Final Exam
5/8/2018
50 questions, 170 minutes, 20 pages
Version A

Name:_____

Student ID:_____

GSI name/Lab number:_____

UC Berkeley Honor Code: "As a member of the UC Berkeley community, I act with honesty, integrity, and respect for others."
On my honor, I have neither given nor received any assistance in the taking of this exam.

Signed: _____

  Instructions:

1. Write your full name on the front of the bubble sheet.

2. Bubble in your student ID number COMPLETELY and CLEARLY. [You may get a point off if your ID is bubbled incorrectly!]

3. Bubble in your exam version.

4. Record your answers on the bubble sheet (pen or pencil is fine). There is one correct answer for each question. Multiple bubbles, incomplete bubbles, or stray marks will be marked incorrect.

5. You may use one 8.5" by 11" sheet of notes (both sides) for this exam provided you do not disturb those sitting nearby.

6. No electronic devices are permitted in your work area.

7. There will be no questions regarding the exam during the examination time except in cases where there is a missing page or printing problem with your exam.

8. At the end of the exam, hand in the completed bubble sheet AND the questions to your primary GSI.

1. What is the color of the resulting image if the following function is applied to all the pixels in the image, assuming `pixel` is a 3x1 array:

```
function [pixel_new] = changeimage(pixel)
    pixel_new = [0 0 0; 0 1 0; 0 0 0] * pixel;
end
```

   (a) red
   (b) green
   (c) blue
   (d) grey
   (e) None of these

2. The MATLAB function `eps` returns the difference between the input number and the next closest number that can be exactly represented by floating point notation. Given that MATLAB's default data type for numbers is a double precision float, what is `eps(1.0)`?

   TIP: Double precision variables use 1 bit for the sign, 52 bits for the fractional significand, and 11 bits for the exponent.

   (a) 2^{-10}
   (b) 2^{-11}
   (c) 2^{-51}
   (d) 2^{-52}
   (e) 2^{-1074}

3. What will the expression `B = mytest(2,3,4)` yield given the following function?

```
function [A] = mytest(a,b,c,varargin)
A = a + b;
    if isempty(varargin)
        A = A * c;
    end
end
```

   (a) $B = 5$
   (b) $B = 8$
   (c) $B = 20$
   (d) MATLAB will throw an error because the variable name B and the output name A are inconsistent.
   (e) MATLAB will throw an error because there are not enough inputs.

4. What will be the value of V after the following code is executed?

```
A = 4;
V = [ 2, 4, 6; 1, 5, 3 ];
V( V < A ) = 0;
```

   (a) An error would be thrown.

   (b) [0, 4, 6, 0, 5, 0]

   (c) [0, 0, 6; 0, 5, 0]

   (d) [2, 4, 0; 1, 0, 3]

   (e) [0, 4, 6; 0, 5, 0]

5. Consider the two following recursive functions:

```
function x = myFunc1(n)
    if n == 0 || n == 1
        x = 1;
    else
        x = 2 * myFunc1(n-1) * myFunc1(n-2);
    end
end

function x = myFunc2(n)
    if n < 1
        x = 1;
    else
        x = 2 * myFunc2(n/2);
    end
end
```

   What are the time complexities of `myFunc1` and `myFunc2`, respectively?

   (a) $O(2n)$ and $O(n/2)$

   (b) $O(n^2)$ and $O(n)$

   (c) $O(C^n)$ and $O(\log(n))$

   (d) $O(C^n)$ and $O(n)$

   (e) $O(n)$ and $O(\log(n))$

6. Given an image represented by `I`, where `I` is a `MxNx3` array of integers between 0 and 255 and M and N are divisible by two, how do you modify `I` such that `imshow(I)` plots the same image with the **bottom left quadrant** blacked out?

