

Undergraduate Examination, 2023
Semester-I
CVAC: Tagore Studies (NEP)
(For Regular candidates)

Time: 3 Hours

Full Marks: 60

দক্ষিণ প্রান্তস্থ সংখ্যা প্রশ্নের মান নির্দেশক

১। যে-কোনো পনেরোটি প্রশ্নের উত্তর পূর্ণবাক্যে দাও:

১৫×১=১৫

- ক) রবীন্দ্রনাথের মায়ের নাম কী?
- খ) রবীন্দ্রনাথ প্রথম হিমালয় ভ্রমণ করেন কার সঙ্গে?
- গ) রবীন্দ্রনাথের কোন আত্মীয় ভারতীয়দের মধ্যে প্রথম আই.সি.এস?
- ঘ) রবীন্দ্রনাথ প্রথমে কোন বিদ্যালয়ে ভর্তি হয়েছিলেন?
- ঙ) রবীন্দ্রনাথের এক দিদি সেকালের বিখ্যাত ঔপন্যাসিক ছিলেন। তাঁর নাম কী?
- চ) রবীন্দ্রনাথের গীতিনাট্য 'বাল্মীকিপ্রতিভা' কোন সালে প্রকাশিত হয়?
- ছ) বিবাহের আগে রবীন্দ্রনাথের স্ত্রীর নাম কী ছিল?
- জ) রবীন্দ্রনাথের প্রথম সন্তানের নাম কী?
- ঝ) শান্তিনিকেতন ব্রহ্মচর্যাশ্রম কবে প্রতিষ্ঠিত হয়?
- ঞ) রবীন্দ্রনাথ কত সালে নোবেল পুরস্কার পান?
- ট) ইংরেজি 'গীতাঞ্জলি'র ভূমিকা কে লিখেছিলেন?
- ঠ) কোন ঘটনার প্রতিবাদে রবীন্দ্রনাথ নাইটহুড ('স্যার' উপাধি) ফিরিয়ে দেন?
- ড) ১৯২২ সালে গ্রাম পুনর্গঠন কেন্দ্র কোথায় স্থাপিত হয়?
- ঢ) বিদেশে কোন শহরে প্রথম রবীন্দ্রনাথের আঁকা ছবির প্রদর্শনী হয়?
- ণ) চীনাভবন কবে প্রতিষ্ঠিত হয়?
- ত) রবীন্দ্রনাথ কাকে 'বিজয়া' নাম দিয়েছিলেন?
- থ) রবীন্দ্রনাথের শেষ জন্মদিনের ভাষণটির নাম কী?
- দ) রবীন্দ্রনাথের মৃত্যুর ইংরেজি তারিখটি কী?

২। যে-কোনো তিনটি বিষয়ে অনধিক পঁচাত্তর (৭৫) শব্দে টীকা লেখো:

৩×৫=১৫

- ক) রবীন্দ্রনাথের বাল্যজীবন
- খ) রবীন্দ্রনাথের প্রথম ইউরোপ ভ্রমণ
- গ) রবীন্দ্রজীবনে শিলাইদহ পর্বের গুরুত্ব
- ঘ) কলাভবন ও সংগীতভবন
- ঙ) শান্তিনিকেতন ব্রহ্মচর্যাশ্রম
- চ) রবীন্দ্রভাবনায় বুদ্ধদেবের গুরুত্ব

৩। যে-কোনো দুটি প্রশ্নের উত্তর দাও:

২×১৫=৩০

- ক) সদর স্ট্রিটের বাড়িতে সূর্যোদয় দেখবার ঘটনা রবীন্দ্রনাথের মনকে কীভাবে প্রভাবিত করেছিল?
- খ) শ্রীনিকেতনে রবীন্দ্রনাথের গ্রাম পুনর্গঠন প্রয়াসের কথা সংক্ষেপে লেখো।
- গ) তোমাদের পাঠ্য 'আশ্রমের শিক্ষা' রচনাটির বক্তব্য নিজের ভাষায় লেখো।
- ঘ) ভারতবর্ষের ইতিহাস প্রবন্ধ অনুসরণে ভারতীয় ও যুরোপীয় সভ্যতার তুলনামূলক আলোচনা করো।
- ঙ) পৃথিবীর প্রতি রবীন্দ্রনাথের মনোভাব 'পৃথিবী' প্রবন্ধ অবলম্বনে লেখো।

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Time: 3 Hours

Full Marks: 60

Marks on the right-hand margin are indicative of the values of the questions.

