Total number of printed pages–24

3 (Sem–6/CBCS) PHY RE 1/2/3/4/5

2025

PHYSICS

(Regular Elective)

Answer the Questions from any one Option.

OPTION – A

Paper : PHY–RE–6016

(Communication Electronics)

Full Marks : 60

Time : Three hours

OPTION – B

Paper : PHY–RE–6[redacted]

(Digital Signal Processing)

Full Marks : 60

Time : Three hours

OPTION – C

Paper : PHY–RE–6036

(Advanced Mathematical Physics–II)

Full Marks : 80

Time : Three hours

OPTION – D

Paper : PHY–RE–6046

(Astronomy and Astrophysics)

Full Marks : 80

Time : Three hours

OPTION – E

Paper : PHY–RE–6056

(Classical Dynamics)

Full Marks : 80

Time : Three hours

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

OPTION–A

Paper : PHY–RE–6016

(Communication Electronics)

Full Marks : 60

Time : Three hours

Answer either in English or in Assames.

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

তলৰ প্ৰশ্নসমূহৰ উত্তৰ কৰা ঃ

(a) Write the full form of IMEI.

IMEI-ৰ প্ৰকাশ ৰাশিটো সম্পূৰ্ণকৈ লিখা।

(b) Define Modulation Index.

কলন সূচক কাক বোলে লিখা।

(c) Write the full form of ASK.

ASK-ৰ প্ৰকাশ ৰাশিটো সম্পূৰ্ণকৈ লিখা।

(d) What is the period of revolution of a geostationary satellite around earth ?

পৃথিৱীৰ চাৰিওপিনে ঘূৰ্ণীয়মান ভূ-স্থৈতিক উপগ্ৰহ এটাৰ পৰ্য্যায়কাল কিমান ?

(e) What are Radio waves ?

ৰেডিয়' তৰংগ কি ?

(f) How many satellites are there in Indian GPS service ?

ভাৰতীয় GPS সেৱাত কিমানটা উপগ্ৰহ আছে ?

(g) What is S/N ratio ?

S/N অনুপাত কি ?

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

তলৰ প্ৰশ্নসমূহৰ উত্তৰ কৰা ঃ

(a) Mention *two* advantages of geostationary satellites.

ভূ-স্থৈতিক উপগ্ৰহৰ *দুটা* সুবিধা উল্লেখ কৰা।

(b) Draw the block diagram of an Electronic communication system.

ইলেক্ট্ৰনিক যোগাযোগ ব্যৱস্থা এটাৰ ব্লক চিত্ৰ অঙ্কন কৰা।

(c) Explain the need for modulation.

কলনৰ প্ৰয়োজনীয়তা ব্যাখ্যা কৰা।

(d) What do you mean by multiplexing ?

মাল্টিপ্লেক্সিং বুলিলে কি বুজা ?

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

তলৰ *যিকোনো তিনিটাৰ* উত্তৰ কৰা ঃ

(a) Write a short note on Electromagnetic communication spectrum.

বিদ্যুৎচুম্বকীয় যোগাযোগ বৰ্ণালীৰ বিষয়ে এটা চমু টোকা লিখা।

(b) Explain the working of a Super Heterodyne Receiver.

ছুপাৰ হেটেৰ'ডাইন ৰিচিভাৰৰ কাৰ্য্যপ্ৰণালী বুজাই লিখা।

(c) What is GPS navigation system? Explain.

GPS নেভিগেচন ব্যৱস্থা কি ? বুজাই লিখা।

(d) Mention the differences between 2G and 4G.

2G আৰু 4G-ৰ' মাজত থকা পাৰ্থক্যসমূহ উল্লেখ কৰা।

(e) What do you mean by Noise in communication system? Mention different types of External Noise and Internal Noise.

যোগাযোগ ব্যৱস্থাত আৰাও (Noise) বুলিলে কি বুজা?

বিভিন্ন প্ৰকাৰৰ বাহ্যিক আৰাও (Noise) আৰু আভ্যন্তৰীণ আৰাওৰ (Noise) নাম উল্লেখ কৰা।

4. Answer the following questions : 10×3=30

তলত প্ৰশ্নসমূহৰ উত্তৰ কৰা ঃ

(a) Write the characteristics of Amplitude Modulation, Frequency Modulation and Phase Modulation.

