INDIAN INSTITUTE OF SCIENCE EDUCATION AND RESEARCH MOHALI

MTH101 (Symmetry)

Mid Semester Examination / February 19, 2022 20 marks / 60 minutes

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Instructions

1. Write your name and roll number on the top of **every page**.
2. Write all arguments precisely and do not leave anything to the evaluator's imagination.
3. **Mysterious or unsupported answers will not receive credit**. A correct answer, unsupported by calculations or explanation will receive no credit; an incorrect answer supported by substantially correct calculations and explanations *might* still receive partial credit.
4. Stop writing at 10:00 AM, and submit your answers by 10:09 AM.

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1. Take a triangle whose two sides have equal length, but the third side is different. Write the composition table of symmetries of this triangle. [2]

2. Take a square and draw two diagonals on it, one with the red color and the other with blue color. Now consider two scenarios.
   Scenario 1: Flip the square first by the red diagonal and then by the blue diagonal.
   Scenario 2: Flip the square first by the blue diagonal and then by the red diagonal.
   Argue, *either using permutations or matrices*, to determine if the final configuration of the square is the same in the two scenarios. [4]

3. Perform the following matrix multiplication of 3×3 matrices, using row operations. [3]

$$S_{1,2}M_2(2)L_{1,2}(-1)S_{2,3}.$$

4. Verify socks-shoe property, $(AB)^{-1} = B^{-1}A^{-1}$, for the following matrices. Remember to use **only** row operations to compute inverses. [4]

$$A = \begin{pmatrix} 1 & 2 \\ 2 & 5 \end{pmatrix}, \quad B = \begin{pmatrix} 2 & 1 \\ 7 & 3 \end{pmatrix}$$

5. Write the matrix that is to be used in balancing the following chemical reaction. Is this matrix a row echelon matrix? [2+1]

$$\mathrm{NaOH} + \mathrm{H_2SO_4} \rightarrow \mathrm{H_2O} + \mathrm{Na_2SO_4}$$

6. For 2×2 matrices $A = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$, define a number $t(A)$ as follows: $t(A) = a + d$ (which is simply the sum of diagonal entries). Determine, if the assignment of matrix A to the number $t(A)$ satisfies row linearity. [4]
