Prince of Songkla University
Faculty of Engineering

Midterm Test
5 January 2014
215-274 Numerical Methods for Mechanical Engineering

Semester 2/2013
09:00-12:00
Room: Robot

Name ______________________________ ID ______________

Direction:
1. All types of calculator and dictionary are permitted.
2. There are totally 5 problems.
3. One sheet of hand-written A4 paper is allowed. No photocopy!!

Perapong Tekasakul
Kittinan Maliwan

Instructors

Problem No.	**Full score**	**Your mark**
1	15	
2	10	
3	15	
4	28	
5	12	
Total	**80**	

1. Determine the root of $\sin x = x^3$, where x is in radian, using bisection method to determine the root to $\varepsilon_a = 2\%$. Employ initial guesses of $x_l = 0.5$ and $x_u = 1.0$. (15 points)

Iter.	x_l	x_u	x_r	ε_a

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2. Give the system of equations (10 points)

$$x_1 + x_2 - x_3 = -3$$
$$6x_1 + 2x_2 + 2x_3 = 2$$
$$-3x_1 + 4x_2 + x_3 = 1$$

(a) Use Gauss elimination to solve for the $x's$

(b) Substitute your results back into the original equation to check your solution

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3. Given the data

x	1	2	3	5	7	8
$f(x)$	3	6	19	99	291	444

Calculate $f(4)$ using Lagrange Polynomials of orders 1, 2, 3. (15 points)

4. (28 points)

4.1 The function $f(x) = 2e^{-1.5x}$ can be used to generate the following table of unequally spaced data:

x	0	0.05	0.15	0.25	0.35	0.475	0.6
$f(x)$	2	1.8555	1.5970	1.3746	1.1831	0.9808	0.8131

Evaluate the integral from a = 0 to b = 0.6 using

(a) analytical means
(b) the trapezoidal rule, and
(c) the best combination of the trapezoidal and Simpson's rules

For (b) and (c), compute the percent relative error (ε_t). (10 points)

(a)

(b)

(c)

4.2 Evaluate

$$\int_0^3 xe^x \, dx$$

Using

(a) analytical means
(b) order of h^8 Romberg integration
(c) four-point Gauss-Legendre formula

For (b) and (c), compute the percent relative error (ε_t). (18 points)

(a)

(b)

n	$O(h^2)$	$O(h^4)$	$O(h^6)$	$O(h^8)$
1				
2				
3				
4				

(c)

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5. The following data was collected for the distance traveled versus time for a rocket:

$t\ (s)$	0	25	50	75	100	125
$y\ (km)$	0	32	58	78	92	100

Use the best numerical method available of accuracy $O(h^2)$ to estimate the rocket's velocity and acceleration at each time. (12 points)

$t(s)$	$y(km)$	$v(m/s)$	$a(m/s^2)$
0	0		
25	32		
50	58		
75	78		
100	92		
125	100		