# NETAJI SUBHAS OPEN UNIVERSITY

স্নাতকোত্তর পাঠক্রম ( P. G.)

অনুশীলন পত্র (Assignment) : জুন, ২০২০/ ডিসেম্বর, ২০২০ (June-2020/Dec.-2020)

## MATHEMATICS

**Paper - 5B : Elements of Continuum Mechanics & Special Theory of Relativity**

পূর্ণমান : ৫০ | **QUESTION PAPER CUM ANSWER BOOKLET** | মানের গুরুত্ব : ২০%

(Full Marks : 50)                 (Weightage of Marks : 20%)

পরিমিত ও যথাযথ উত্তরের জন্য বিশেষ মূল্য দেওয়া হবে। অশুদ্ধ বানান, অপরিচ্ছন্নতা এবং অপরিষ্কার হস্তাক্ষরের ক্ষেত্রে নম্বর কেটে নেওয়া হবে। উপান্তে প্রশ্নের মূল্যমান সূচিত আছে।

**Special credit will be given for precise and correct answer. Marks will be deducted for spelling mistakes, untidiness and illegible handwriting. The figures in the margin indicate full marks.**

Name (in Block Letter) : ...................................................................................................

Enrolment No.

Study Centre Name : ................................................................... Code : .....................

| To be filled by the Candidate | Serial No. of question answered | | | | | | | | | | | | | **TOTAL** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| For Evaluator's only | Marks awarded | | | | | | | | | | | | | |

Q.P. Code : **PA/4/VB**

**PG-Sc.-AP-17106**

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Signature of Evaluator with Date

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## জরুরি নির্দেশ / Important Instruction

আগামী শিক্ষাবর্ষান্ত পরীক্ষায় **(T.E. Exam.)** নতুন ব্যবস্থা অর্থাৎ প্রশ্নসহ উত্তর পুস্তিকা **(QPAB)** প্রবর্তন করা হবে। এই নতুন ব্যবস্থার সঙ্গে পরীক্ষার্থীদের অভ্যস্ত করার জন্য বর্তমান অনুশীলন পত্রে নির্দেশ অনুযায়ী প্রতিটি প্রশ্নের উত্তর নির্দিষ্ট স্থানেই দিতে হবে।

**New system *i.e.* Question Paper Cum Answer Booklet (QPAB) will be introduced in the coming Term End Examination. To get the candidates acquainted with the new system, assignment answer is to be given in the specified space according to the instructions.**

### Detail schedule for submission of assignment for the
### PG Term End Examination June-2020/Dec.-2020

| | | |
|---|---|---|
| 1. | Date of Publication | : 20/06/2020 |
| 2. | Last date of Submission of answer script by the student to the study centre | : 19/07/2020 |
| 3. | Last date of Submission of marks by the examiner to the study centre | : 16/08/2020 |
| 4. | Date of evaluated answer scripts distribution by the study centre to the students (Students are advised to check their assignment marks on the evaluated answer scripts and marks lists in the study centre notice board. If there is any mismatch / any other problems of marks obtained and marks in the list, the students should report to their study centre Co-ordinator on spot for correction. The study centre is advised to send the corrected marks, if any, to the COE office within five days. No changed / correction of assignment marks will be accepted after the said five days.) | : 23/08/2020 |
| 5. | Last date of submission of marks by the study centre to the Department of C.O.E. on or before | : 31/08/2020 |

## এখানে কিছু লিখবেন না
## Do Not Write Anything Here

Answer Question No. 1 and any *four* from the rest.

1. Answer any *five* questions :              $2 \times 5 = 10$

a) Define holonomic and non-holonomic system. Give example.

b) Show that for the velocity field given by $v_1 = ax_3 - bx_2$,   $v_2 = bx_1 - cx_3$ and $v_3 = cx_2 - ax_1$ the motion is rotational.

c) Find the complex potential of a source.

d) The water in a river moves west at the speed of 6 metre/sec and a boat heads north at 8 metre/sec with respect to the water. Find out the direction and velocity of the boat with respect to the ground.

e) Determine the Cauchy stress quadric at $P$ for a state of stress $(T_{ij}) = \begin{pmatrix} 2 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 7 \end{pmatrix}$.

f) Define body and surface force on a continuum body.

g) State Kelvines' theorem on minimum kinetic energy.

**First Answer :**

**Second Answer :**

**Third Answer :**

**Fourth Answer :**

**Fifth Answer :**

2.  a)  Establish the Navier-Stokes equations for incompressible viscous fluid.

    b)  The stress tensor at $P$ is given by $T_{ij} = \begin{pmatrix} 3 & 1 & 1 \\ 1 & 0 & 2 \\ 1 & 2 & 0 \end{pmatrix}$. Determine principal stress and

        principal directions.                                                      5 + 5

3.  State Galilean transformation for two dimensional frame of reference. What was its drawbacks ? What modifications made by Lorentz and derive his transformation. Show that the time interval in the proper frame of clock will be smaller than the observed time interval in the laboratory frame.                                 2 + 4 + 4

4.  a)  State the principle of least action. Using it establish the Lagrange's equations of motion.

    b)  Show that the shortest distance between two points on the surface of a sphere is a great circle.                                                       5 + 5

5.  a)  Define Poisson bracket. Show that for any three dynamical variables $u, v$ and $w$ the following holds $\{u,\{v,w\}\} + \{v,\{w,u\}\} + w,\{u,v\}\} = 0$, where $\{\cdot\}$ is the Poisson bracket.                                                                         5

    b)  What is canonical transformation ? Show that $(q, p) \to (Q,P)$ defined by

        $q = \sqrt{\dfrac{2P}{m\omega}} \sin Q$, $p = \sqrt{2m\,\omega P} \cos Q$ is a canonical transformation.       5

6.  a)  Define circulation $(\Gamma)$ for any moving fluid. Show that for the conservative force of field air circulation is constant.                                       5

    b)  Find the stream function for a two-dimensional source given by the velocity potential $Q = -\dfrac{m}{2\pi} \log r$, where $r$ is the distance from the source.           5

7.  Define dilation, rotation vector, shear, principal strain and the principal axes. For the following displacement relation

    $u_1 = a(X_1 + 2X_2 + 3X_3)$

    $u_2 = a(-2X_1 + X_2)$

    $u_3 = a(X_1 + 4X_2 + 2X_3)$

    find all the above defined quantities.                                          10

**First Answer :**

**Second Answer :**

**Third Answer :**

**Fourth Answer :**