   (a) `I(1:M/2,1:N/2,:)  = 0;`

   (b) `I(1:M/2,N/2+1:N,:)  = 0;`

   (c) `I(M/2+1:M,1:N/2,:)  = 0;`

   (d) `I(M/2+1:M,N/2+1:N,:)  = 0;`

   (e) `I(M/2+1:M,M/2+1:M,:)  = 0;`

7. You write the following code in order to grayscale an image stored in the variable `img`. When comparing with a classmate, you notice that your code takes much longer to run than theirs for a sample 800x600 resolution image. What is the time complexity for your algorithm? Note that functions called within the code may contribute to the time complexity.

```
[M,N,~] = size(img);
for k = 1:3
    for i = 1:M
        for j = 1:N
            img(:,:,k) = mean(img,3);
        end
    end
end
```

  (a) $O(M^2*N^2)$

  (b) $O(M^2)$

  (c) $O(N^2)$

  (d) $O(M*N)$

  (e) $O(k*M*N)$

8. The following code is executed successively in the command window:

```
S(1).Name = 'UCB';
S(1).Pop = 35700;
S(2).Name = 'UMich';
S(2).Pop = 43400;
S(3).Name = 'GTech';
S(3).Pop = 21500;
```

What is the result when `size([S.Name])` is now executed?

  (a) `ans = [3 1]`

  (b) `ans = [1 13]`

  (c) `ans = [1 3]`

  (d) `ans = [1 19]`

  (e) An error would be thrown.

9. What is the value of `myFn(5)`?

```
function out = myFn(n)
    if n > 2
        out = myFn(n-2) + 2 * myFn(n-1);
    else
        out = 1;
    end
end
```

(a) `ans = 5`

(b) `ans = 17`

(c) `ans = 21`

(d) `ans = 41`

(e) `ans = 99`

10. After writing the following code to make a simple plot, you now want to modify it to store a figure handle to this figure you are creating. Where in this code could you add the line, `fig = figure;`, in order to do this?

```
plot(-10:10,(-10:10).^2);
title('Basic Quadratic');
xlabel('x');
ylabel('y');
```

(a) Before the call to `plot`

(b) Between the call to `plot` and the call to `title`

(c) After all of these function calls

(d) B or C

(e) A, B, or C

11. Consider the following function

```
function out = myFunction(txt)
    if txt == 'first'
        out = 1;
    elseif txt == 'second'
        out = myFunction('third');
    elseif txt == 'third'
        out = myFunction('first') + 1;
    end
end
```

What will MATLAB return after calling `myFunction('third')`?

(a) 1

(b) It will go through an infinite loop

(c) 2

(d) An error would be thrown

(e) 3

12. Consider the following line of code:

`quiver(X, Y, u, v)`

Given that `X` and `Y` are `meshgrid` outputs specifying the (x, y) locations of each point to be plotted, what do `u` and `v` specify?

(a) `u` and `v` specify the color of the contour line at each point specified by `X` and `Y`

(b) `u` specifies the location in the third dimension while `v` specifies the color of each point specified by `X` and `Y`

(c) `u` specifies the location in the third dimension while `v` specifies the size of each point specified at each `X` and `Y`

(d) `u` specifies the color and `v` specifies the size of each point specified by `X` and `Y`

(e) `u` and `v` specify the magnitudes in the x- and y-directions of the arrows to be plotted at each point specified by `X` and `Y`

13. Consider the following lines of the code:

```
x = -pi : pi/8 : pi;
y1 = sin(x);
y2 = cos(x);
y3 = tan(x)+1;
figure(1)
plot(x,y1,'r')
plot(x,y2,'g--o');
hold on;
plot(x,y3,'y*-');
```

After executing the code above, what does the final plot in figure 1 look like?

(a) 3 lines (red solid line for y1, green dashed line with circle marker for y2 and yellow solid line with star marker for y3)

(b) 2 lines (green dashed line with circle marker for y2 and yellow star markers for y3 without a line)

(c) 2 lines (red solid line for y1 and green dashed line with circle marker for y2)

(d) 2 lines (green dashed line with circle marker for y2 and yellow line with star markers for y3)

(e) 1 line (yellow star markers for y3 with solid line)

14. You are given a matrix `A` of size `m-by-n` and array `b` of size `m-by-1`. Given that `rank([A,b]) == rank(A)`, what condition must be met so that there exists only one solution of `x`, where `x` is the solution to `Ax = b`?

(a) `rank(A) = m`

(b) `rank(A) = n`

(c) `rank(b) = m`

(d) `rank(b) = n`

(e) None of the above

15. How many iterations of Newton's Method will it take to converge to within 0.0001 given $f(x) = 4.71x - 6.32$ with initial guess $x_0 = 1$?

(a) 1

(b) 2

(c) 3

(d) 4

(e) >4

16. You are given a set of data points of length n, separated into two variables, `x` and `y`. Both vectors have size 1-by-n.