1. Answer the following questions in **complete** sentences (*any 15*) **15×1=15**
 - a. What is the name of Tagore's mother?
 - b. With whom did Tagore make his first trip to the Himalayas?
 - c. Who, among Tagore's relatives, became the first Indian I.C.S.?
 - d. Name the first school in which Tagore was admitted.
 - e. One of Tagore's elder sisters was a famous novelist of her time. Name her.
 - f. In which year was Tagore's opera named *Valmiki Pratibha* published?
 - g. What was the name of Tagore's wife before her marriage?
 - h. What is the name of Tagore's first child?
 - i. In which year was the Santiniketan *Brahmacharyashram* founded?
 - j. In which year did Tagore receive the Nobel Prize?
 - k. Who wrote the 'Introduction' to *Gitanjali: Song Offerings*?
 - l. In response to which incidence did Tagore renounce the Knighthood?
 - m. Where was the rural reconstruction centre established in 1922?
 - n. In which foreign city was the first-ever exhibition of Tagore's paintings held?
 - o. In which year was the Cheena Bhavana established?
 - p. Whom did Tagore name 'Vijaya'?
 - q. What is the title of Tagore's last birthday address?
 - r. Write the date of Tagore's demise according to the Gregorian calendar.
2. Write short notes on *any three (3)* of the following topics with not more than **75 words** for each. **3×5=15**
 - a) Tagore's childhood,
 - b) Tagore's first voyage to Europe,
 - c) The significance of the Shelaidaha phase of Tagore's life,
 - d) Kala Bhavana and Sangit Bhavana,
 - e) Santiniketan *Brahmacharyashram*,
 - f) The importance of Buddhadeva in Tagore's philosophy.
3. Answer *any two* of the following questions. **2×15=30**
 - a. Discuss how the experience of watching the sunrise from the Sudder Street house impacted Tagore's mind.
 - b. Write briefly about Tagore's project of the rural reconstruction centre in Sriniketan.
 - c. Write the main subject matter of 'Asrama Education' in your own words, a text included in your syllabus.
 - d. Following the essay, "The Message of India's History," write a comparative analysis of Indian and European civilisations.
 - e. Write about Tagore's feelings for the earth as expressed in the text "The Earth."

(3)

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Time: 3 Hours

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दाहिनी ओर की संख्या प्रश्नों का मान निर्देशक है

1. किन्हीं पंद्रह प्रश्नों के उत्तर पूर्णवाक्य में दीजिए :

15×1=15

- क. रवींद्रनाथ की माता का नाम क्या था ?
- ख. रवींद्रनाथ ने प्रथम हिमालय यात्रा किसके साथ की थी ?
- ग. रवींद्रनाथ के परिवार का कौन प्रथम भारतीय आई. सी. एस. अधिकारी था ?
- घ. रवींद्रनाथ पहले किस विद्यालय में भर्ती किए गए थे ?
- ङ. रवींद्रनाथ की एक दीदी उन दिनों की विख्यात उपन्यासकार थीं। उनका नाम क्या था ?
- च. रवींद्रनाथ का गीतिनाट्य 'बाल्मीकि-प्रतिभा' किस वर्ष प्रकाशित हुआ ?
- छ. विवाह के पूर्व रवींद्रनाथ की पत्नी का नाम क्या था ?
- ज. रवींद्रनाथ की पहली संतान का क्या नाम था ?
- झ. शांतिनिकेतन में ब्रह्मचर्याश्रम की स्थापना कब हुई ?
- ञ. रवींद्रनाथ को नोबेल पुरस्कार कब मिला ?
- ट. अंग्रेजी गीतांजलि की भूमिका किसने लिखी ?
- ठ. किस घटना के विरोध में रवींद्रनाथ ने नाइटहुड ('सर') उपाधि लौटा दी ?
- ड. 1922 में ग्राम पुनर्गठन केंद्र कहां स्थापित हुआ ?
- ढ. विदेश में किस शहर में प्रथम बार रवींद्रनाथ द्वारा अंकित चित्रों की प्रदर्शनी हुई ?
- ण. चीनभवन की स्थापना कब हुई ?
- त. रवींद्रनाथ ने किसका नाम 'विजया' रखा था ?
- थ. रवींद्रनाथ के अंतिम जन्मदिन के भाषण का नाम क्या है ?
- द. रवींद्रनाथ की मृत्यु किस अंग्रेजी साल में हुई ?

