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UNIVERSITÉ LAURENTIENNE

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Questions 6

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Professeur

Time allowed 3 hours
Durée de l'examen .

USE OF TEXTBOOKS IS PERMITTED. ALL PROBLEMS HAVE EQUAL WEIGHTS. WRITE YOUR NAME ON THE QUESTION PAPER AND HAND IN WITH ANSWER SHEETS. MARKS WILL BE DEDUCTED FOR UNNECESSARY STATEMENTS.
Name:
ID:

Problem 1

The critical load for the buckling of a clamped-pinned column may be obtained by solving the following nonlinear equation:

$$x = \tan x$$

The equation may be solved by using an iterative procedure in which an initial guess is made for x and a “new” value of x is computed by using the above equation. The iteration is stopped when the difference between the previous or “old” value and the “new” value is less than a tolerance value.

Write a clear and concise C++ program to compute and display the value of x by entering the values of initial guess, the tolerance value and the maximum number of iterations. The program should display the message “NO SOLUTION” if the required accuracy is not achieved after the maximum number of iterations.

ENGR 1077 EL – Page 2
Problem 2

Write a clear and concise C++ function to accomplish the following**:**

i) Accept from the main program three real numbers as the lengths of three straight lines.

ii) Determine and display whether the three lengths can form a triangle or not. (Hint: to form a triangle, the sum of any two of the lengths must be greater than the third)

iv) If a triangle is formed, determine and display whether the triangle is a right angle triangle or not

Problem 3

A data file "seismic.inp" contains the data for time (seconds) and ground acceleration (m/s^2) in one column each.

Write a clear and concise C++ program to accomplish the following:

i) Read and save the data for time and acceleration as one-dimensional arrays

ii) Determine the number of data points

iii) Divide the data by $g = 9.81\ m/s^2$ to express the acceleration in a non-dimensional form

iv) Compute the maximum magnitude of acceleration (absolute value)

v) Compute the time when the magnitude of acceleration (absolute value) is maximum.

ENGR 1077 EL – Page 3
Problem 4

Write clear and concise Maple statements to solve the following problem:

A robotic manipulator is used in a space station to investigate zero-g manufacturing techniques. The cylindrical coordinates of a point P are given by:

$$r = 1.5\left(1 + \sin\theta\right) \; \textit{metres}$$

$$\theta = 0.45 t^2 \; \textit{radians}$$

$$z = 2.4\left(1 + \theta\right) \textit{metres}$$

The magnitude of acceleration of a point is given by:

$$a = \sqrt{a_r^2 + a_\theta^2 + a_z^2}$$

where

$$a_r = \frac{d^2 r}{dt^2} - r\left(\frac{d\theta}{dt}\right)^2$$

$$a_\theta = r\frac{d^2\theta}{dt^2} + 2\frac{dr}{dt}\frac{d\theta}{dt}$$

$$a_z = \frac{d^2 z}{dt^2}$$

Write Maple statements to compute the maximum acceleration of P and the time of its occurence.

ENGR 1077 EL – Page 4
Problem 5

Write cell name, defined name (if any) and contents (value, FORMULA or text) of the cell and complete the SOLVER window (if needed) to solve the following problem by using Excel:

The discharge rate Q for the laminar flow of a fluid through the annular space between two concentric circular tubes is given by:

$$Q = C\left[r_o^4 - r_i^4 - \frac{(r_o^2 - r_i^2)}{\ln\left(\frac{r_o}{r_i}\right)}\right]$$

in which C is a constant that depends on the pressure drop per unit length of the pipe and the density and viscosity of the fluid,

r_i = radius of the inner circle

r_o = radius of the outer circle.

The cross sectional area of flow is 40 cm^2 and the pipe is subject to the following restraints:

$$4.0 \le r_i < r_o \le 20.0\,cm^2$$

Fill in the attached answer sheet for Problem 5 to compute the values of r_i and r_o to maximize the discharge rate Q.

Problem 6

Write cell name, defined name (if any) and contents (value, FORMULA or text) of the cell and complete the SOLVER window (if needed) to solve the following problem by using Excel:

The turbulent flow of a fluid in a pipe network may be obtained by solving the following system of three nonlinear equations expressed in terms of nodal pressures p_1, p_2 and p_3:

$$0.3\sqrt{400 - p_1} = 0.2\sqrt{p_1 - p_2} + 0.1\sqrt{p_1 - p_3}$$

$$0.2\sqrt{p_1 - p_2} = 0.1\sqrt{p_2} + 0.2\sqrt{p_2 - p_3}$$

$$0.1\sqrt{p_1 - p_3} = 0.2\sqrt{p_2 - p_3} + 0.1\sqrt{p_3}$$

Fill in the attached answer sheet for Problem 6 to compute the values of p_1, p_2 and p_3.