Fill in your name and ID No. in the space above. There should be 9 pages including this one.

The exam is closed book, and one double-sided sheets of notes is permitted. **No collaboration with others!**

For multiple choice questions, choose the **single, BEST** answer.

For work-out problems, write down all general equations used and intermediate algebraic steps. Show all your work. Failure to do so will result in a lower score.

You have 50 minutes to complete the exam.

<table>
<thead>
<tr>
<th>Problem</th>
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<tbody>
<tr>
<td>Multiple choice:</td>
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<td>Workout problem 1:</td>
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<td>Workout problem 2:</td>
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<td><strong>Total:</strong></td>
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Answers to the multiple choice questions. Circle the letter that corresponds to your answer for each of the multiple choice questions. Please note that only the answers you provide on this sheet will be graded.

1. A B C D E
2. A B C D E
3. A B C D E
4. A B C D E
5. A B C D E
6. A B C D E
7. A B C D E
8. A B C D E
9. A B C D E
10. A B C D E
11. A B C D E
12. A B C D E
13. A B C D E
14. A B C D E
15. A B C D E
I. (60 pts total) Multiple choice problems worth 4 points each. Circle the answer that is the most appropriate or closest numerically to your answer and then select that answer on the answer sheet (page 2).

1. Which of the following is NOT known as a selection or iteration control structure?
   a. DO-EXIT loop  
   b. END statement  
   c. IF-THEN-ELSE block  
   d. DO-FOR loop  
   e. CASE-SELECT block

2. In Matlab, which of the following symbols CANNOT be used in the condition statement within an IF-statement?
   a. >  
   b. <=  
   c. ~=  
   d. =  
   e. <

3. If a numerical method yields a biased estimate of the solution, then the solution
   a. is accurate  
   b. cannot be precise  
   c. converges on the true answer  
   d. converges on something other than the true answer  
   e. will never converge on a final answer

4. An example of truncation error is
   a. chopping a result after a specified number of significant figures  
   b. approximating an infinite series by the first three terms of the series  
   c. rounding a result to a specified level of precision  
   d. moving the decimal point to keep the mantissa of a number in scientific notation within its allowable range  
   e. using an exact derivative instead of a linear finite difference approximation
For problems 5 – 9 refer to the following flow charts:

Flow chart A:

Flow chart B:

Flow chart C:

Flow chart D:

5. Which flow chart is a DO-FOR loop?
   a. Flow chart A.
   b. Flow chart B.
   c. Flow chart C.
   d. Flow chart D.
   e. None of the above.
6. Which flow chart is an IF-THEN-ELSE structure?
   a. flow chart A.
   b. Flow chart B.
   c. Flow chart C.
   d. Flow chart D.
   e. None of the above.

7. Which flow chart could be used to depict the following pseudocode:

   DO
   x_{i+1} = \exp(x_i) - 4
   IF \ x_{i+1} = x_i \ EXIT
   \ iter = \ iter + 1
   ENDDO

   a. Flow chart A.
   b. Flow chart B.
   c. Flow chart C.
   d. Flow chart D.
   e. None of the above.

8. Which complete flow chart could be used to depict the following single line of a Matlab
   program:

   if ea > etol, break, end

   a. Flow chart A.
   b. Flow chart B.
   c. Flow chart C.
   d. Flow chart D.
   e. None of the above.

9. Which two flow charts represent selection structures (Hint: the three main structures
   are sequence, selection, and iteration)?

   a. Flow charts A and B.
   b. Flow charts C and D.
   c. Flow charts A and D.
   d. Flow charts B and C.
   e. Flow charts A and C.
10. Which of the following statements about the Newton-Raphson root-finding method is NOT true

a. It is an open method, so sometimes it may not converge on a root
b. It requires an exact expression for the derivative of the function
c. It approximates a function using a linear Taylor-series expansion
d. It generally converges faster than the bisection method
e. It requires two initial guesses, but they do not have to bracket the root

For problems 11 through 15, consider the function

\[ f(x) = 7 - 20(e^{-0.2x} - e^{-0.75x}) \]

11. The first-order Taylor series approximation for \( x = 1.4 \) using a base point of \( x = 1.2 \) is

a. -1.56
b. -1.19
c. -0.67
d. -0.53
e. -0.01

12. A second-order Taylor series approximation for \( x = 0.85 \) gives \( f = 0.75 \). The truncation error (value of the remainder term) \( \nu \) for this estimate is

a. -0.07
b. -0.05
c. 0.05
d. 0.07
e. None of the above
13. A second-order Taylor series approximation for $x = 0.85$ gives $f = 0.75$. The true relative error for this estimate in percent is

a. 2.7  

b. 4.3  

c. 5.2  

d. 7.4  

e. None of the above  

14. Use the bisection method with initial guesses of $x_l = 0.5$ and $x_u = 1.2$ to find the root of $f(x) = 0$. After two iterations, the root estimate is

a. 0.5  

b. 0.675  

c. 0.85  

d. 1.025  

e. 1.2  

15. For an initial guess of $x_0 = 1.2$, the root estimate for $f(x) = 0$ after one iteration of the Newton-Raphson method is

a. -5.51  

b. -3.71  

c. -0.805  

d. 0.996  

e. 2.06
II. (40 pts total) Work-out problems worth 20 points each. Problem parts are valued as noted. State all important assumptions and indicate which tables you are reading values from.

1. The following lines of Matlab code solve the quadratic equation. There are at least 7 syntax errors. Indicate where 7 of the errors are AND what needs to be changed to correct the error. Assume there are no algorithmic errors.

```matlab
while
    a = input('Enter coefficient value for a: ');
    b = input('Enter coefficient value for b: ');
    c = input('Enter coefficient value for c: ');
    if a == 0
        if b ~= 0
            r1 = -c / b;
        else
            disp('Trivial Solution');
        end
    else
        discr = b^2 - 4*a*c;
        if discr >= 0
            r1 = (-b + sqrt(discr)) / (2*a);
            r2 = (-b - sqrt(discr)) / (2*a);
        else
            r1 = -b / (2*a);
            i1 = sqrt(abs(discr)) / (2*a);
            i2 = -i1;
        end
    end
end
response = input('Continue? (1=yes, 0=no) ');
if response == 0
    break
end
```
2. Your construction company buys a piece of equipment for $P = $300,000 for nothing down and $A = $70,000 per year for $n = 6$ years. The formula relating $P$, $A$, $n$, and interest rate $i$, expressed as $x=(1+i)$, is

$$A = P \frac{(x-1)x^n}{x^n - 1}.$$ 

Note also that

$$\frac{d}{dx} \left( P \frac{(x-1)x^n}{x^n - 1} \right) = -P \frac{-x^{2n} + x^n + n(x-1)x^{n-1}}{(x^n - 1)^2}$$

a. Define the function $g(x) = 0$ so $g$ defines a root-finding problem in $x$. The roots of $g$ will be related to the interest rate as $x_r = (1 + i)$. (5 pts)

b. What is the root estimate for $x$ after two iterations of the Newton-Raphson method using an initial guess of $x_0 = 1.08$? (10 pts)

c. What is the approximate relative error in percent for your final root in Part b? (5 pts)

d. What is the approximate relative error for the interest rate $i$ based on your root estimates for $x$ and the relationship $x = (1 + i)$? (5 pts)