2. किन्हीं तीन विषयों पर पचहत्तर (75) शब्दों के भीतर टीका लिखिए :

3×5=15

- क. रवींद्रनाथ का बाल्य जीवन
- ख. रवींद्रनाथ की पहली यूरोप-यात्रा
- ग. रवींद्र जीवन में शिलाइदह काल का महत्व
- घ. कला भवन और संगीत भवन
- ङ. शांतिनिकेतन का ब्रह्मचर्याश्रम
- च. रवींद्र-चिंतन में भगवान बुद्ध का महत्व

3. किन्हीं दो प्रश्नों के उत्तर दीजिए :

2×15=30

- क. सदर स्ट्रीट के गृह में सूर्योदय देखने की घटना ने रवींद्रनाथ के मन को किस प्रकार प्रभावित किया ?
- ख. श्रीनिकेतन में रवींद्रनाथ द्वारा ग्राम पुनर्गठन के प्रयास का संक्षेप में उल्लेख कीजिए।
- ग. पठित पाठ 'आश्रम की शिक्षा' में अभिव्यक्त वक्तव्य को अपनी भाषा में लिखिए।
- घ. भारतवर्ष का इतिहास शीर्षक निबंध के आधार पर भारतीय और यूरोपीय सभ्यता की तुलनात्मक आलोचना कीजिए।
- ङ. 'पृथ्वी' शीर्षक निबंध के आधार पर पृथ्वी के संबंध में रवींद्रनाथ के मनोभावों का वर्णन कीजिए।

Four Year Undergraduate Programme, SEM-I (NEP), Examination-2023
Subject -AECC Hindi
Course : Modern Indian Language-1 (Paper -1)

(हिन्दी व्याकरण और रचना)

Time : 2 Hours

Full Marks : 40

Questions are of value as indicated in the margin.

1. निम्नलिखित प्रश्नों के उत्तर दीजिए।

(क) दिये गये किन्हीं पाँच शब्दों के दो-दो पर्यायवाची शब्द लिखें। 5

अग्नि, अमृत, पक्षी, पुत्री, मेघ, सूर्य, सोना

(ख) दिये गये किन्हीं पाँच शब्दों के विलोम (विपरीतार्थक) शब्द लिखें। 5

अल्पज्ञ, अग्रज, अतिवृष्टि, उपसर्ग, कृतज्ञ, जय, पक्ष

(ग) दिये गये किन्हीं पाँच का 'अनेक शब्दों के लिए एक शब्द' लिखें। 5

जो युद्ध में स्थिर रहता है, जो स्त्री कविता लिखती है, बिना वेतन के काम करनेवाला, पढ़ने योग्य, जहाँ दो नदियाँ मिलती हों, जो पुस्तकों की आलोचना करता है।

(घ) किन्हीं पाँच मुहावरों का अर्थ लिखकर वाक्य में प्रयोग करें। 5

अपने मुँह मियाँ मिट्टू बनना, चार दिन की चाँदनी, गड़े मुर्दे उखाड़ना, पाँचों उँगलियाँ घी में, आँखों का काँटा होना, कान में तेल डालना, आगे नाथ ना पीछे पगहा।

(ङ) संज्ञा और सर्वनाम की सोदाहरण परिभाषा दीजिए। 5

(च) निम्नलिखित अवतरण का संक्षेपण करते हुए उपयुक्त शीर्षक दें। 5

अनन्त रूपों में प्रकृति हमारे सामने आती है— कहीं मधुर, सुसज्जित या सुन्दर रूप में ; कहीं रूखे, बेडौल या कर्कश रूप में; कहीं भव्य, विशाल या विचित्र रूप में; ओर कहीं उग्र, कराल या भयंकर रूप में । सच्चे कवि का हृदय उसके उन सभी रूपों में लीन होता है, क्योंकि उसके अनुराग का कारण अपना खास सुखभोग नहीं बल्कि चिरसाहचर्य द्वारा प्रतिष्ठित वासना है। जो केवल प्रफुल्ल प्रसूनप्रसाद के सौरभ—संचार, मकरन्दलोलुप मधुकर के गुंजार, कोकिलकूजित निकुंज और शीतल सुखस्पर्श समीर की ही चर्चा किया करते हैं, वे विषयी या भोगलिप्सु हैं। इसी प्रकार जो केवल मुक्ताभासहित—विन्दुमण्डित मरकताभ शाद्वलजाल, अत्यन्त विशालगिरिशिखर से गिरते जलप्रपात की गम्भीर गति से उठी हुई सीकरनीहारिका के बीच विविधवर्ण स्फुरण की विशालता, भव्यता और विचित्रता में ही अपने हृदय के लिए कुछ पाते हैं। वे तमाशबीन हैं, सच्चे भावुक या सहृदय नहीं। प्रकृति के

