BPHE-102/PHE-02

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

OSCILLATIONS AND WAVES

Valid from January 1, 2022 to December 31, 2022

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
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2022

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, 2022 to December 31, 2022**. 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.

We wish you good luck.

Tutor Marked Assignment
OSCILLATIONS AND WAVES

Course Code: BPHE-102/PHE-02
Assignment Code: BPHE-102/PHE-02/TMA/2022
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. The amplitude of oscillations of a simple harmonic oscillator is 0.30 m and it completes 50 oscillations in 2 minutes. i) Calculate its time period and angular frequency. ii) If the initial phase is 45°, write expressions for instantaneous displacement, velocity and acceleration. iii) Also calculate the maximum values of velocity and acceleration of the oscillator. (2+6+2)

2. A spring mass system is characterized by $k = 10\ \text{Nm}^{-1}$ and $m = 1.0$ kg. The system is oscillating with amplitude of 0.30 m. i) Calculate the angular frequency of oscillation. ii) Obtain an expression for the velocity of the block as a function of displacement and calculate its value at $x = 0.2$ m. iii) Also calculate energy of the spring-mass system. (2+4+4)

3. Establish the equation of motion of a damped oscillator and show that for a weakly damped oscillator, the displacement is given by

$$x(t) = a_0 \exp(-bt)\cos(\omega_d t + \phi)$$

where symbols have their usual meanings. (4+6)

4, In a series LCR circuit, $L = 15$ mH, $C = 1.0$ μF and $R = 0.5$ Ω. i) Write the equation of motion when the charged capacitor discharges and discuss the nature of the discharge. ii) Will it be oscillatory or dead beat? iii) How long do the charge oscillations take to decay to half its initial value? (4+2+4)

5. A body of mass 0.3 kg is suspended from a spring of force constant $70\ \text{Nm}^{-1}$. A dampingforce is acting on the system for which $\gamma = 5\ \text{Nsm}^{-1}$. Write down the equation of motion of the system and calculate the period of its oscillations. Now a harmonic force $F = 15\cos 10ta$ is applied. Calculate a and θ when the steady state response is given by $a\cos(\omega t - \theta)$. (4,4,2)

6. Consider N identical masses connected through springs of same 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.

   i) Depict the equilibrium configuration as well as instantaneous configuration.
   ii) Derive the equation of wave motion.
   iii) Calculate the velocity of wave when a force of 450 N acts on a system with mass per unit length $0.25\ \text{kgm}^{-1}$. (6+2+2)

7. The equation of a stationary wave is given by $y(x,t) = 2\sin \pi x \cos 100\pi t$, where x and y are measured in metre and t in second. Calculate the amplitude, wavelength and frequency of component waves whose superposition generated this stationary wave. Also write the equations of component waves. (6,4)

8. a) For surface waves in shallow water, the frequency and wavelength are connected throughthe relation

$$f = \sqrt{\frac{2\pi S}{\rho \lambda^3}}$$

where S and ρ respectively denote surface tension and density of water. Calculate the group velocity of waves. How is it related to phase velocity? (4,2)

b) For gravity waves

$$v_p = C\lambda^{1/2}$$

Obtain the relation between v_p and v_g. (4)

9. 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)

10. Two waves, travelling along the same direction, are given by

$$y_1(x,t) = a\sin(\omega_1 t - k_1 x)$$

and

$$y_2(x,t) = a\sin(\omega_2 t - k_2 x)$$

Suppose that ω_1 and k_1 are respectively slightly greater than ω_2 and k_2. i) Obtain an expression for the resultant wave arising due to their superposition; and ii) explain the formation of wave packets. (5+5)

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