BPHE-102/PHE-02

ASSIGNMENT BOOKLET
Bachelor's Degree Programme (B.Sc.)

OSCILLATIONS AND WAVES

Valid from January 1, 2024 to December 31, 2024

It is compulsory to submit the Assignment before filling up the Term-End Examination Form.

Please Note

- **You can take electives (56 to 64 credits) from a minimum of TWO and a maximum of FOUR science disciplines, viz. Physics, Chemistry, Life Sciences and Mathematics.**
- **You can opt for elective courses worth a MINIMUM OF 8 CREDITS and a MAXIMUM OF 48 CREDITS from any of these four disciplines.**
- **At least 25% of the total credits that you register for in the elective courses from Life Sciences, Chemistry and Physics disciplines must be from the laboratory courses. For example, if you opt for a total of 64 credits of electives in these 3 disciplines, at least 16 credits should be from lab courses.**
- **You cannot appear in the Term-End Examination of any course without registering for that course. Otherwise, your result will not be declared and the onus will be squarely on you.**

School of Sciences
Indira Gandhi National Open University
Maidan Garhi, New Delhi-110068

2024

Dear Student,

We hope you are familiar with the system of evaluation to be followed for the Bachelor's Degree Programme. At this stage you may probably like to re-read the section on assignments in the Programme Guide for Elective Courses that we sent you after your enrolment. A weightage of 30 percent, as you are aware, has been earmarked for continuous evaluation which consists of **one tutor-marked assignment** for this 2-credit course. **Submit your assignments at your study centre.**

Instructions for Formatting Your Assignments

Before attempting the assignment, please read the following instructions carefully:

1) On top of the first page of your TMA answer sheet, please write the details exactly in the following format:

ENROLMENT NO.:……

NAME :……

ADDRESS :……

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COURSE CODE: …….

COURSE TITLE : …….

ASSIGNMENT NO. ……..…

STUDY CENTRE: ……..….. DATE:……...

PLEASE FOLLOW THE ABOVE FORMAT STRICTLY TO FACILITATE EVALUATION AND TO AVOID DELAY.

2) Use only foolscap size writing paper (but not of very thin variety) for writing your answers.

3) Leave 4 cm margin on the left, top and bottom of your answer sheet.

4) Your answers should be precise and in your own words. Do not copy answers from study material.

5) While solving problems, clearly indicate the question number along with the part being solved. Write units at each step of your calculations as done in the text because marks will be deducted for such mistakes. Take care of significant digits in your work. Recheck your work before submitting it.

6) **This assignment will remain valid from January 1, 2024 to December 31, 2024**. However, you are advised to submit it within **12 weeks** of receiving this booklet to accomplish its purpose as a teaching-tool.

Answer sheets received after the due date shall not be accepted.

We strongly feel that you should retain a copy of your assignment response to avoid any unforeseen situation and append, if possible, a photocopy of this booklet with your response. If you have any problems or queries related to the course, you can write to us on the e-mail **srjha@ignou.ac.in.**

We wish you good luck.

Tutor Marked Assignment
OSCILLATIONS AND WAVES

Course Code: BPHE-102/PHE-02
Assignment Code: BPHE-102/PHE-02/TMA/2024
Max. Marks: 100

Note: Attempt all questions. Symbols have their usual meanings. The marks for each question are indicated against it.

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1. a) i) An object is executing simple harmonic motion. Obtain expressions for its kinetic and potential energies. (5)

   ii) A spring mass system is characterized by $k = 15\ \text{Nm}^{-1}$ and $m = 0.5$ kg. The system is oscillating with amplitude of 0.40 m. Obtain an expression for the velocity of the block as a function of displacement and calculate its value at $x = 0.15$ m. (5)

   b) Consider a particle undergoing simple harmonic motion. The velocity of the particle at position x_1 is v_1 and velocity of the particle at position x_2 is v_2. Show that the ratio of time period (T) and amplitude (A) is:

$$\frac{T}{A} = 2\pi\sqrt{\frac{{x_2}^2 - {x_1}^2}{{v_1}^2{x_2}^2 - {v_2}^2{x_1}^2}} \qquad (10)$$

   c) Establish the equation of motion of a damped oscillator. Solve it for a weakly damped oscillator and discuss the significance of the results. (3+5+2)

   d) A body of mass 0.2 kg is suspended from a spring of force constant 80 Nm^{-1}. A damping force is acting on the system for which $\gamma = 4\ \text{Nsm}^{-1}$. Write down the equation of motion of the system and calculate the period of its oscillations. Now a harmonic force $F = 10\cos 10t$ is applied. Calculate a and θ when the steady state response is given by $a\cos(\omega t - \theta)$. (4+4+2)

   e) Consider N identical masses connected through identical springs of force constant k. The free ends of the coupled system are rigidly fixed at $x = 0$ and $x = l$. The masses are made to execute longitudinal oscillations on a frictionless table.

      i) Depict the equilibrium as well as instantaneous configurations.

      ii) Write down their equations of motion, decouple them and obtain frequencies of normal modes. (2+2+4+2)

2. a) A Transverse waves propagating on a stretched string encounter another string of different characteristic impedance. (i) Write down the equations of particle displacement due to the incident, reflected and transmitted waves. (ii) Specify the boundary conditions and (iii) use these to obtain expressions for reflection and transmission amplitude coefficients. (3+2+5)

   b) i) A sound wave of frequency 400 Hz travels in air at a speed of 320 ms^{-1}. Calculate the phase difference between two points on the wave separated by a distance of 0.2 m along the direction of travel of the wave. (5)

ii) A train moving with speed 72 km h^{-1} emits a whistle of frequency 500 Hz. A person is standing stationary on the platform. Calculate the frequency heard by the person if the train (i) approaches and (ii) recedes away from the listener. (5)

c) i) The equation of transverse wave on a string is given by

$$y = 5 \sin \pi (4.0t - 0.02 x)$$

where y and x are in cm and t is in second. Calculate the maximum speed of a particle on the string and wavelength of the wave. (5)

ii) The linear density of a vibrating string is 1.3×10^{-4} kg m^{-1}. A transverse wave is propagating on the string and is described by the equation:

$$y(x,t) = 0.021 \sin (x + 30\, t)$$

where x and y are in meters and t is in seconds. Calculate the tension in the string. (5)

d) Standing waves are produced by superposition of the following waves:

$$y_1(x,t) = 0.2 \sin \pi(t - 2x) \quad \text{and} \quad y_2(x,t) = 0.2 \sin \pi(t + 2x)$$

(i) Obtain the resultant displacement of the particle at x at time t. (ii) For what value of x will the displacement be zero at all times? (iii) What is the distance between two nearest values of x at which displacements are zero? Is this distance related to the wavelength of the standing wave? (3+3+4)

e) i) Show that only odd harmonics can be generated in a closed-end organ pipe. (5)

ii) Determine the fundamental frequency and the first 3 overtones of an organ pipe of length 1.7 m and closed at one end. Take the speed of sound to be 340 ms^{-1}. (5)

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