A 10*kHz* wave is modulated 50% by a carrier wave of frequency 10*MHz* and amplitude 50*V*. Find the frequencies and amplitudes of the sidebands produced. 6+4=10

বিস্তাৰ কলন (AM), কম্পনাংক কলন (FM) আৰু দশা কলন (PM)-ৰ বৈশিষ্ট্যসমূহ লিখা।

10*kHz* তৰংগ এটাক 10*MHz* কম্পনাংক আৰু 50*V* বিস্তাৰৰ বাহক তৰংগৰ দ্বাৰা 50% কলিত কৰা হৈছে। সৃষ্টিহোৱা পাৰ্শ্বপটিৰ কম্পনাংক আৰু বিস্তাৰ নিৰ্ণয় কৰা।

Or / নাইবা

Mention the basic principles used in PAM, PWM and PPM. Explain Sampling theorem. 6+4=10

PAM, PWM আৰু PPM-ত ব্যৱহৃত মূলনীতিসমূহ উল্লেখ কৰা। নমুনা সংগ্ৰহ উপপাদ্যটো ব্যাখ্যা কৰা।

(b) Briefly explain the concepts of ASK, FSK, PSK and BPSK. ½×4=10

ASK, FSK, PSK আৰু BPSK-ৰ ধাৰণাসমূহ চুটিকৈ ব্যাখ্যা কৰা।

Or / নাইবা

(i) Explain the need for satellite communication.

(ii) What is a Geosynchronous satellite orbit?

(iii) Draw a simplified block diagram of Earth Station. 3+2+5=10

(i) উপগ্রহ যোগাযোগ ব্যৱস্থাৰ প্রয়োজনীয়তা ব্যাখ্যা কৰা।

(ii) ভূ-সমকালীন উপগ্রহৰ কক্ষপথ বুলিলে কি বুজা?

(iii) ভূ-কেন্দ্র (Earth Station) এটাৰ সৰলীকৃত ব্লক চিত্র অঙ্কন কৰা।

(c) Explain, in brief, the idea of GSM, CDMA, TDMA and FDMA technologies. ½×4=10

GSM, CDMA, TDMA আৰু FDMA প্রযুক্তি কেইটাৰ ধাৰণাসমূহ চমুকৈ ব্যাখ্যা কৰা।

Or / নাইবা

Write short notes on : **(any two)** 5×2=10

চমু টোকা লিখা : *(যিকোনো দুটা)*

(i) Need for Digital Transmission

ডিজিটেল সংক্রমণৰ প্রয়োজনীয়তা

(ii) Uplink and Downlink

আপলিংক আৰু ডাউনলিংক

(iii) Need for Data Encryption

ডাটা এনক্রিপচনৰ প্রয়োজনীয়তা

OPTION–B

Paper : PHY–RE–6026

(Digital Signal Processing)

Full Marks : 60

Time : Three hours

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

   (a) Define Discrete Time System.

   (b) What is Sampling ?

   (c) What is another term used for two-sided z-transform?

   (d) The interface between an analog signal and a digital signal processor is :

   (i) D/A converter

   (ii) A/D converter

   (iii) Modulator

   (iv) Demodulator

   (e) What is the necessary condition for an LTI system to be casual in nature?

   (f) Define Periodic signal.

   (g) In the context of digital filters, FIR stands for_____.

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

   (a) What is the area of a Unit Impulse Function ? Write the other name of a Continuous Time Unit Impulse Function.

   (b) What is the circular convolution of the sequences $X(n)=\{2,1,2,1\}$ and $Y(n)=\{1,2,3,4\}$, find using the DFT and IDFT concepts?

   (c) What are the advantages of digital filters?

   (d) Determine and plot the impulse response of FIR system.

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

   (a) Compare DIT algorithm with DIF algorithm.

   (b) Write down the procedure to design the FIR Filter using Frequency Sampling Method.

   (c) Compare the computational complexity of direct DFT computation with FFT computation of a sequence, with $N=64$.

   (d) What is region of convergence in z-transform ? Discuss its properties. 2+3=5

   (e) Calculate the inverse z-transform of

$$H(z)=\frac{2z}{\left(z-\left[\frac{1}{2}\right]\right)}.$$

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

(a) Explain in detail, the important properties of the Discrete Fourier Transform.

(b) Explain phase delay and group delay with mathematical expressions. Realize the linear phase FIR filter having impulse response given by

$$h(n)=\delta(n)+\frac{1}{4}\delta(n-1)-\frac{1}{8}\delta(n-2)+\frac{1}{4}\delta(n-3)+\delta(n-4)$$

2+2+6=10

(c) Discuss the steps how an IIR filter can be designed by impulsive invariance method.

