Mansoura University	Engineering Faculty	Mech. Power Eng.
Master Exam	September 2013	Time allowed 3h

Computational Fluid Dynamics 3704

Course notes (power point only) are allowed – Total number of questions: 4

1. Perform tasks A, B, C, D Below for the linear system in table 1, as well as task E for the nonlinear system given in table 2 (30 points)

A) Would you recommend pivoting for the following system AX=b (Table 1)? How?

B) After pivoting, would it be solvable by relaxation? Would you recommend relaxation?

C) The system has the following eigenvalues: 10.56, 5.32, 7.13. What is the condition number? What is the error level expected in the solution if vector b had an error of 1%?

D) Solve the system using LU

Table 1

A			X	b
10	1	1	x_1	15
0	-4	4.5	x_2	5.5
5	8.5	1.5	x_3	26.5

Table 2
$(z+1)^2\, y = 4 \tan(x)$
$zy = 0.8*(1 - zx)$
$xyz = 0.2$
Initial guess: x=0.4, y=0.5, z=1

E) Perform the first iteration to solve the system given in Table 2, using the initial guess given and show how subsequent iterations would be performed as well as an adequate criterion to stop relaxation using: maximum absolute error 10^{-6}, maximum relative error 10^{-3}.

2. Use Finite Volume method to study the problem having the plan (Figure 1) (thickness = 1m) to get temperatures at A and B, as well as heat flux leaving the right most wall. (30 points)

3. Study the problem given in Figure 2 (Equilateral triangle of side 6m, thickness = 1m) using the Finite Element Method, knowing that volumetric heating q_v is applied for the whole domain 150 W/m^3. First, get equations for the generic element given below relating temperatures at the 3 nodes to the variable heat flux density on all walls and the volumetric heating. Second, use symmetry to deduce directly equations for all other elements. Third, assemble to get system equations required to get temperatures at C, D. Finally, find heat entering the base AB.

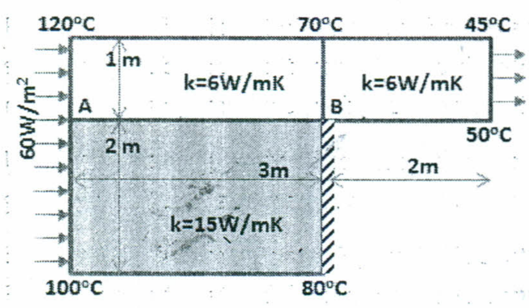

Figure 1

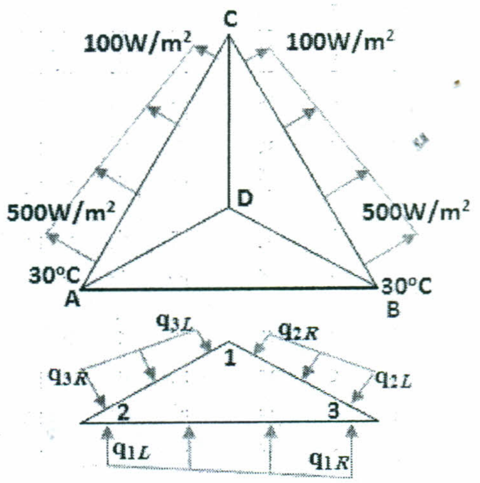

Figure 2

Good Luck – Prof. MN Sabry