ENEE 241/MATH 242 Dr. Wolfe ASSIGNMENT #7 Due April 13/14, 2004

Readings: *Linz & Wang* , Sections 6.3, 6.5.

The first three problems are concerned with the computation of the integral

$$I = \int_0^1 \frac{4}{1+x^2}\,dx = \pi$$

1. Use the MATLAB function QUADL on I. Use several different values of TOL.
2. Compute the Gauss-Legendre approximations of I with $n = 2, 4, 6, 8$. I have supplied an m-file with the weights and nodes. Remember, you have to make a change of variable to transform the integal to one whose limits of integration are -1 and 1.
3. The 11 point Newton-Cotes integration rule on $[0, 1]$ is

$$\int_0^1 f(x)\,dx \approx \sum_{i=0}^{10} w_i f(\frac{i}{10})$$

with the w_i determined by requiring that the rule be exact for $f(x) = 1, x, x^2, \ldots x^{10}$.
(a) Use MATLAB to find the weights w_i.
(b) Apply the rule to I. Note the error.

Problems 4 & 5 refer to the integral

$$J = \int_2^3 \frac{dx}{5-x}$$

4. Determine N so that the N-panel trapezoidal rule can be used to compute J with an accuracy of 5×10^{-9}.
5. Determine N so that the N-panel Simpson's rule can be used to compute J with an accuracy of 5×10^{-9}.

6. In a standard shell and tube heat exchanger hot vapor condenses on the tube, maintaining a constant temperature T_s. If the input is at temperature T_1 and the output must be at temperature T_2, then the length of tube required is given by

$$L = \frac{m}{\pi D} \int_{T_1}^{T_2} \frac{c_\rho dT}{h(T_s - T)}.$$

(All quantities must be in consistent units.) Here T is the temperature in °F.
$T_1 = 0$°F is the inlet temperature.
$T_2 = 180$°F is the desired outlet temperature.

$T_s = 250°\text{F}$ is the condensate temperature.
m is the fluid flow rate $= 45,000$ lb/hr.
D is the diameter of the tube $= 1.032$ in.
c_ρ is the specific heat of the fluid $= (0.53 + 0.00065T)\,\text{BTU/(lb°F)}$.
h is the local heat transfer coefficient $= \frac{0.023k}{D}(\frac{4m}{\pi D\mu})^{0.8}(\frac{\mu c_\rho}{k})^{0.4}$.
k is the thermal conductivity of the fluid $= 0.153\,\text{BTU/(hr ft°F)}$.
μ is the viscosity of the fluid and has units lb/(ft hr). μ varies with temperature so that

T	0	50	100	150	200
μ	242	82.1	30.5	12.6	5.57

Use spline interpolation to define μ for other values of T and calculate the required length of the heat exchanger.
You will need to use the MATLAB functions SPLINE and QUADL . The answer is about 158.7 ft.