BPHE-102/PHE-02

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

OSCILLATIONS AND WAVES

Valid from January 1, 2020 to December 31, 2020

It is compulsory to submit the Assignment before filling in 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

2020

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, 2020 to December 31, 2020**. 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/2020
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. i) Show that the average kinetic energy associated with SHM is $\frac{1}{4}ka^2$. (5)

   ii) A rubber pad acts as an elastic spring. When a mass of 200 g is placed on it, a compression of 2.0 cm is produced. The spring-mass system begins to oscillate when the mass is gently tapped downwards. Calculate the frequency of oscillation. (5)

2. Two collinear harmonic oscillations are made to superpose. If their displacements are represented as:

   $$x_1 = 2a \cos \omega t \quad \text{and} \quad x_2 = 3a \cos (\omega t + \phi)$$

   Calculate the amplitude of the resultant oscillation when the phase difference is

   (i) 2π, (ii) 0, (iii) $\pi/2$ and (iv) π. (10)

3. Write down the differential equation for a damped harmonic oscillator. What is the basis of representing the damping force in terms of velocity? Show that the average energy of a weakly damped oscillator is given by:

   $$< E > = E_0 \exp (-2bt)$$ (3,2,5)

4. i) Suppose that you are pushing a child on a swing, initially at rest, periodically. (a) Draw a displacement-time graph for the resulting oscillatory motion of the swing. (b) Is it an example of free or damped or damped forced oscillation? (3,2)

   ii) The equation of motion of a particle moving along the *x*-axis is given by:

   $$\frac{d^2x}{dt^2} + 4\frac{dx}{dt} + 8x = 20\cos 2t$$

   Calculate the amplitude, period and frequency of the oscillation after a long time has elapsed. (8)

5. Consider two simple pendulums *P* and *Q* of equal length ℓ and masses m_1 and m_2 respectively. Suppose the bobs of the pendulum are connected to each other by a weightless spring of force constant *k* such that in the equilibrium position, the spring is unstretched. Calculate the normal mode frequencies, and draw labelled diagrams corresponding to each mode. (7)

6. A wave is described by the following equation:

   $$y = (2.0 \text{ mm}) \sin 2\pi \left[\frac{t}{0.01\text{s}} - \frac{x}{2.0\,\text{cm}} \right]$$

i) Calculate the time period and the wavelength of the wave.

ii) Obtain the expression for the velocity of the particles.

iii) Calculate the speed of the particles at x = 3.0 cm, 4.0 cm and 6.0 cm at t = 0.01 s.

iv) Calculate speed of the particles at x = 2.0 cm, at t = 0.011 s, 0.012 s and 0.013 s. (5,2,4,4)

7. A locomotive engine passes a stationary observer at a speed of 72 km h^{-1} emitting a note of frequency 600 Hz. Calculate the frequency of sound heard by the observer (i) before, and (ii) after the engine passes the observer. The speed of sound in air is 340 ms^{-1}. (5,5)

8. A stretched string is observed to vibrate with a frequency 20 Hz in its fundamental mode when the supports are 60 cm apart. The amplitude at the antinode is 2 cm. The string length between the supports has a mass of 30 g. Calculate the speed of propagation of the wave and the tension in the string. (5,5)

9. Consider two cylindrical pipes of equal length. One of these acts as a closed organ pipe and the other as open organ pipe. The frequency of the second harmonic in the closed pipe is 200 Hz higher than the first harmonic of the open pipe. Calculate the fundamental frequency of the closed pipe. (10)

10. A tuning fork of unknown frequency produces three beats per second with a tuning fork of frequency 380 Hz. The beat frequency decreases when a small quantity of wax is put on the prong of the first fork. Calculate its frequency. (5)

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