(d) Discuss the relation between z-transform and DFT.

(e) Explain the concept of circular convolution. Find the circular convolution of the following two sequences :

$$x[n]=\{1,2,3\}$$

$$h[n]=\{4,5,6\}$$

5+5=10

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

(i) Zero-phase filter

(ii) Windowing Method

OPTION–C

Paper : PHY–RE–6036

(Advanced Mathematical Physics–II)

Full Marks : 80

Time : Three hours

1. Answer the following : 1×10=10

(a) We cannot define _____ for a non-conservative force. *(Fill in the blank)*

(b) The number of degree of freedom on a chess board is ____. *(Fill in the blank)*

(c) If the Lagrangian does not depend explicitly on time, the _____ is constant. *(Fill in the blank)*

(d) How many constraints are involved in the motion of a simple pendulum ?

(e) What is the Lagrangian ?

(f) What state of a system is described by Hamilton Principle ?

(g) Define mutually exclusive sets.

(h) Define a proper subset.

(i) What do you mean by Conditional Probability ?

(j) How is the Normal distribution related to the Binomial distribution ?

2. Answer the following : 2×5=10

(a) How can constraints be classified ?

(b) What is the degree of freedom of a particle moving along x-direction in 3-dimensional space ?

(c) What is the Lagrange Product ?

(d) What do you mean by Gaussian Distribution ?

(e) Define Poisson's Distribution.

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

(a) Show that the shortest curve joining two fixed points is a straight line.

(b) Explain the physical significance of Hamilton's Principle.

(c) The Lagrangian of a particle of mass moving in a plane is given by $L = \frac{1}{2}m\left(v_x^2 + v_y^2\right) + a\left(xv_y - yv_x\right)$, where v_x and v_y are velocity components and a is a constant. Find the canonical momenta and Hamiltonian of the particle.

(d) What do you mean by Finite and Infinite Sets. Explain with the help of examples.

(e) Define Inverse Mapping. Find the inverse mapping of $f: x \to y$, where $f(x) = (x+5)^{1/2}$, $x \geq -5$.

(f) Out of 800 families with 5 children each, how many families would you expect to have (a) exactly 3 boys, (b) exactly 5 girls, (c) exactly either 2 or 3 boys *(Assume equal probabilities for boys and girls)* ?

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

(a) State and explain Hamilton's Principle. Derive Lagrangian Equation from Hamilton's Principle. 5+5=10

(b) Establish Euler-Lagrangian equation of motion. Discuss the motion of a simple pendulum in the Lagrangian function. 6+4=10

(c) What do you mean by Poisson's Bracket ? Explain with the help of an example. Write *any five* properties of Poisson's Bracket. 2+3+5=10

(d) What is a Random Variable and the expectation of a Random Variable ? Show that the expectation of the sum of two random variables X and Y is the sum of their expectations $E(x)$ and $E(y)$. 5+5=10

(e) Define, with examples an Abelian group and a Non-Abelian group. Prove that the set $\{1, -1, i, -i\}$ is an Abelian multiplicative finite group of order 4. 5+5=10

(f) Explain the Bayes' theorem of probability and establish its proof systematically. Describe about the continuous and discrete random variables . 5+5=10

(g) Define Binomial Distribution. Write *any three* characteristics of the Binomial Distribution. Compute the following for a Binomial Distribution with parameters $p = 0{\cdot}7$, $N = 60$:

(a) mean (b) variance and (c) standard deviation. 5+5=10

OPTION–D

Paper : PHY–RE–6046

(Astronomy and Astrophysics)

Full Marks : 80

Time : Three hours

Answer either in English or in Assames.

1. Answer the following questions : 1×10=10

তলত দিয়া প্রশ্নবোৰৰ উত্তৰ লিখা ঃ

(a) What is the primary factor that determines a Star's lifetime ?

এটা তৰাৰ আয়ুস নির্ণয় কৰা প্রাথমিক কাৰকটো কি?

(b) Define Radiant flux.

ৰেডিয়েন্ট ফ্লাক্সৰ সংজ্ঞা দিয়া।

(c) Write the relationship between brightness and apparent magnitude of star.

