



**PURE MATHEMATICS**

TIME ALLOWED: THREE HOURS

MAXIMUM MARKS = 100

- NOTE:** (i) Attempt FIVE questions in all by selecting TWO Questions each from SECTION-A&B and ONE Question from SECTION-C. ALL questions carry EQUAL marks.  
(ii) All the parts (if any) of each Question must be attempted at one place instead of at different places.  
(iii) Write Q. No. in the Answer Book in accordance with Q. No. in the Q.Paper.  
(iv) No Page/Space be left blank between the answers. All the blank pages of Answer Book must be crossed.  
(v) Extra attempt of any question or any part of the attempted question will not be considered.  
(vi) Use of Calculator is allowed.

**SECTION-A**

- Q. 1. (a) Find centre of  $S_3$ . (10)  
(b) Using the row operations, show that the matrix  $\begin{pmatrix} 1 & 2 & -3 \\ 1 & -2 & 1 \\ 5 & -2 & -3 \end{pmatrix}$  has no inverse. (10) (20)
- Q. 2. (a) For any group  $G$ , show that  $\frac{G}{\{e\}} \cong G$ , and  $\frac{G}{G} \cong \{e\}$ . (10)  
(b) Suppose  $U$  and  $W$  are distinct four dimensional subspaces of a vector space  $V$  of dimension six. Find the possible dimension of  $U \cap W$ . (10) (20)
- Q. 3. (a) For what value of  $\alpha$  is the matrix  $\begin{pmatrix} \alpha & \alpha-1 & \alpha+1 \\ 1 & 2 & 3 \\ 2-\alpha & \alpha+3 & \alpha+7 \end{pmatrix}$  is singular? (10)  
(b) Define  $T : \mathbb{R}^3 \rightarrow \mathbb{R}^3$  by  $T(x_1, x_2, x_3) = (-x_3, x_1, x_1 + x_3)$ . Find  $N(T)$ . Is  $T$  one-to-one? (10) (20)

**SECTION-B**

- Q. 4. (a) Find the value of  $\theta$  and the limit in order that  $\lim_{x \rightarrow 0} \frac{\sin 2x + \theta \sin x}{x^3}$  be finite. (10)  
(b) Show that  $x < \sin^{-1} x < \frac{x}{\sqrt{1-x^2}}$ ,  $0 < x < 1$ . (10) (20)
- Q. 5. (a) Given that  $U = \frac{1}{x^2 + y^2 + z^2}$ . Verify that  $U_{xx} + U_{yy} + U_{zz} = 0$ . (10)  
(b) Evaluate  $\iint (x^2 + y^2) dx dy$ , over the domain bounded by  $y = x^2$  and  $x = y^2$ . (10) (20)
- Q. 6. (a) Evaluate  $\iint (x^2 + y^2) dx dy$ , over the region bounded by  $xy=1$ ,  $y=0$ ,  $y=x$  and  $x=2$ . (10)  
(b) Find an equation of a normal to the hyperbola  $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$  in the form  $ax \cos \theta + by \cot \theta = a^2 + b^2$ . Prove that the normal is external bisector of the angle between the focal distances of its foot. (10) (20)

# Pure Mathematics Past Paper

**Jiyuan Zhang**



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