साधारण, असाधारण सब प्रकार के रूपों को रखनेवाले वर्णन हमें वाल्मीकि, कालिदास, भवभूति इत्यादि संस्कृत के प्राचीन कवियों में मिलते हैं। पिछले खेदे के कवियों ने मुक्तक रचना में तो अधिकतर प्राकृतिक वस्तुओं का अलग-अलग उल्लेख केवल उद्दीपन की दृष्टि से किया है। प्रबन्धरचना में थोड़ा-बहुत संश्लिष्ट चित्रण किया है, वह प्रकृति की विशेष रूपविभूति को लेकर ही।

2. दिये गये किसी एक विषय पर निबन्ध लिखें।

1X10

(क) नयी शिक्षा नीति

(ख) सोशल मीडिया

(ग) पुस्तकालय

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4 year Undergraduate Examination 2023

Subject : AECC/MIL—Bengali .

Course 01

Time : 2 hours

Full Marks : 40

যে-কোনো একটি প্রশ্নের উত্তর দাও :

১৫X১=১৫

- ১। 'লক্ষ্মণের শক্তিশেল' নাটকে রামায়ণ আখ্যান ব্যবহার করে কীভাবে হাস্যরস সৃষ্টি করা হয়েছে?
- ২। রোমাঞ্চকাহিনি হিসেবে 'যকের ধন'-এর সার্থকতা বিচার করো।
- ৩। 'গুণনোগুহারের দেশে' রচনার যে প্রাকৃতিক পরিবেশের বর্ণনা পাওয়া যায়, তা নিজের ভাষায় লেখো।
- ৪। 'মনোজদের অদ্ভুত বাড়ি' গল্পে মনোজের বাড়ির সদস্যদের পরিচয় দাও।

৫। যে-কোনো তিনটি বিষয়ে টীকা লেখো :

৫X৩=১৫

- ক. হনুমান
- খ. করালী মুখুজ্জ
- গ. গুণনোগুহার
- ঘ. 'মনোজদের অদ্ভুত বাড়ি' গল্পের নাম-পরিচয়হীন ফটোগ্রাফ

৬। যেকোনো দশটি প্রশ্নের উত্তর দাও :

১X১০=১০

- ক. 'লক্ষ্মণের শক্তিশেল' কী জাতীয় রচনা?
- খ. 'কাল রাত্তিরে আমি একটা চমৎকার স্বপ্ন দেখেছি' — কোন স্বপ্নের কথা বলা হয়েছে?
- গ. জাম্বুবান লক্ষ্মণের জন্য কী ওষুধের সন্ধান দিয়েছিলেন?
- ঘ. 'তুই ব্যাটা জানোয়ার নিকর্মার অবতার/ কাজকর্মে দিস বড় ফাঁকি'—কার কথা বলা হয়েছে?
- ঙ. 'মনোজদের অদ্ভুত বাড়ি' রচনায় বাজাডু কে?
- চ. 'মনোজদের অদ্ভুত বাড়ি' রচনার গোয়েন্দার নাম কী?
- ছ. রাখোবাবু কে?
- জ. 'লোকে বলে ওইটাই তাঁর নেশা'—কোন নেশার কথা বলা হয়েছে?
- ঝ. "গুণনোগুহারের দেশে" রচনার কথক কে?
- ঞ. "গুণনোগুহারের দেশে" রচনার পটভূমিতে কোন মহাদেশের কথা পাওয়া যায়?
- ট. ভুশুগা কে?
- ঠ. মাসাই সর্দারের নাম কী?
- ড. যকের ধনের খোঁজ প্রথম কার কাছে পাওয়া যায়?
- ঢ. 'যকের ধন' রচনায় কোন পাহাড়ের উল্লেখ রয়েছে?
- ণ. 'যকের ধন' গল্পের মূল চরিত্রদ্বটির নাম লেখো।
- ত. যকের ধনের সংকেত কোথায় লেখা ছিল?