    How do you set up matrix `A` and vector `beta` such that running `coeff = A \ beta` will give you the coefficients a, b and c of a linear regression that fits the following equation: $y = a+b\sin(x)+c\exp(x)$?

    (a) `A=[1,x,y]; beta=y`

    (b) `A=[ones(length(x),1),sin(x),exp(x)]; beta=y`

    (c) `A=[ones(length(x),1),sin(x),y]; beta=exp(x)`

    (d) `A=[ones(length(x),1),(sin(x))',(exp(x))']; beta=y'`

    (e) `A=[1,sin(x),exp(x)]; beta=y'`

17. Regression problems are defined by linear systems that:

    (a) Have infinitely many solutions

    (b) Have no solution

    (c) Are overdetermined

    (d) A and C

    (e) B and C

18. Consider the code below:

    ```
    f = @(x) exp(x);
    a = fzero(f,0);
    ```

    which returns

    ```
    a = -926.8190
    ```

    Is the variable, `a`, a true root of the function f?

    (a) No, there are no real roots to the given function

    (b) No, exp(a) approaches infinity

    (c) Yes, exp(a) approaches infinity

    (d) Yes, exp(a) approaches 0

    (e) There is not enough information available

19. Which of the following statements about matrix inverse is FALSE?

    (a) A singular matrix has no inverse

    (b) If a system of linear equations does not have a unique solution or has many solutions, `pinv(A)` can be used and it returns the pseudoinverse of matrix A.

    (c) A matrix is invertible if its determinant is not zero

    (d) `x = A\b` is always computed the same as `x = inv(A)*b`

    (e) If A is invertible, `inv(A)` will not throw an error

20. Given `A = [6 4 12; 0 0 0; 3 2 6]`, what is `rank(A)`?

    (a) 0
    (b) 1
    (c) 2
    (d) 3
    (e) `rank(A)` cannot be determined.

21. Consider the following lines:

    ```
    fun = @(x) sin(x); % function
    x0 = 3; % initial point
    x = fzero(fun,x0)
    ```

    What is displayed at the command line after entering the above code?

    (a) x = 0
    (b) x = 3.1416
    (c) x = pi
    (d) MATLAB will throw an error
    (e) None of above

22. Consider the equation below used to describe the goodness-of-fit of a fitted regression line to data.

$$R^2 = 1 - \frac{SSE_{\text{linear}}}{SSE_{\text{mean}}} \tag{1}$$

    Which of the following statements is true?

    (a) SSE_{mean} represents the sum of squared errors between the data and the mean
    (b) SSE_{linear} represents the sum of squared errors between the data and the fitted regression line
    (c) R^2 can never be 0
    (d) A and B
    (e) A, B, and C

23. Which of the following is/are required in order to use the bisection method to finds the real roots of polynomial f between a and b?

    (a) $\text{sign}(a) \sim= \text{sign}(b)$
    (b) f is continuous over $[a, b]$
    (c) f is differentiable over $[a, b]$
    (d) All of the above
    (e) (a) and (b) only

24. Recall the Maclaurin series for five common functions:

$$
\begin{aligned}
\frac{1}{1-x} &= 1 + x + x^2 + x^3 + x^4 + \dots \\
\ln(1+x) &= x - \frac{x^2}{2!} + \frac{x^3}{3!} - \frac{x^4}{4!} + \dots \\
\exp(x) &= 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + \dots \\
\cos(x) &= 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} + \frac{x^8}{8!} - \dots \\
\sin(x) &= x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \frac{x^9}{9!} - \dots
\end{aligned}
$$

Which function does the following code approximate?

```
f = 0;
for i = 0:N
    f = f + (-1)^i * x^(2*i+1) / factorial(2*i+1);
end
```

(a) $f(x) = 1/(1-x)$

(b) $f(x) = \ln(x)$

(c) $f(x) = \exp(x)$

(d) $f(x) = \cos(x)$

(e) $f(x) = \sin(x)$

25. In addition to passing through each data point, what additional conditions are applied when setting up a cubic spline problem?

(a) 1st and 2nd derivative matches with adjacent splines at each interior data point, as well as 1 additional condition for the system.

(b) 1st and 2nd derivative matches with adjacent splines at each interior data point, as well as 2 additional conditions for the system.

(c) 1st and 2nd derivative matches with adjacent splines at each interior data point, as well as 4 additional conditions for the system.

(d) 1st, 2nd, and 3rd derivative matches with adjacent splines at each interior data point, as well as 2 additional conditions for the system.

