Quiz 2: MT3164: Numerical Analysis

10:00 am to 10:50 am on 12^{th} September, 2025

The documents contain series of instructions, questions, and skeleton of the problem. Do not change the input format.

The commands assumes that your enrollment number is 20301234.
Please change 20301234 to your enrollment number.

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1. (a) Open VS Code (or some other editor) to create a new file `20301234-q2p1.py` and save it on Desktop.

   (b) To obtain a sample input, run the following command.

   ```
   cp /nfscommon/common/prafullkumar/public/input-q2p1.txt ./
   ```

   (c) Use the following code to convert the above text file into matrix A.

   ```python
   import numpy as np

   print("20301234 \t Alan Turing")
   # Replace 20301234 by your roll number and 'Alan Turing' by your name.

   # Read matrix from input file
   with open("input-q2p1.txt", "r") as f:
       lines = f.readlines()

   # Convert file contents to numpy array
   A = np.array([[float(num) for num in line.split()] for line in lines])

   ```

   (d) Computing the following 10 quantities for A using print them (one per row) after you have printed your name. Don't print any other information/text on the line.

   i. Determinant of matrix obtained by element-wise multiplication A with itself.
   ii. Rank of A
   iii. Largest eigenvalue of A
   iv. Sum of elements in the 5^{th} row of A^{-1}.
   v. Largest element in the 3^{rd} column of A^3.
   vi. Frobenius norm of A
   vii. 1-norm (maximum column sum),
   viii. ∞-norm (maximum row sum), and
   ix. Condition number of A (using the default 2-norm).
   x. Rank of matrix obtained by replacing last row of A by all 1's.

   (e) Check the output of your program using the following command.

   ```
   python3 20301234-q2p1.py
   ```

   (f) Show your working code to the instructor.

   (g) Submit the solutions only if you are confident with it. **You are only allowed to submit code once**. Use the following command for submission.

   ```
   /nfscommon/common/prafullkumar/submit 20301234-q2p1.py
   ```

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2. (a) Open VS Code (or some other editor) to create a new file 20301234-q2p2.py and save it on Desktop.

   (b) To obtain a sample input, run the following command.

   ```
   cp /nfscommon/common/prafullkumar/public/input-q2p2.txt ./
   ```

   (c) Use the following code to convert the above text file into matrix A.

```python
import numpy as np

print("20301234 \t Alan Turing")
# Replace 20301234 by your roll number and 'Alan Turing' by your name.

# Read matrix from input file
with open("input-q2p2.txt", "r") as f:
    lines = f.readlines()

# Convert file contents to numpy array
A = np.array([[float(num) for num in line.split()] for line in lines])

```

   (d) Complete the first 3 steps of the Gaussian Elimination where you have to select a pivot row for which the quantity a_{i1}/s_i is largest. Here, $s_i = \max_{j=1}^{n} |a_{i,j}|$.

   (e) After you have printed your roll number and name, print index of pivot row in each line.

   (f) Check the output of your program using the following command.

   ```
   python3 20301234-q2p2.py
   ```

   (g) Show your working code to the instructor.

   (h) Submit the solutions only if you are confident with it. **You are only allowed to submit code once**. Use the following command for submission.

   ```
   /nfscommon/common/prafullkumar/submit 20301234-q2p2.py
   ```

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3. (a) Open VS Code (or some other editor) to create a new file `20301234-q2p3.py` and save it on Desktop.

   (b) To obtain a sample input, run the following command.

   ```
   cp /nfscommon/common/prafullkumar/public/input-q2p3-A.txt ./
   cp /nfscommon/common/prafullkumar/public/input-q2p3-b.txt ./
   cp /nfscommon/common/prafullkumar/public/input-q2p3-x0.txt ./
   ```

   (c) Using the commands similar to the previous questions, import the above files to create matrix A, vector b, and vector x_0.

   (d) Use `Richardson method` to compute solution for $Ax = b$. Run this method for 10 iterations.

   (e) Print your enrollment number and name in the specified format. In the next 10 lines, output appropriate l_2-norm that shows that the sequence generated is converging to x.

   (f) Check the output of your program using the following command.

   ```
   python3 20301234-q1p3.py
   ```

   (g) Show your working code to the instructor.

   (h) Submit the solutions only if you are confident with it. **You are only allowed to submit code once**. Use the following command for submission.

   ```
   /nfscommon/common/prafullkumar/submit 20301234-q2p3.py
   ```
