson distribution $2P(x=1)=P(x=2)$, then standard deviation is .....

পয়চন বণ্টনত $2P(x=1)=P(x=2)$, তেনেহলে মানক বিচলন হ'ব .....।

(g) The order of $(-i)$ in the multiplicative group $G=\{1, -1, i, -i\}$ is equal to

গুণাধীনৰ সংঘ $G=\{1, -1, i, -i\}$ত $(-i)$ৰ মৌলাংক হ'ব

(i) 1

(ii) 4

(iii) -4

(iv) -1

(h) How many generators are there in a cyclic group?

চক্রীয় সংঘ এটাৰ কেইটা জেনেৰেটৰ থাকে?

(i) What is Scleronomic constraint?

স্ক্লেৰ'নোমিক বাধা কি?

(j) Write the formula for $P(B|A)$ where A, B are two events in a sample space.

প্রতিদর্শ সমষ্টিত $P(B|A)$ ৰ সূত্র লিখা য'ত A আৰু B হ'ল দুটা ঘটনা।

2. Answer the following questions : 2×5=10

তলৰ প্রশ্নবোৰৰ উত্তৰ দিয়া ঃ

(a) Distinguish between Lagrangian and Hamiltonian formalisms.

লাগ্রেঁঝীয় আৰু হেমিল্টনীয় পদ্ধতি দুটাৰ মাজত থকা পার্থক্য লিখা।

(b) Identify the type of constraint for a body on a inclined plane and write the equation of constraint.

হেলনীয়া তলত থকা বস্তু এটাৰ বাবে প্রতিবন্ধৰ প্রকাৰৰ ন্যায্যতা প্রতিপাদন কৰা। প্রতিবন্ধৰ সমীকৰণটো লিখা।

(c) Write the product of cycles (1 2 3) and (4 5).

দুটা চক্র (1 2 3) আৰু (4 5) পূৰণফল লিখা।

(d) Show that the set S of all integers does not form a group under the operation defined as $x * y = x - y \ \forall \ \ x, y \in S$.

দেখুওৱা যে পূর্ণ সংখ্যাৰ সংহতি S টোয়ে $x * y = x - y \ \forall \ \ x, y \in S$ সঞ্চালনত সংঘ গঠন নকৰে।

(e) Define a group. When a group is said to abelian?

সংঘৰ সংজ্ঞা লিখা। সংঘ এটা কেতিয়া এৱেলীয় কোৱা হয়?

3. Answer ***any four*** of the following questions : 5×4=20

তলৰ প্ৰশ্নবোৰৰ *যিকোনো চাৰিটাৰ* উত্তৰ দিয়া ঃ

(a) The kinetic energy of a particle of mass m moving in a force field of potential V is given by T in spherical co-ordinates (r, θ, ϕ). Find the appropriate Hamiltonian of the system.

V বিভবযুক্ত বলক্ষেত্ৰত ঘূৰি থকা m ভৰৰ কণিকা এটাৰ বাবে গোলকীয় স্থানাংকত গতিশক্তি হ'ল T। ইয়াৰ কাৰণে উপযুক্ত হেমিল্টনিয়ান উলিওৱা।

(b) Define Lagrange bracket of two variables. Show that it is invariant under canonical transformation. 2+3=5

দুটা চলৰাশিৰ লাগ্ৰেঁঝীয় বন্ধনীৰ সংজ্ঞা লিখা। দেখুওৱা যে বিহিত ৰূপান্তৰণৰ অধীনত লাগ্ৰেঁঝীয় বন্ধনী অপৰিবৰ্তিত থাকে।

(c) *(i)* Define Bernoulli trials with example.

উদাহৰণৰ সৈতে বাৰ্ণলি অভিপ্ৰয়োগৰ সংজ্ঞা লিখা।

(ii) Determine which of the following is not a probability density function :

তলত দিয়াবিলাকৰ কোনটো সম্ভাৱিতা ঘনফলন নহয় নিৰ্ণয় কৰা ঃ

1. $f(x) = \frac{x}{36}$, over (বিস্তাৰ) [5, 10]

2. $f(x) = 2\sin 2x$, over (বিস্তাৰ) $[0, \pi/4]$

2+1½+1½=5

(d) An urn contains 5 black balls and 10 red balls. Two balls are drawn at random, one after another without replacement. What is the probability that the first ball selected is red if the second ball is known to be red?