Undergraduate Programme (NEP) Semester - I Examination, 2023

Paper Code: MDPH01 (Physics)

Paper Name: Introduction to Astronomy and Astrophysics

Time: 3 Hours

Full Marks: 60

Questions are of value as indicated in the margin.

Answer any five questions.

1. a) What is meant by astronomical parallax?
b) The parallax of our nearest star, Proxima Centauri, is $0.785''$. Find its distance in parsec, light years, and astronomical units.
c) Estimate the mass of the Sun using the general form of Kepler's third law (use $a = 1.5 \times 10^8$ km, $p = 365$ days, and $G = 6.6743 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$, where symbols have their usual meaning).
d) Explain the reason behind the total lunar eclipse.
e) Define luminosity (L) of a star. How is it related to the radiant flux (F) received from a star at a distance?

2+2+3+2+3=12

2. a) Explain what happens to a low mass star once its fuel gets exhausted.
b) Mention the differences between red giants and white dwarfs.
c) What are black holes? Define event horizon of a black hole.
d) What is the central point source at our galactic center? How do we know that it is a black hole?
e) What are peculiar galaxies? How are they formed?
f) What are Kuiper belt objects?

3+2+2+(1+1)+(1+1)+1=12

3. a) The Jeans mass is an estimate of the minimum mass required for a gas cloud to collapse due to gravity. Show that for a spherical cloud the Jean's criteria is given by

$$M_J > \left(\frac{375}{32\pi} \right)^{\frac{1}{2}} \left(\frac{kT}{Gm} \right)^{\frac{3}{2}} \rho^{-\frac{1}{2}}$$

where symbols have their usual meaning.

- b) (i) In astronomy, distances are often expressed in light-years. Define the unit light year.
(ii) If the distance to a star is 3.3 light-years, what is the distance in meters?
c) What are the two major ways in which nuclear fusion takes place inside a star? Write down the nuclear reactions that take place in a carbon-nitrogen cycle.
d) What will happen when the Sun will reach its Red giant stage?

4+(1+2)+(1+2)+2=12

4. a) Define parsec and express it in meters. Given $1 \text{ AU} = 1.5 \times 10^8 \text{ km}$.
- b) Explain how Cepheid variables can be used for measuring distances in astronomy.
- c) What is Hubble's law?
- d) Consider two stars A and B with apparent magnitudes +9 and -1 respectively. Which star is brighter? By how much is it brighter?
- e) Explain how the rotation curve of the Milky Way suggests that it contains dark matter?

$$(1+1)+3+2+(1+1)+3=12$$

5. a) What are synodic month and sidereal month? Explain why synodic month is longer than the sidereal month?
- b) Why do we have seasons on Earth? Why the length of a day changes in different seasons?
- c) What is the condition for a star to be circumpolar? Explain why no star can be circumpolar at the Earth's equator.
- d) Venus's synodic period is 1.599 years. What is its actual orbital period?
- e) What are the two important adjustments made in the Gregorian calendar?

$$3+3+(1+1)+2+2=12$$

6. a) What are the advantages of using the reflecting type telescopes?
- b) What important considerations are needed to choose a good observatory site?
- c) What is the grazing angle for X-ray reflection? Discuss the need for space telescopes for X-ray observations.
- d) What is meant by the resolving power of a telescope? What is Rayleigh's criterion regarding the same.
- e) Calculate the resolving power of a 1m telescope at a wavelength of 5000 \AA .

$$2+2+(1+1)+(2+2)+2=12$$

7. a) Explain zenith, nadir and meridian.
- b) Explain how right ascension and declination are used to locate objects on the celestial sphere.
- c) Mention four differences between Jovian planets and terrestrial planets.
- d) Draw a schematic diagram showing the internal structure of the Sun.
- e) An elliptical galaxy is numbered as E5. Find out the ratio between its semi-minor and semi-major axes.

$$3+3+2+2+2=12$$

B. Sc. (Honours) Examination, 2023 (NEP)

Semester - I

Physics (Honours)

Paper Code: MJPH01

Paper Name: Mathematical Physics - I

Time: 3 Hours

Full Marks: 80

Questions are of value as indicated in the margin.

Answer question no. 1 and any five from the rest of the questions.