তৰাৰ উজ্জ্বলতা আৰু আপাত মানৰ মাজৰ সম্পর্ক লিখা।

(d) What is Kuiper belt ?

কুইপাৰ বেল্ট কি?

(e) What is Celestial sphere ?

আকাশী গোলক কি?

(f) What is hour angle of a Star ?

এটা তৰাৰ ঘণ্টা কোণ কিমান?

(g) Define Greenwich Mean Time.

গ্রীনউইচ গড় সময়ৰ সংজ্ঞা দিয়া।

(h) Name *two* major types of telescope.

টেলিস্কোপৰ *দুটা* প্ৰধান প্ৰকাৰৰ নাম লিখা।

(i) Define resolution of a telescope.

টেলিস্কোপৰ ৰিজলিউচনৰ সংজ্ঞা দিয়া।

(j) What is Quasar ?

কোৱাছাৰ কি?

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

তলত দিয়া প্ৰশ্নবোৰৰ উত্তৰ লিখা ঃ

(a) Define effective temperature of Sun.

সূৰ্য্যৰ কাৰ্যকৰী উষ্ণতাৰ সংজ্ঞা দিয়া।

(b) What is Bolometric magnitude ?

বলমেট্ৰিক মান কি?

(c) What do you mean by colour temperature of a star ?

তৰা এটাৰ কালাৰ উষ্ণতা কি?

(d) If the distance of star is increased by a factor 2, then how much the radiation flux received changes ?

যদি তৰাৰ দূৰত্ব ২ গুণ বৃদ্ধি কৰা হয়, তেন্তে বিকিৰণ প্ৰবাহ কিমান সলনি হয়?

(e) What is the difference between Sidereal time and Solar time ?

নক্ষত্ৰীয় সময় আৰু সৌৰ সময়ৰ মাজত পাৰ্থক্য কি?

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

তলৰ *যিকোনো চাৰিটাৰ* উত্তৰ লিখা ঃ

(a) Give *two* reasons of the variations of Apparent solar day. How many Solar days are there in a lunar calendar?

আপাত সৌৰ দিনৰ তাৰতম্যৰ *দুটা* কাৰণ দিয়া। চন্দ্ৰ পঞ্জিকাত কিমান সৌৰ দিন থাকে?

(b) What are the *four* components of Galaxy ? Distinguish between Stars of population I and II.

গেলাক্সিৰ *চাৰিটা* উপাদান কি কি? I আৰু II ৰ তৰাৰ মাজত পাৰ্থক্য লিখা।

(c) Explain the formation of Neutron star.

নিউট্ৰন তৰাৰ গঠন ব্যাখ্যা কৰা।

(d) What do you mean by hydrostatic equilibrium in a star ? Derive the equation of Hydrostatic equilibrium for a Star.

তৰা এটাত হাইড্ৰ'ষ্টেটিক ভাৰসাম্য বুলিলে কি বুজা? এটা তৰাৰ বাবে হাইড্ৰ'ষ্টেটিক ভাৰসাম্যৰ সমীকৰণ উলিওৱা।

(e) State Hubble's law and explain. How Hubble's constant indicates the age of the Universe?

হাবলৰ সূত্ৰ লিখা। হাবলৰ ধ্ৰুৱকে বিশ্বব্ৰহ্মাণ্ডৰ বয়স কেনেকৈ সূচায়?

(f) Explain the types of Active Galaxies.

সক্ৰিয় তাৰকাৰাজ্যৰ প্ৰকাৰ ব্যাখ্যা কৰা।

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

তলৰ *যিকোনো চাৰিটা* প্ৰশ্নৰ উত্তৰ লিখা ঃ

(a) Define Celestial Sphere. Draw the neat diagram of celestial sphere showing Zenith, Nadir, Celestial poles and Celestial equator.

আকাশী গোলকৰ সংজ্ঞা লিখা। জেনিথ, নাদিৰ, আকাশী মেৰু আৰু আকাশী বিষুৱৰেখা দেখুওৱা আকাশী গোলকৰ পৰিপাটি ডায়াগ্ৰামটো আঁকা।

(b) What do you mean by main Sequence Star? Write down the Spectral Classes of Stars. In which class the Sun belongs to?

মূল ক্ৰম তৰা বুলিলে কি বুজা ? তৰাৰ বৰ্ণালী শ্ৰেণীসমূহ লিখা? সূৰ্য্য কোন শ্ৰেণীৰ?

(c) Give a brief description of Solar atmosphere.