(e) 1st, 2nd, and 3rd derivative matches with adjacent splines at each interior data point, as well as 4 additional conditions for the system.

26. Given the data $x = [0, 1, 2]$ and $y = [3, 1, 2]$, what is the Lagrange interpolation at $x = 1.5$?

    (a) 0.625

    (b) 1.125

    (c) 1.5

    (d) 1.625

    (e) 2

27. Which of the following is NOT true about Taylor series?

    (a) An infinite number of terms is always required to completely describe a given function.

    (b) Taylor series can be used to describe periodic functions like sine and cosine.

    (c) A linear approximation is the first two terms of a function's Taylor series expansion.

    (d) A and B

    (e) A, B, and C

28. Consider the following function f. What is the value of $f'(2)$ as estimated by first-order forward difference with spacing $\Delta x = 1$?

    ```
    f = @(x) x^2 - 2*x + 1;
    ```

    (a) 3

    (b) 1

    (c) 4

    (d) 2

    (e) 2.5

29. Consider the three following finite difference schemes, and assume uniform grid spacing (i.e. $x_i - x_{i-1} = x_{i+1} - x_i = \Delta x$) (note: the first expression is a fourth-order central scheme):

$$\frac{df}{dx}\bigg|_{x_k} = \frac{f(x_{k-2}) - 8f(x_{k-1}) + 8f(x_{k+1}) - f(x_{k+2})}{12(x_{k+1} - x_k)}$$

$$\frac{df}{dx}\bigg|_{x_k} = \frac{f(x_{k+1}) - f(x_k))}{x_{k+1} - x_k}$$

$$\frac{df}{dx}\bigg|_{x_k} = \frac{f(x_{k+1}) - f(x_{k-1}))}{x_{k+1} - x_{k-1}}.$$

In the log-log plot of the numerical error associated to those schemes vs. grid spacing Δx, what would be the approximate slope for the first, second and third scheme, respectively?

    (a) 1, 2, 3

    (b) 4, 1, 2

    (c) 4, 1, 1

    (d) 4, 2, 1

    (e) There wouldn't be any linear trends.

30. Given `x = [0,1,2,4]` and `y = [2,-1,0,5]` and the function below, what will running
    `A = knowyourdifferences(x,y)` in the MATLAB command window output?

    ```
    function [diffvec] = knowyourdifferences(xvec,yvec)
        for k = 1:length(xvec)
            diffvec(k) = (yvec(k+1) - yvec(k)) / (xvec(k+1)-xvec(k));
        end
    end
    ```

    (a) An error saying "index exceeds matrix dimensions."

    (b) `A=[-3,-1,2.5]`

    (c) `A=[-3,-1,2.5,0]`

    (d) `A=[-3,-1,2,2.5]`

    (e) None of the above

31. Suppose that you are given $y = f(x)$. The x values are $[5, 8, 13, 21]$ and the corresponding y values are $[32, 45, 61, 92]$. Given $x = 17$, use linear interpolation to find the corresponding y value:

    (a) 62.03

    (b) 76.5

    (c) 79

    (d) 83.4

    (e) 93

32. Consider the code below:

    ```
    x = linspace(0,10,11);
    y = exp(x);
    z = linspace(0.5,9.5,9);
    w = interp1(x,y,z);
    a = size(w);
    ```

    What is the variable, `a`?

    (a) `[1,1]`

    (b) `[1,9]`

    (c) `[1,11]`

    (d) `[9,11]`

    (e) `[11,9]`

33. Which of the following statements regarding numerical differentiation is FALSE?

    (a) Central difference has a higher order of accuracy than forward or backward difference

    (b) Finite difference schemes contain numerical errors due to the approximation of derivatives

    (c) The central difference scheme is called "second order" because it has $O(h^2)$ time complexity

    (d) The difference between the finite difference and exact solutions changes with the size of the discretization step

    (e) Taylor series can be used to derive high-order finite difference formulas.

34. Assume that at a specific time, a car has a velocity $v(t)$, where t is time in seconds and Δt is the time interval. We want to calculate the acceleration a of the car using the car's velocity. Which of the formulas below is a second-order approximation?