1. Answer any **four** questions.

4 × 5 = 20

(a) Find a unit vector perpendicular to the plane of the vectors $\vec{A} = 3\hat{i} - 2\hat{j} + 4\hat{k}$ and $\vec{B} = \hat{i} + \hat{j} - 2\hat{k}$.

(b) Prove that $\frac{d}{du}(\vec{A} \times \vec{B}) = \vec{A} \times \frac{d\vec{B}}{du} + \frac{d\vec{A}}{du} \times \vec{B}$, where \vec{A} and \vec{B} are differentiable function of u .

(c) Verify the result $\vec{\nabla} \times (\vec{\nabla} \times \vec{A}) = \vec{\nabla} (\vec{\nabla} \cdot \vec{A}) - \nabla^2 \vec{A}$ if $\vec{A} = 3xz^2\hat{i} - yz\hat{j} + (x+2z)\hat{k}$.

(d) Solve: $x dy + (x^2 - y) dx = 0$.

(e) Find the particular integral of the following differential equation: $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} - 3y = -10 \sin x$.

(f) Prove the multiplication rule of probability, $P(A \cap B) = P(A)P(B)$.

(g) Give the definition of the Dirac delta function and represent the same as limiting form of the rectangle function.

2. (a) Show that $\vec{\nabla} \cdot (\vec{A} \times \vec{B}) = \vec{B} \cdot (\vec{\nabla} \times \vec{A}) - \vec{A} \cdot (\vec{\nabla} \times \vec{B})$.

(b) if $\vec{A} = \frac{\vec{r}}{r}$ find $\vec{\nabla} \cdot (\vec{\nabla} \times \vec{A})$.

(c) if $\vec{A} = (2x - y + 4)\hat{i} + (5y + 3x - 6)\hat{j}$, evaluate $\oint \vec{A} \cdot d\vec{r}$ around a triangle with vertices at $(0, 0, 0)$, $(3, 0, 0)$, $(3, 2, 0)$.

4+3+5=12

3. (a) Show that $\nabla^2 r^n = n(n+1)r^{n-2}$.

(b) Show that $\vec{A} \cdot \vec{B}$ remains invariant under rotation.

(c) Verify Stokes' theorem for $\vec{A} = (2x - y)\hat{i} - yz^2\hat{j} - y^2z\hat{k}$ where S is the upper half surface of the sphere $x^2 + y^2 + z^2 = 1$ above the xy -plane and C is the boundary.

3+3+6=12

4. (a) Solve the initial value problem $\frac{dy}{dx} + y = \sin x$, $y(\pi) = 1$.

(b) A particle, while falling from rest due to the force of gravity, is subjected to a resisting force proportional to its velocity. Calculate its velocity at any instant and also the maximum velocity it will attain if the height through which it falls is very large.

(c) Find the particular integral of the differential equation $\frac{d^2y}{dx^2} - 3\frac{dy}{dx} + 2y = xe^x$ using the method of variation of parameters.

4+4+4=12

5. (a) Obtain a general solution of the following differential equations:

$$\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + 2y = e^x \cos x.$$

(b) Find the particular integral of the differential equation $2\frac{d^2y}{dx^2} + 5\frac{dy}{dx} + 2y = x^2$ using the method of undetermined co-efficients.

(c) Discuss the role of Wronskian concerning the solution of a second-order differential equation.

5+3+4=12

6. (a) A series LR circuit has an emf of 5 volts, a resistance of 50 ohms, an inductance of 1 henry, and no initial current. Find the current in the circuit at any time t .

(b) Find the unit vectors \hat{e}_r , \hat{e}_θ , \hat{e}_ϕ of a spherical coordinate system in terms of \hat{i} , \hat{j} , \hat{k} . Also check that $\hat{e}_r \cdot \hat{e}_r = 1$, $\hat{e}_\theta \cdot \hat{e}_\phi = 0$ and $\hat{e}_r \times \hat{e}_\theta = \hat{e}_\phi$.

(c) How does a curvilinear coordinate system differ from rectangular cartesian co-ordinate system?

4+6+2=12

7. (a) Obtain the expression for $\vec{\nabla} \cdot \vec{A}$ in orthogonal curvilinear coordinates.

