Faculty of Mechanical Engineering

Universiti Teknologi Malaysia

MMJ 1113 Computational Methods for Engineers — Test 1

Answer all questions, Open book — $1\frac{1}{2}$ hour

Question 1.

a) If $x = 0.3721487765$ and $y = 0.3720214366$,what is the relative error in the computation of $x + y$ in a computer that has five decimal digits of accuracy? Did you round-off or chop-off?

b) The value of e^x can be evaluated using

$$e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + \cdots$$

Evaluate e^x using the expression above to the *6th* term. Find the absolute and relative error by comparing with the value of $e = 2.71828183$.

Question 2.

When two spheres in contact , such as ball bearings, transmit a load P, the normal stresses developed at a point along the z axis are given by

$$\frac{\sigma_x}{p_{\max}} = \frac{\sigma_y}{p_{\max}} = -\left[1 - \left(\frac{z}{a}\right)\tan^{-1}\frac{1}{\left(\frac{z}{a}\right)}\right](1+\mu) + \frac{1}{2\left(1+\left(\frac{z}{a}\right)^2\right)}$$

where σ_x and σ_y are the normal stresses in the x and y directions, respectively, $p_{\max}$ is the maximum pressure at the contact point, and a is the radius of the deformed flat circular surface around the contact point.

a) Find the value of $\left(\frac{z}{a}\right)$ at which $\left(\frac{\sigma_x}{p_{\max}}\right)$ attains a value 0f -0.5. Assume the value of Poisson's ratio (μ) as 0.3. Perform only 3 iterations.

b) State the reason for your method of choice in a) compared with other methods. What is your relative error after your three iterations?

Question 3.

A steel cylinder, of weight W=500 and diameter 1, is placed in a steel V-block. When a moment M is applied about the axis of the cylinder, the cylinder starts to rotate. The force equilibrium equations along the x and y directions and the moment equilibrium equation about the axis of the cylinder are given by

$$(R_1 + \mu R_1 - R_2 + \mu R_2)\sin 45^\circ = 0$$

$$(R_1 - \mu R_1 + R_2 + \mu R_2)\cos 45^\circ = W$$

and

$$6(\mu R_1 + \mu R_2) - M = 0$$

Assuming the coefficient of friction $\mu = 0.25$,

a) considering you have limited time in this test, decide which method might give a solution quickly. Perform your chosen method to find the moment (M) and the reactions at the points of contact (R_1 and R_2). Mention and use a sensible stopping point to your solution.

b) How would you solve part a) in Matlab/Octave?