    (a) $a(t) = [v(t_{i+1}) - 2v(t_i) + v(t_{i-1})]/\Delta t^2$

    (b) $a(t) = [v(t_{i+1}) - v(t_i)]/\Delta t$

    (c) $a(t) = [v(t_{i+1}) - v(t_{i-1})]/(2\Delta t)$

    (d) $a(t) = [v(t_{i-2}) - 8v(t_{i-1}) + 8v(t_{i+1}) - v(t_{i+2})]/(12\Delta t)$

    (e) $a(t) = [v(t_{i+1}) - v(t_{i-1})]/\Delta t$

35. Consider the following function for the next question:

$$f(x) = \frac{1+x}{(1 + \sin(x\pi/2))^2}. \tag{2}$$

    What is the trapezoidal approximation of the integral of $f(x)$ from 0 to 2 with a step of $\Delta x = 1$?

    (a) 1

    (b) 1.5

    (c) 2

    (d) 2.5

    (e) 5

36. The area under a function, f, can be approximated using Simpson's Rule:

$$\frac{h}{3}\left[f(x_0) + 4\left(\sum_{\substack{i\,=\,1 \\ i\ \text{odd}}}^{n-1} f(x_i)\right) + 2\left(\sum_{\substack{i\,=\,2 \\ i\ \text{even}}}^{n-2} f(x_i)\right) + f(x_n)\right] \tag{3}$$

Given the following code, what would you insert in place of '?' below to solve for the area under the function?

```
x=[-pi:pi/8:pi];
y=sin(x)+(2*pi);
h=pi/8;
Area=h/3*(y(?)+sum(4*y(?))+sum(2*y(?))+y(?))
```

(a) `0, 1:2:end-1, 1:2:end-2, end`

(b) `0, 1:2:end-1, 3:2:end-2, end`

(c) `1, 1:2:end-1, 1:2:end-2, end`

(d) `1, 2:2:end-1, 3:2:end-2, end`

(e) None of the above

37. To numerically solve a generic ODE written as $dy/dt = f(t,y)$, a 2nd-order Runge-Kutta predictor-corrector model can be used:

$$\text{Step } 1 : y^*_{n+1} \;=\; y_n + f(t_n, y_n)\Delta t$$
$$\text{Step } 2 : y_{n+1} \;=\; y_n + \frac{1}{2}(f(t_n, y_n) + f(t_{n+1}, y^*_{n+1}))\Delta t$$

This scheme is used on the equation

$$\frac{dy}{dt} = 2y + 1. \tag{4}$$

What would be the value of y_2, using $\Delta t = 1$, and the initial condition $y_0 = 0$?

(a) 2

(b) 7

(c) 5

(d) 12

(e) 1

38. Given an anonymous function definition `dfdt = @(t,F) t` which defines the slope $df/dt = t$, consider the values of the following variables which are inputs and/or outputs to a call to `ode45`:

```
a = [0, 0.5, 1]
b = [0, 0.5, 1]
c = [0, 0.1250, 0.5]
d = 0
```

Note that floating point doubles such as `0.125000...` have been truncated for brevity. The `ode45` help page reads:

```
ODE45   Solve non-stiff differential equations, medium order method.
   [TOUT,YOUT] = ODE45(ODEFUN,TSPAN,Y0) with TSPAN = [T0 TFINAL]
      integrates the system of differential equations y' = f(t,y)
      from time T0 to TFINAL with initial conditions Y0. ODEFUN is
      a function handle. To obtain solutions at specific times
      T0,T1,...,TFINAL (all increasing or all decreasing), use
      TSPAN = [T0 T1 ... TFINAL].
```

Which of the following lines represents a correct call to `ode45` which is consistent with the values given above for `a, b, c` and `d`?

(a) `[a, b] = ode45(dfdt, c, d);`

(b) `[a, c] = ode45(dfdt, b, d);`

(c) `[c, a] = ode45(dfdt, b, d);`

(d) `[d, c] = ode45(dfdt, a, b);`

(e) None of the above

39. What are the orders of accuracy over the whole integral for the left Riemann, midpoint, Trapezoid, and Simpson's rule, respectively?

(a) $O(h), O(h^2), O(h^3), O(h^4)$

(b) $O(h), O(h^2), O(h^2), O(h^4)$

(c) $O(h^2), O(h^3), O(h^3), O(h^4)$

(d) $O(h^2), O(h^3), O(h^4), O(h^5)$

(e) $O(h^2), O(h^3), O(h^4), O(h^4)$

40. Consider the standard decay ODE:

$$\frac{dy}{dt} = -k * y. \tag{5}$$

When an explicit Euler's method is applied to this ODE with time step Δt, and $k > 0$, what conditions will always lead to a numerically **stable** solution?