পাত্র এটাত 5টা কলাবল আৰু দহটা ৰঙাবল আছে। প্রতিস্থাপন নকৰাকৈ এটাৰ পিছত এটাকৈ দুটা বল সংগ্রহ কৰা হ'ল। দ্বিতীয় বলটো ৰঙা হ'ব জনাকৈ প্রথম বলটো ৰঙা হোৱাৰ সম্ভাৱনা কি?

(e) (i) Using the following data :

প্রদত্ত তথ্য ব্যবহাৰ কৰি ঃ

Value of X (Xৰ মান)	:	1	2	3	4	5
Probability of $f(X)$	:	0·1	0·1	0·3	0·3	0·2

evaluate $E(X^2)$. 2

$E(X^2)$ ৰ মান উলিওৱা।

(ii) Define the order of a group.

Prove that $\phi : G \to G$ such that $\phi(x) = 2x \quad \forall\, x \in G$ is a homomorphism of groups. 1+2=3

সংঘ এটাৰ ক্রমৰ সংজ্ঞা দিয়া।

প্রমাণ কৰা যে $\phi : G \to G$ য'ত $\phi(x) = 2x \quad \forall\, x \in G$, সংঘৰ অনুৰূপ।

(f) Explain the principle of Least squares. Mention *one* merit and *one* demerit of it. 3+1+1=5

ন্যূনতম বর্গ পদ্ধতিৰ নীতি ব্যাখ্যা কৰা। পদ্ধতিটোৰ এটাকৈ সুবিধা আৰু অসুবিধা উল্লেখ কৰা।

4. Answer the following questions : 10×4=40

তলৰ প্রশ্নবোৰৰ উত্তৰ দিয়া ঃ

(a) (i) Discuss the motion of a one-dimensional linear harmonic oscillator in the Lagrangian formalism.

লাগ্রেঁঝীয় পদ্ধতিত একমাত্রীয় ৰৈখিক সমঞ্জস দোলকৰ গতি আলোচনা কৰা।

Test for an extremum of the functional

ফলনৰ চৰমতা পৰীক্ষা কৰা

$$J[y(x)] = \int_0^1 \left[xy + y^2 - 2y^2 y'\right] dx$$

$y(0) = 1, \quad y(1) = 2$ 4+6=10

OR / অথবা

(i) The Lagrangian of a particle of mass m moving in a plane is given by

$$L = \frac{1}{2}m\dot{x}^2 - axy$$

Find out canonical momentum and Hamiltonian. 2+2=4

সমতলত ঘূৰি থকা m ভৰযুক্ত কণিকাৰ বাবে লাগ্ৰেঁঝীয়া $L = \frac{1}{2}m\dot{x}^2 - axy$ বিহিত ভৰবেগবিলাক আৰু হেমিল্টনৰ প্ৰকাশৰাশি উলিওৱা।

Define partition of a set. 2

সংহতিৰ বিভাজনৰ সংজ্ঞা দিয়া।

Show that the set of Q of non-zero rational numbers form a group with respect to binary operation of ordinary multiplication. 4

দেখুওৱা যে অশূণ্য পৰিমিত সংখ্যাবিলাকৰ সংহতি Q সাধাৰণ গুণাত্মক দ্বৈত প্ৰক্ৰিয়াৰ সাপেক্ষে সংঘ গঠন কৰে।

(b) (i) Write the physical significance of Hamilton's equation. 2

হেমিল্টনৰ সমীকৰণৰ ভৌতিক তাৎপর্য্য লিখা।

Derive Lagrange's equation from Hamilton's principle. 8

হেমিল্টনৰ নীতিৰ পৰা লাগ্ৰেঁঝীয় সমীকৰণ উলিওৱা।

OR / অথবা

(i) If G is a group and $a, b \in G$ then show that the equation $ax = b$ has a unique solution $a^{-1}b \in G$. 5

যদি G এটা সংঘ হয় আৰু $a, b \in G$ তেতিয়া দেখুওৱা যে $ax = b$ সমীকৰণটোৰ অদ্বিতীয় সমাধান হ'ল $a^{-1}b \in G$.