(b) Paraboloidal coordinates u, v, ϕ are defined in terms of Cartesian coordinates by $x = uv \cos \phi$, $y = uv \sin \phi$, $z = \frac{1}{2}(u^2 - v^2)$, where $u \geq 0$, $v \geq 0$, $0 \leq \phi < 2\pi$. Show that the system of coordinate is an orthogonal and determine its scale factors.

(c) Given the coordinate transformation $u_1 = xy$, $2u_2 = x^2 + y^2$, $u_3 = z$. Find $J \left(\frac{x, y, z}{u_1, u_2, u_3} \right)$.

5+4+3=12

8. (a) Discuss the elementary properties of probability.

(b) Derive an expression for the Poisson distribution function and calculate the mean of this probability distribution.

(c) Show that $\delta(kx) = \frac{1}{|k|} \delta(x)$, where k is any non-zero constant.

3+6+3=12

B.Sc (Honours) Examination, 2023

Semester-I

Physics (Honours)

Paper Code: MJPH02T

Paper Name: Mechanics (Theory)

Time : Three Hours

Full Marks : 60

Answer any six questions

1. (a) Define center of mass for a system of particles (consider both discrete and continuous cases).
(b) Show that the linear momentum, angular momentum and kinetic energy of a system of particles with respect to an external origin (O) can be expressed by,

$$\vec{P}_{\text{sys}}(O) = \vec{P}_{CM}(O),$$

$$\vec{L}_{\text{sys}}(O) = \vec{L}_{CM}(O) + \vec{L}_{\text{sys}}(CM)$$

and

$$T_{\text{sys}}(O) = T_{CM}(O) + T_{\text{sys}}(CM),$$

respectively; where the symbols have their usual meaning.

- (c) Write the Newton's law for a system of particles, and show that the linear momentum of the system will be conserved if external force is zero. [2+6+2]=10
2. (a) Define central force.
(b) Show that the motion of a particle (reduced particle) under a central force is confined on a two dimensional plane.
(c) Then considering plane polar coordinates (r and θ), find the equation of motion of a particle moving under a central force and identify the centripetal force.
(d) With the help of equations of motion, show that the path of a particle moving under inverse square force will be a conic section.
(e) Find the eccentricity of the conic section in terms of the particle's energy.
(f) Then show that the conic section is an ellipse when the particle's energy is negative (analytically and graphically). [Hints: For analytical purpose, you need to show that the eccentricity is less than unity; for graphical purpose, you need to show that there exists two turning points] [1+2+2+2+1+2]=10
3. (a) Define rotation between two inertial frames in 3-dimensional space.
(b) Express a general rotation (matrix) in terms of three Euler angles.
(c) Define an infinitesimal rotation between two inertial frames, and find the corresponding matrix (you may use the matrix for finite rotation from the previous question).
(d) Show that two finite rotations are not commutative, while two infinitesimal rotations are. [1+4+2+3]=10
4. Consider two frames (S_1 and S_2) moving with a uniform relative velocity.
(a) Write down the coordinate transformation (the Galilean transformation) between the two frames.
(b) How does the Galilean transformation modify if S_2 moves with an uniform linear acceleration \vec{a} w.r.t. S_1 ? In this case, determine the transformation rules for velocity and acceleration of a particle, and hence, find the pseudo force.
(c) Once again, find the transformation rules for coordinate and velocity of a particle (in terms of Euler angles) if S_2 rotates with an uniform angular velocity ($\vec{\omega}$) w.r.t. S_1 about a common origin. [1+3+6]=10

5. (a) Consider a damped harmonic oscillator with natural frequency ω_0 :
- Write the equation of motion.
 - Directly from the equation of motion, show that the damping term always causes the decrease of energy of the particle (w.r.t. time).
- (b) Consider a damped driven harmonic oscillator with natural frequency ω_0 and the frequency of the periodic force is ω :
- Write the equation of motion.
 - Solve the equation and find the position of the particle at some instant t .
 - Discuss the three cases: slow driving, fast driving and resonance.
 - Show, that at the resonance condition, the energy of the particle remains conserved (i.e. the amount of energy loss due to damping gets exactly compensated by the driving force). [[2×1)+(4×2)] = 10
6. (a) Show that a two body problem can be reduced to an equivalent one body problem under the condition that the interaction potential between the two particles depends only on their inter-separation distance.
- (b) Define Laplace-Lunge-Renz vector of a particle (reduced particle) moving under a central force.
- (c) Prove that the Laplace-Lunge-Renz vector remains conserved along the particle's motion. [5+1+4]=10
7. Consider two frames moving with an uniform relative velocity.
- Write the Lorentz transformation connecting the coordinates between the two frames.
 - Show, that under the Lorentz transformation, the length of a moving rod gets shortened with respect to the rest length. Determine the fractional change of length in terms of the relative velocity between the frames.
 - Using relativistic Newton's law, determine the speed of a particle (as a function of time). Hence show that the speed can never cross the speed of light. [1+4+5]=10
8. (a) Two spaceships approach each other, each moving with the same speed as measured by a stationary observer on the Earth. Their relative speed is $= 0.70c$. Determine the velocities of each spaceship as measured by the stationary observer on Earth.
- (b) The path of a particle moving under a central force is given by: $r = 2a \cos \theta$. Find the force law.
- (c) For a damped harmonic oscillator, the damping factor $\gamma = 0.1$ (in SI unit). Find the fractional rate of change of energy of the oscillator. [4+3+3]=10