(a) When $k = 2/\Delta t$

(b) When $|1 + k\Delta t| > 1$

(c) When $|1 - k\Delta t| > 1$

(d) When $|1 - k\Delta t| < 1$

(e) None of these

41. Based on the following figure, what is the midpoint rule approximation of $\int_2^{10} F(x)dx$? You can take $\Delta x = 2$.
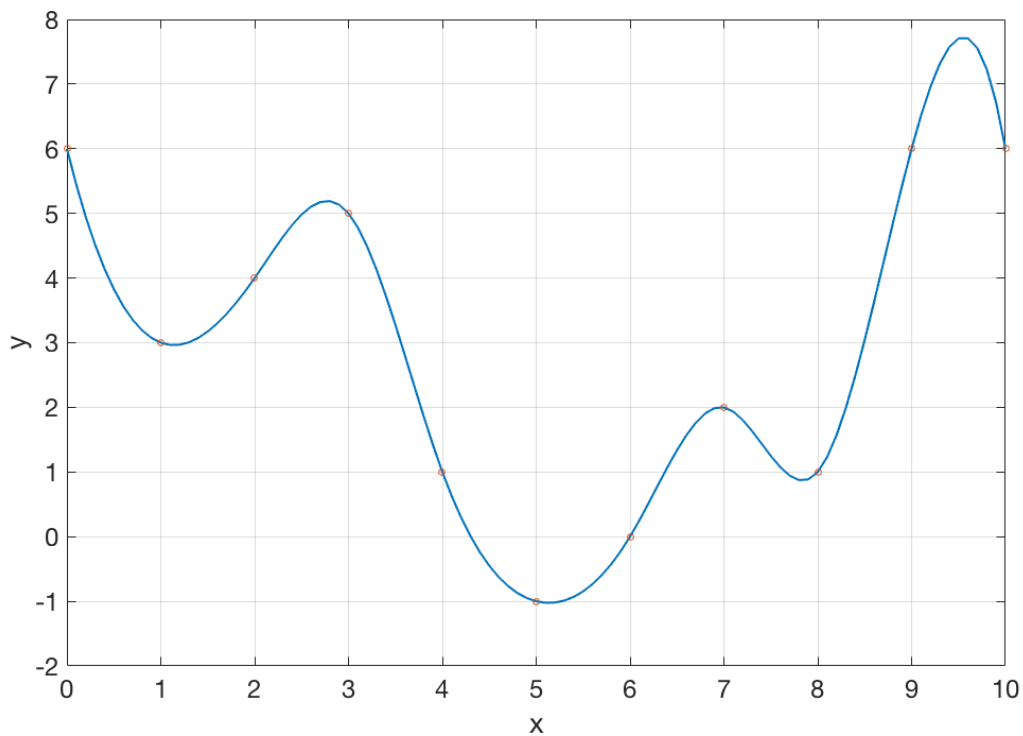
(a) 12

(b) 20

(c) 21

(d) 23

(e) 24

42. To compute a left Riemann integral, the following code is written:

```
1  function [intest] = leftriemann(xvec,yvec)
2      stepsize=xvec(2)-xvec(1);
3      % missing code
4      intest=sum(A);
5  end
```

You can assume that data `xvec` and `yvec` are the same length. What is the correct line of code that should appear in line 3?

(a) `A=yvec(2:end).*stepsize`

(b) `A=yvec(1:end-1).*stepsize`

(c) `A=(yvec(1:end-1)+yvec(2:end))./2.*stepsize`

(d) `A=yvec(k+1).*stepsize`

(e) None of the above

43. Consider the organization of data in object-oriented programming.

If a button called `myPushButton` and a text field called `ResultEditField` were created in MATLAB's `appdesigner`, which of the following lines of code can be written in `myPushButton`'s callback function to display the text `'Pushed'` whenever the button is pressed?

(a) `app.ResultEditField = 'Pushed'`

(b) `ResultEditField = 'Pushed'`

(c) `app.ResultEditField.Value = myPushButton`

(d) `app.ResultEditField.Value = 'Pushed'`

(e) None of the above

44. A climate stabilization wedge, as defined by Pacala and Socolow (2004), is a carbon-mitigation strategy that yields:

(a) The reduction of one Gt of carbon from the atmosphere over 50 years.