সৌৰ বায়ুমণ্ডলৰ চমু বিৱৰণ দিয়া।

(d) Describe the trigonometric parallax method for determining steller distance. Mention the limitations of the method.

স্টেলাৰৰ দূৰত্ব নিৰ্ণয়ৰ বাবে ত্ৰিকোণমিতিক প্যাৰালেক্স পদ্ধতিৰ বৰ্ণনা কৰা। পদ্ধতিৰ সীমাবদ্ধতা উল্লেখ কৰা।

(e) (i) Define Angular Magnification and Light Gathering Power of a telescope. Distinguish between refracting and reflecting telescope.

টেলিস্কোপৰ Angular Magnification আৰু Light Gathering Power-ৰ সংজ্ঞা দিয়া। প্ৰতিসৰিত আৰু প্ৰতিফলিত টেলিস্কোপৰ মাজত পাৰ্থক্য কৰা।

(ii) Discuss briefly the application of various online tools in Astronomy.

জ্যোতিৰ্বিজ্ঞান (Astronomy) ত বিভিন্ন অনলাইন সঁজুলিৰ প্ৰয়োগৰ বিষয়ে চমুকৈ আলোচনা কৰা।

(f) (i) Distinguish between Elleptical and Spiral Galaxy. What is an active Galactic nucleus ?

এলেপ্টিকেল আৰু স্পাইৰেল গেলেক্সীৰ মাজত পার্থক্য কৰা? সক্রিয় গেলেক্টিক নিউক্লিয়াছ কি?

(ii) Discuss briefly how a super massive black hole can be formed.

চুপাৰ মাছিভ Black Hole কেনেকৈ গঠন হ'ব পাৰে সেই বিষয়ে চমুকৈ আলোচনা কৰা।

(g) What is meant by Hertzsprug-Russell diagram ? Trace evolutionary tracks of stars and discuss on Steller evolution.

Hertzsprug - Russell ডায়াগ্রাম বুলিলে কি বুজা? তৰাৰ বিৱর্তনৰ ট্রেক ট্রেচ কৰা আৰু স্টেলাৰ বিৱর্তনৰ ওপৰত আলোচনা কৰা।

(h) Write short notes on ***any two*** :

যিকোনো দুটাৰ ওপৰত চুটি টোকা লিখা ঃ

(i) Virial theorem

ভাইৰিয়েল উপপাদ্য

(ii) White dwarf

হোৱাইট ডোৱার্ফ

(iii) Steller magnitude scale

স্টেলাৰ মান স্কেল

OPTION–E

Paper : PHY–RE–6056

(Classical Dynamics)

Full Marks : 80

Time : Three hours

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

(a) What do you mean by generalized co-ordinates ?

(b) Give an example of non-holonomic constraint.

(c) Define Hamiltonian of a system.

(d) Draw potential energy *vs.* displacement curve for an unstable equilibrium.

(e) What is time-like event ?

(f) What is the value of Raynolds number for turbulent flow ?

(g) What do you mean by proper length ?

(h) What is stable equilibrium ?

(i) What do you understand by normal mode ?

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

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

(a) What do you mean by degrees of freedom ? Give example.

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

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

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

(e) What are symmetric and anti-symmetric modes of vibration ?

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

(a) Explain the motion of a charged particle moving perpendicular to a magnetic field.

(b) State and prove the principal of virtual work.

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

(d) Derive the expression for length contraction.

(e) Find the Lagrangian equation of motion for a falling body near to the surface of earth in uniform gravity.

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

(g) The Lagrangian of a system is given by $L = 1/2\left(\dot{r}^2 + r^2\dot{\theta}^2\right) - V(r)$. Find the Hamiltonian of the system.

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

(a) Derive Lagrange's equation of motion for a conservative system from D'Alembert's principle.

(b) Give physical significance of Hamiltonian. Derive Hamilton's equation of motion for a system. 2+8=10

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

Contd.

(d) What is twin paradox ? Explain with the help of space-time diagram.

2+8=10

(e) Derive the Lorentz transformation equation for space and time. In what condition, Lorentz transformation become similar to Galilean transformation ?

(f) Show that in a constant electric field the total energy of a charged particle remains conserved. Derive the expression for the trajectory of a charged particle when it moves perpendicular to an electric field.

5+5=10

(g) Differentiate between streamline and turbulent flow. Derive Poiseuille's equation for flow of liquid through a pipe.
