BPHE-101/PHE-01

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

ELEMENTARY MECHANICS

Valid from January 1, 2023 to December 31, 2023

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 the course. Otherwise, your result will not be declared and the onus will be on you.**

School of Sciences
Indira Gandhi National Open University
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2023

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 would consist of **one** tutor-marked assignment for this course.

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.

5) While solving problems, clearly indicate the question number along with the part being solved. Be precise. 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, 2023 to December 31, 2023**. 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
ELEMENTARY MECHANICS

Course Code: BPHE-101
Assignment Code: BPHE-101/PHE-01/TMA/2023
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 car of mass 1500 kg moving with a speed of 30 ms^{-1} is brought to rest in 10.0 s when brakes are applied. Determine the coefficient of friction between the car tires and the road surface. Take g = 10 ms^{-2}. (10)

2. A bullet of mass 20 g, traveling at 350 ms^{-1}, strikes a steel plate at an angle of 30º. It ricochets off at the same angle, at a speed of 320 ms^{-1}. What is the magnitude of the impulse experienced by the bullet? If the collision with the plate takes place over a time $\Delta t = 10^{-3}$ s, what is the average force exerted by the plate on the projectile. (10)

3. The speed of an aeroplane is $1200\,ms^{-1}$. The engines take in 80 kg of air per second and mix it with 40 kg of fuel. This mixture is expelled after it ignites and it moves at a velocity of $3000\,ms^{-1}$ relative to the aeroplane. Calculate the thrust of the engine. (10)

4. A centrifuge which has the shape of a cylinder of mass 10 kg and radius 0.2m is spinning at a speed of 60,000 rpm. Calculate the minimum braking torque that must be applied, in order to stop the centrifuge in under 20 s from when the motor is turned off. (10)

5. A block of mass 6.0 kg slides from rest at a height of 2.0 m down to a horizontal surface where it passes over a 1.5 m rough patch. After crossing this patch it climbs up another incline which is at an angle of 30° to the ground. The rough patch has a coefficient of kinetic friction $\mu_k = 0.25$. What height does the block reach on the incline before it comes to rest? (10)

6. Three point masses of 2 kg each have the following position vectors:

$$\vec{\mathbf{r}}_1(t) = (2t + 3t^2)\,\mathrm{m}\,\hat{\mathbf{i}} + t\,\mathrm{m}\,\hat{\mathbf{k}}; \vec{\mathbf{r}}_2(t) = 4t^2\,\mathrm{m}\,\hat{\mathbf{j}} + 3\,\mathrm{m}\,\hat{\mathbf{k}}; \vec{\mathbf{r}}_3(t) = (3t - 1)\,\mathrm{m}\,\hat{\mathbf{i}} + 3t^2\,\mathrm{m}\,\hat{\mathbf{j}}$$

   Determine the velocity and acceleration of the centre of mass of the system. (10)

7. A horizontal disk of rotational inertia 10 kg m^2 with respect to its axis of symmetry is spinning counterclockwise about its axis of symmetry, at 15 rps. A second disk, of rotational inertia 2 kg m^2 with respect to its axis of symmetry, spinning clockwise about the same axis at 7 rps is dropped on top of the first disk. The two disks stick together and rotate as one about their common axis of symmetry. What is the angular velocity of the system? (10)

8. A particle of mass 10.0 kg, initially moving with a velocity of $5.0\,ms^{-1}$ collides elastically with a particle of mass 5.0 kg, initially moving with a velocity of $-8.0\,ms^{-1}$. What are the velocities of the two particles before and after the collision in the centre of mass frame of reference? What are the velocities of the two particles after the collision in the laboratory frame? (10)

9. The comet Encke has an aphelion distance of 6.1×10^{11}m and perihelion distance of 5.1×10^{11}m. The mass of the sun is 2.0×10^{30}kg. Find the speed of the comet at the perihelion and the aphelion. (10)

10. a) Consider a simple pendulum of mass *m* mounted inside a railroad car that is accelerating to the right with constant acceleration *a*. Analyze this problem in the non inertial frame of reference to find the angle ϕ with the vertical direction at which the pendulum will remain at rest relative to the moving car. (5)

    b) On Jupiter a day lasts for 9.9 earth hours and the circumference at the equator is 448600 km. If the measured value of gravitational acceleration at the equator is $24.6\,\mathrm{ms}^{-2}$, what is the true gravitational acceleration and the centrifugal acceleration. (5)

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