Show that the right co-set of set S of inverses of elements is a left co-set. 5

দেখুওৱা যে সংহতি S এটাৰ উপাদানবিলাকৰ বিপৰীত উপাদানবিলাক লৈ গঠিত দক্ষিণ সহ-সংহতি হৈ যায় Sৰ বাঁও সহ-সংহতি।

(c) (i) What do you mean by reflexive relation on a set? 1

সংহতি এটাত প্রতিফলনীয় সম্বন্ধ বুলি কলে কি বুজা?

Examine if the set $\{1, w, w^2\}$ is Abelian finite group with respect to multiplication. 4

$\{1, w, w^2\}$ সংহতিটো পূৰণৰ সাপেক্ষে পৰিমিত এবেলীয় সংঘ হয় নেকি পৰীক্ষা কৰা।

Prove that the shortest distance between any two points in a plane is a straight line. 4

দেখুওৱা যে সমতল এখনত দুটা বিন্দুৰ মাজৰ ন্যূনতম দূৰত্ব এডাল সৰলৰেখা হয়।

Examine if the set {1} is a group with respect to addition. 1

{1} সংহতি যোগাত্মক প্রক্রিয়াৰ সাপেক্ষে সংঘ হয় নে নহয় পৰীক্ষা কৰা।

OR / অথবা

(i) What is variational principle? Derive Euler's equation using variational principle. 2+8=10

পৰিবৰ্তনশীল নীতি কি? পৰিবৰ্তনশীল ব্যৱহাৰ কৰি অয়লাৰৰ সমীকৰণ উলিওৱা।

(d) What are Legendre transformation equations? Derive Hamilton's equations using Legendre transformations. 2+8=10

লিজেন্দ্রীয় ৰূপান্তৰকৰণৰ সমীকৰণবোৰ কি? লিজেন্দ্রীয় ৰূপান্তৰকৰণৰ আধাৰত হেমিল্টনীয় সমীকৰণবোৰ উলিওৱা।

OR / অথবা

Define random variables and give example. Write down the expression for Gaussian distribution function.
Find the mean and variance of Binomial distribution with parameter n, p. 1+1+2+2+4=10

যাদৃচ্ছিক চলকৰ সংজ্ঞা লিখা, উদাহৰণ দিয়া। গাউছ বণ্টনৰ প্রকাশৰাশি লিখা। দ্বিপদ বণ্টনৰ n, p পৰামিতি সাপেক্ষে গড় আৰু মানক বিচলন উলিওৱা।

OPTION–D

(Astronomy and Astrophysics)

Paper : PHY–RE–6046

1. Give short answers to the following questions : 1×10=10

   (a) What is luminosity of a star ?

   (b) Write the range of value of the Azimuth of celestial objects.

   (c) What are white dwarf stars ?

   (d) Which of the following features does not pertain to a telescope ?

   (i) Light-gathering

   (ii) Magnification

   (iii) Dispersion

   (iv) Resolution

   (e) What are vernel equinox and the right ascension (RA) ?

   (f) Which class of the stars are found in the disc of the Milky Way ?

   (g) The sequence of classification of stars is

   (i) OAFBGKM

   (ii) OMABFGK

   (iii) OBAFGKM

   (iv) ABFGKMO

   (h) What is Solar Corona ?

   (i) Define active Galaxy.

   (j) State the Cosmological principle.

2. Answer the following questions : 2×5=10

   (a) Write the difference between sidereal time and solar time.

   (b) Calculate the ratio of Radiant fluxes received from two stars. Whose magnitudes differ by 2·5 ?

   (c) Calculate the resolving power of a telescope having a diameter of 2·34*m*, when a radiation of wavelength 5500Å is detected.

(d) Define parsec and calculate its value in meter.

(e) Draw a schematic diagram of Milky Way showing its different parts.

3. Answer ***any four*** of the following questions : 5×4=20

(a) What are apparent and absolute magnitude of a shining object? Derive a relation between them. 2+3=5

(b) Describe the sequence of reactions in the carbon-nitrogen cycle for energy production of a star.

(c) Explain the formation of neutron star and its internal structure.

(d) With an appropriate diagram, explain Hubble's classification of galaxies. 2+3=5

(e) Obtain the ratio of radii of two stars in terms of their surface temperatures and absolute magnitudes, using Stefan-Boltzmann law of radiation.

(f) Describe the Trigonometric Parallax method used to determine the distance of a star.

