BPHE-102/PHE-02

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

OSCILLATIONS AND WAVES

Valid from January 1, 2021 to December 31, 2021

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

2021

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 per cent, 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, 2021 to December 31, 2021**. 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/2021
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. Establish the differential equation for simple harmonic motion (SHM) in one dimension. Show that for SHM, the velocity and acceleration of the particle is proportional to ω_0 and ω_0^2 respectively, where ω_0 is the angular frequency of the particle. (5+3+2)

2. The displacement of an object executing SHM is given by:

   $$x = 0.02 \cos 4\pi (t + 0.625) \text{ m}$$

   Calculate the amplitude, period, maximum velocity, maximum acceleration and initial displacement of the object. (5×2=10)

3. i) Two collinear SHMs of amplitudes 3 and 4 units add up to an SHM of amplitude $\sqrt{35}$ units. Calculate the phase difference between the two superposing SHMs. (5)

   ii) A particle is simultaneously subjected to two mutually perpendicular oscillations given by

   $$x = 3 \sin \omega t \text{ cm}, \quad y = 3 \cos \omega t \text{ cm}$$

   Determine its trajectory of motion. (5)

4. Write the differential equation for a damped oscillator and obtain its general solution. On the basis of the general solution, list various possible types of damping. (6+4)

5. i) The natural angular frequency of an oscillator is ω_0. It is subjected to a damping force proportional to velocity and the damping force per unit mass per unit velocity is b. A periodic force given by $F \cos \omega t$ is applied to it. Establish the differential equation for the oscillator and obtain the condition for velocity resonance. (5+5)

   ii) The weight on a vertical spring undergoes forced vibrations according to the following equation:

   $$\frac{d^2x}{dt^2} + 4x = 8 \sin \omega t$$

   where x is the displacement from the equilibrium position and $\omega > 0$ is a constant.

   If at $t = 0$, $x = 0$ and $\frac{dx}{dt} = 0$, calculate x as a function of t. (5)

6. i) Two waves are represented by:

   $$y = a \sin (\omega t - kx)$$

   and

   $$y = b \cos (\omega t - kx)$$

   Calculate the phase difference between the waves. (3)

ii) The intensity ratio of two waves of same frequency and travelling in the same direction is 1:16. Calculate the ratio of their amplitudes. (3)

iii) A wave is expressed as:

$$y = 0.5 \sin \pi (0.01x - 3t)$$

Calculate the speed of propagation of the wave. (4)

7. A vibrating turning fork of frequency 500 Hz is moved away from a stationary listener and towards a stationary wall at a speed of 3 ms^{-1}. The listener hears two frequencies; one due to direct sound and the other due to reflected wave. Calculate the number of beats heard by the listener per second. Take velocity of sound in air as 340 ms^{-1}. (5)

8. i) Standing waves are produced by the superposition of the following two waves:

$$y_1 (x, t) = 0.2 \sin \pi (t - 2x)$$

and

$$y_2 (x, t) = 0.2 \sin \pi (t + 2x)$$

a) Obtain the resultant displacement of the particle at x at time t. (5)

b) Calculate the value(s) of x for which displacement is zero. (5)

c) Calculate the difference between two nearest values of x for which the displacement is zero. Is it related to the wavelength? (5)

ii) Calculate the fundamental frequency and the first 3 overtones of a pipe of length 1.7 m and closed at one end. (5)

9. What do you understand by wave impendence? Derive an expression for the impedance offered to sound waves propagating in a gaseous medium. (3+7)

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