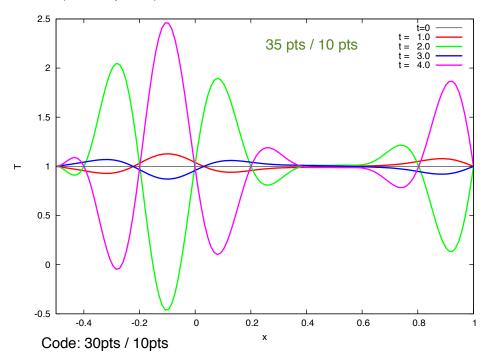
#### Homework 6 Solution

# Problem 1(100 points total)

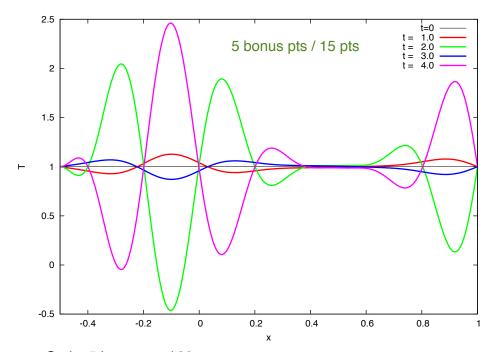
Task 1 (25 / 5 points) scan

### Task 2 (65 / 20 points)



Task 3 (12 bonus points / 30 points) scan

Task 4 (10 bonus points / 35 points)



Code: 5 bonus pts / 20pts

### Homework 6 Solution

Task 5 (10 points / 10 points) can use FTCS as well, results can be inconsistent, but need to be documented.

# 8 points

CN	Tmax (t=100)	р	f(h=0)	GCI	GCI23	asymptotic?
64	2.48776E+00					
128	2.49329E+00					
256	2.49409E+00	2.79895E+00	2.49422E+00	0.0067%	0.0465%	0.9997

Answer: Crank Nicholson, T= 2.49422E+00 +/- 0.0067% (2 points)

FTCS: 
$$\frac{T_{i}^{n+1}-T_{i}^{n}}{\Delta t} = \frac{\alpha}{q^{2}} \left(T_{i+1}^{n}-2T_{i}^{n}+T_{i-1}^{n}\right) + q_{i}^{n}$$

$$T_{n+1}^{n} = 2T(x=1,t) - T_{n}^{n}$$

$$= 2T(x=1,t) - T_{n}^{n}$$

time step 
$$\Delta t = \frac{1}{2} \frac{h^2}{\alpha}$$
  $(5/1)$ 

3) 
$$CN: T_{i}^{n+1} - T_{i}^{n} = \frac{1}{2} \left\{ \frac{\alpha}{g_{2}} \left( T_{i+1}^{n+1} - 2T_{i}^{n+1} + T_{i-1}^{n+1} \right) + \frac{\alpha}{g_{2}} \left( T_{i+1}^{n} - 2T_{i}^{n} + T_{i-1}^{n} \right) + q_{i}^{n+1} + q_{i}^{n} \right\}$$

$$= -\frac{\alpha \, \delta \, t}{2 \, A^2} \, T_{i-1}^{n+1} + \left(1 + \frac{\alpha \, \delta \, t}{a^2}\right) T_i^{n+1} - \frac{\alpha \, \delta \, t}{2 \, a^2} \, T_{i-1}^{n+1} = \frac{\alpha \, \delta \, t}{2 \, a^2} \, T_{i-1}^{n} + \left(1 - \frac{\alpha \, \delta \, t}{a^2}\right) T_i^{n} + \frac{\alpha \, \delta \, t}{2 \, a^2} \, T_{i-1}^{n} + \frac{\delta \, t}{$$

$$i=1: \quad T_0^{n+1} = 2T(x=\frac{1}{2},t) - T_1^{n+1}$$

$$(b_{1} + \frac{\alpha \Delta t}{2 \beta_{1}^{2}}) T_{1}^{n+1} - c_{1} T_{2}^{n+1} = d_{1} + \frac{\kappa \Delta t}{4^{2}} T_{3}^{n+1} - d_{1}^{n+1}$$

$$= b_{1}$$

$$= 1 + \frac{3}{2} \frac{\kappa \Delta t}{2 c}$$

$$= b_{1} + \frac{3}{2} \frac{d^{2}}{d^{2}} = d_{1} + \frac{d_{1}}{d^{2}} = d_{1}$$

) Find one solution to Ax = 0 and two incerty independent solutions to  $A^{-}y = 0$ .

What conditions on the components of b do we need for Ax = b to have a red inchbed a laws this illustrates. What are the currents? What are the solutions f (Compute  $A^{T}A$ , You'get positive numbers on the diagonal. These numbers count the characteries (All in this blank). When are the collinear extraction of the solution  $A^{T}A$  and when are

sch node has (all in the blank). When are the off diagonal entries -1 and when are they report ) What is  $N(A^TA)^2$  Why does  $A^TAx = f$  have a solution only when  $f_1 + f_2 + f_3 = f_4 = 0$ ?

roblem 2 (10 points)
to problem 10 on page 123.

Problem 3 (10 points)
Do problem 12 on pag. 124

Popular Son page 133.

What is the axis of rotation and the transformation matrix that takes (x, relxg) to (x, x, x)? For 3 become coints. When is the angle of rotations?

Problem 8 (10 points)
Do Problem 30 on nava 135.

Problem 7 (10 points)
De Problem 59 en page 137

Problem 8 (10 points)
De Problem 2.8 on page 137

Problem 9 (10 points) De Problem 2.5 on sage 137.