4. Answer ***any four*** of the following questions : 10×4=40

(a) What is Hertzsprung-Russell diagram? Write the common features of the stars on the main sequence of H–R diagram. Show that a heavy star stays in the main sequence for a shorter period as compared to that for a lighter star when the Luminosity $L \propto M^{\alpha}$, where M is the mass of star $\alpha > 1$. 2+3+5=10

(b) What is the basis of spectral classification of stars? Enumerate the special features of Harvard special sequence. 4+6=10

(c) (i) What do you understand by hydrostatic equilibrium in a star? Derive the equation of hydrostatic equilibrium of a star. 2+3=5

(ii) State Hubble's law and explain how Hubble's constant indicates the age of the universe. 2+3=5

(d) Write down the sequence of events leading to the formation of a protostar. Explain how a star is formed from a protostar. 6+4=10

(e) Discuss qualitatively the different stages in the evolution of a star.

(f) Establish the Virial theorem and find the relationship between pressure and gravitational binding energy. 6+4=10

(g) (i) Distinguish between refracting and reflecting telescopes. What are the advantages of reflecting telescope over refracting telescope? 2+3=5

(ii) What is light gathering power of a telescope? Compare the light-gathering power of the $8m$ telescope and $0{\cdot}8m$ telescope. 2+3=5

(h) Write short notes on ***any two*** of the following : 5×2=10

(i) Black holes

(ii) Kuiper belt

(iii) Stellar magnitude scale

(iv) Milky Way

OPTION–E

(Classical Dynamics)

Paper : PHY–RE–6056

1. Give short answer to the following questions : 1×10=10

(a) What is Lagrangian of a system?

(b) Write the type of constraint which depends on time.

(c) If the magnetic field increases, the gyro radius or the Larmor radius of a charged particle ..... . *(Fill in the blank)*

(d) Write the general expression of Hamiltonian (H) of a system in terms of Lagrangian (L).

(e) If the Lagrangian (L) of a system does not depend on time (t), the Hamiltonian becomes ..... . *(Fill in the blank)*

(f) What is stable equilibrium?

(g) What do you understand by normal mode?

(h) What is space-time interval?

(i) What do you mean by world line in Minkowski space?

(j) Write the *four* components of velocity four-vector.

2. Briefly answer the following questions: 2×5=10

(a) Show that in constant magnetic field, the kinetic energy of a charged particle is constant.

(b) Write the D'Alembert's principle.

(c) Write *two* properties of central force.

(d) What is the difference between Minkowski space and Euclidean space?

(e) What do you mean by critical velocity of a fluid?

3. Answer ***any four*** of the following questions: 5×4=20

(a) What is holonomic and non-holonomic constraints? Explain with example.

(b) What is cyclic or ignorable coordinate? Prove that the generalized momentum conjugate to cyclic coordinate is conserved. 2+3=5

(c) Explain the motion of a charged particle in uniform magnetic field (B).

(d) Explain the difference between real and virtual displacements. In a virtual displacement, the work done by the forces of constraint is zero. Explain why. 2+3=5

(e) What is four-vector? Show that the magnitude of momentum four-vector is an invariant quantity. 1+4=5

(f) What do you mean by light-like and space-like events? Explain with the help of space-time diagram. 2½+2½=5

4. Answer ***any four*** of the following questions: 10×4=40

(a) Show that in a constant electric field, the total energy of a charged particle remain conserved. Derive the expression of the trajectory of a charged particle when it moves perpendicular to an electric field. 5+5=10

Contd.

(b) Explain generalized coordinate with examples. Find the Lagrangian and Lagrange's equation of motion for a falling body in uniform gravity. 3+2+5=10

(c) What is Hamiltonian principle? Find the Hamiltonian and Hamilton's equation of motion for simple harmonic oscillator. 2+2+6=10

(d) Derive Hamilton's canonical equations of motion.

(e) Show that in case of central force, the energy and momentum are constant of motion.

(f) What is Reynold's number? Obtain an expression for Reynold's number and explain its physical significance. 2+6+2=10

(g) What is twin paradox? Explain with the help of space-time diagram. 2+8=10

(h) What is the difference between incompressible and compressible fluid? Derive Navier-Stokes equation for the flow of an incompressible fluid. 2+8=10