Script Information

```
% ME112 HW 5

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```

Problem 1

```
clear; close all; clc;


f = @(x) (x + 1./x).^2;


a = 1;

b = 2;


syms x;

std_sol = int((x + 1/x)^2, x, a, b);

fprintf('True value is %.4f\n', std_sol);


for n = 1:4

    X = linspace(a, b, n+1);

    Y = f(X);

    trapz_res = trapz(X, Y);
```

```
    err = abs((std_sol - trapz_res) / std_sol);

    fprintf('For n = %d: \n', n);
    fprintf('Approximation: %.6f, error: %.6f%%\n', trapz_res, err * 100);
end
```

```
True value is 4.8333
For n = 1:
Approximation: 5.125000, error: 6.034483%
For n = 2:
Approximation: 4.909722, error: 1.580460%
For n = 3:
Approximation: 4.867685, error: 0.710728%
For n = 4:
Approximation: 4.852744, error: 0.401595%
```

Problem 2

```
clear; close all; clc;

f = @(x) x.^2 .* exp(x);
a = 0; b = 3;

syms x_sym
std_sol = int(x_sym .^2 .* exp(x_sym), a, b);

n = 4;
X = linspace(a, b, n+1);
Y = f(X);
```

```matlab
trapz_res = trapz(X, Y);


simpsons_res = simpson13_multiple(f, a, b, 4);


% Calculate percent relative errors

trapz_err = abs((std_sol - trapz_res) / std_sol) * 100;

simpsons_err = abs((std_sol - simpsons_res) / std_sol) * 100;


% Display results

fprintf('Analytical Result: %.6f\n', std_sol);

fprintf('Trapezoidal Result: %.6f, Error: %.6f%%\n', trapz_res, trapz_err);

fprintf('Simpson''s 1/3 Result: %.6f, Error: %.6f%%\n', ...

    simpsons_res, simpsons_err);


function I = simpson13_multiple(f, a, b, n)

    n = n*3;

    intervals = linspace(a, b , n+1);

    y = f(intervals);


    n1 = y(1) + y(n+1);

    n2 = 0; n3 = 0;

    for i=2:n

       if rem(i,2)==0

          n2 = n2 + 4*y(i);

       else

          n3 = n3 + 2*y(i);

       end

    end

    I=(b-a) * (n1+n2+n3) / (3*n);
```

```
end
```

```
Analytical Result: 98.427685

Trapezoidal Result: 112.268394, Error: 14.061805%

Simpson's 1/3 Result: 98.441752, Error: 0.014292%
```

Problem 3

```
clear; close all; clc;


a = 0; b = 10;


y_data = [0, 1, 3, 5, 7, 8, 9, 10];

H_data = [0, 1, 1.5, 3, 3.5, 3.2, 2, 0];

U_data = [0, 0.1, 0.12, 0.2, 0.25, 0.3, 0.15, 0];

H_pp = spline(y_data, H_data);

U_pp = spline(y_data, U_data);


H_f = @(x) ppval(H_pp, x);

U_f = @(x) ppval(U_pp, x);


% a.

disp('a.');


I_H = integral(H_f, a, b);

avg_depth = I_H / (b-a);

fprintf('Average Depth: %.4f m\n', avg_depth);



% b.
```

```
disp('b.');


Ac = I_H;

fprintf('Cross-sectional Area: %.4f m^2\n', Ac);




% c.

disp('c.');


avg_velocity = integral(U_f, a, b) / (b -a);

fprintf('Average Velocity: %.4f m/s\n', avg_velocity);


% d.

disp('d.');


dQ = @(x) ppval(U_pp, x) .* ppval(H_pp, x);

Q = integral(dQ, a, b);

fprintf('Flow Rate: %.4f m^3/s\n', Q);
```

```
a.

Average Depth: 2.1416 m

b.

Cross-sectional Area: 21.4162 m^2

c.

Average Velocity: 0.1626 m/s

d.

Flow Rate: 4.2395 m^3/s
```

Problem 4

```
clear; close all; clc;


t_data = [0 1 5.5 10 12 14 16 18 20 24];

c_data = [1 1.5 2.3 2.1 4 5 5.5 5 3 1.2];


a = 0; b = 24;


c_pp = spline(t_data, c_data);

c_f = @(x) ppval(c_pp, x);

Q_f = @(t) 20 + 10 .* sin(2.*pi./24.*(t-10));

dUp = @(x) c_f(x) .* Q_f(x);


I_res = integral(dUp, a, b) / integral(Q_f, a, b);


fprintf('Final result is %.6f\n', I_res);
```

```
Final result is 3.332989
```

Problem 5

```
clear; close all; clc;


% a.

disp('a.');


t_data = [7.5 7.75 8 8.25 8.75 9.25];

R_data = [18 23 14 24 20 9].* (60/4);
```

```
n = length(R_data);


n1 = R_data(1) + R_data(n);

n2 = 0; n3 = 0;

for i=2:n-1

   if rem(i,2)==0

      n2 = n2 + 4*R_data(i);

   else

      n3 = n3 + 2*R_data(i);

   end

end


pass_total=(t_data(n)-t_data(1)) * (n1+n2+n3) / (3*(n-1));


fprintf('Total number is %.4f\n', pass_total);


% b.


disp('b.');


per_m = pass_total / t_data(n) - t_data(1);


fprintf('Pass per minute is %.4f\n', per_m);
```

```
a.

Total number is 495.2500

b.

Pass per minute is 46.0405
```

End

```
clear; close all; clc;
```

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