(b) The reduction in emissions of one Gt of carbon/year after 50 years.

(c) The reduction of one Gt of all pollutants from the atmosphere over 50 years.

(d) The reduction of one Gt of emissions of all ozone depleting substances from the atmosphere over 50 years.

(e) The colloquial name for a slice of cake eaten by climate scientists to calm their fears about climate change.

45. Consider this code for the following question. Debug points are placed on lines 3, 5, and 8.

```
1  function [y] = mainFunction(x)
2      n = rem(x,2); %rem(x,2) returns 0 if even, 1 if odd
3      y = x * subFunction(n);
4      y = -1 * y;
5  end
6
7  function [y] = subFunction(x)
8      y = (x+1) * (x-1);
9  end
```

With debug points as above, you enter `y = mainFunction(6)` into the command window. Then you press continue twice. Immediately after, what are the values of `x`, `y` and `n` in your workspace, if any?

   (a) 6, 6, and 0

   (b) undefined, 6, and undefined

   (c) 6, -6, and 0

   (d) 0, undefined, and undefined

   (e) None of the above

46. Parallel computing allows faster solution of large problems by splitting the problem into parts that can be tackled by different processors. In the Richardson's forecast factory example, which *additional* factor must be considered due to the parallel processing?

   (a) communication between processors

   (b) memory and data storage

   (c) two-dimensional arrangement of the grid points

   (d) processor time complexity

   (e) solution of a partial differential equation

47. Which of these could you use to automatically create a plot of historical emissions data when an app is run inside `appdesigner`?

   (a) value changed function

   (b) value changing function

   (c) startup function

   (d) All of the above

   (e) None of the above

The next 3 questions refer to the following code:

Imagine that this summer you have been hired by a structural engineering firm in New York City. Your first task as their esteemed Cal intern is to document all of the historic skyscrapers in downtown. You decide to utilize the skills you learned in E7 to help you, namely your object oriented programming skills. Consider the following class definition for data type: `buildings`, which can be used to construct a portfolio of the buildings you are scoping out:

```
classdef buildings

    properties
        name
        year
        floors
    end

    methods
        function obj = buildings(inputArg1,inputArg2,inputArg3)
            if nargin == 3
                obj.name = inputArg1;
                obj.year = inputArg2;
                obj.floors = inputArg3;
            end
        end

        function obj = method1(obj,arg)
            obj.name{end+1} = arg.bldg;
            obj.year(end+1) = arg.year;
            obj.floors(end+1) = arg.numfloor;
        end

        function obj = method2(obj,bldgArg,entryArg)
            obj.name{bldgArg} = entryArg.bldg;
            obj.year(bldgArg) = entryArg.year;
            obj.floors(bldgArg) = entryArg.numfloor;
        end

        function obj = method3(obj,bldgArg)
            obj.name(bldgArg) = [];
            obj.year(bldgArg) = [];
            obj.floors(bldgArg) = [];
        end

    end
end
```

48. Suppose you have an instance of `buildings`, called `portfolio`. How do `method1` and `method2` change `portfolio`, respectively?

    (a) Add an entry into `portfolio`, replace an entry in `portfolio`.

    (b) Replace an entry in `portfolio`, add an entry in `portfolio`.

    (c) Add an entry into `portfolio`, remove an entry from `portfolio`.

    (d) Remove an entry from `portfolio`, add an entry into `portfolio`.

    (e) None of the above

49. You execute the following commands:

    ```
    NYC_portfolio = buildings({},[],[]);

    bldg1 = struct('bldg','Chrysler','year',1930,'numfloor',77);
    bldg2 = struct('bldg','Flatiron','year',1903,'numfloor',23);

    NYC_portfolio = NYC_portfolio.method1(bldg1);
    NYC_portfolio = NYC_portfolio.method1(bldg2);
    ```

    How many elements are in NYC_portfolio.name?

    (a) NYC_portfolio.name is empty.

    (b) 1

    (c) 2

    (d) An error occurs.

    (e) None of the above

50. You execute the following commands, in addition to the commands executed in the previous problem:

    ```
    NYC_portfolio = NYC_portfolio.method2(1,bldg2);
    NYC_portfolio = NYC_portfolio.method3(1);
    ```

    What is the value of NYC_portfolio.year?

    (a) 1903

    (b) 1903 1903

    (c) 1930 1903

    (d) 1930

    (e) An error occurs