B.Sc. (Honours) Sem I Examination, 2023 (NEP)

Physics

Paper : Mechanics

Paper Code: MNPH01T

Time: Three Hours

Full Marks: 60

Answer any four questions. Marks are of value as indicated.

- Q.1(a) A vector field $\vec{V} = x^2y \hat{i} + y^2z \hat{j} + z^2x \hat{k}$. Find the curl and divergence of the field.
- (b) Derive an expression for torsional rigidity of a uniform solid cylinder of length "l" and radius "r". What will happen if the cylinder is hollow of external radius "r₁" and internal radius is "r₂" ?
- (c) Derive an interrelationship between γ , η , and σ where symbols have their usual meaning.

4+(5+2)+4 = 15

- Q.2(a) Explain the dynamical method of measuring shearing modulus deriving the relevant formula.
A disc of 10 cm radius and mass 1kg is suspended in a horizontal plane by a vertical wire attached to the center. If the diameter of the wire is 1mm and its length is 1.5 meter and time period of oscillations is 5 second, find the rigidity modulus of the material of the wire.
- (b) Define gravitational "potential" and "intensity". Obtain the expression for the gravitational potential for an unit mass which is situated at a distance "r" from a gravitating mass "M".

(4+3) + (4+4) = 15

- Q.3(a) What are the characteristics of the motion of a particle in a central force field? Prove that the areal velocity is constant for a particle moving in a central force field.
- (b) Obtain the expressions for "escape velocity" and "parking velocity of geostationary satellites". What should be the velocity in km per hour of an earth satellite revolving round the earth at an altitude of 1600 kms along a circular trajectory?
- (Given: Radius of the earth = 6400 kms, Mass of earth = 6×10^{24} kg, and $G = 6.67 \times 10^{-11} \text{ m}^3/\text{kg}/\text{sec}^2$).

(3+5)+(4+3)=15

- Q.4(a) Write the differential equation for a simple harmonic oscillator and obtain its solution.
A body having mass 4 gms executes S.H.M. , the force acting on the body is 24 gm weight when its displacement "x" is 8 cm. Hence find out the time period of oscillations T and also angular velocity ω .
- (b) In case of a damped harmonic oscillator what do you understand by logarithmic decrement ? In a spring mass system undergoing damped harmonic oscillations amplitude decreases from 10cm to 2.5cm in 200 seconds. Find the damping constant "b", and the time in which amplitude falls to 1/e times the initial value.

(4+4)+(3+4)=15

- Q.5 (a) Is the angular displacement " θ " a vector ? Justify.
Obtain the relation between angular velocity " ω " and linear velocity "v" of a rigid body undergoing a fixed axis rotation.
- (b) Write the expression of moment of inertia for a fixed axis rotation and hence define radius of gyration for a system of particles. Find out the moment of inertia of a circular disc , about an axis perpendicular to the disc.

(3+5)+(3+4)=15

- Q.6(a) State and prove the perpendicular axis theorem. Find out the moment of inertia of a rectangular lamina about an axis passing through the center of the lamina and perpendicular to the plane of the lamina.
- (b) State the fundamental postulates of theory of Einstein's special theory of relativity.
Write Lorentz space time transformation equations. Obtain the relativistic expression for u in terms u' and v, where v \cong c is the velocity of the relativistic frame S' with respect to the observer in the S frame (where the symbols have their usual meaning).

(3+4)+(3+5)=15