3) Over a computer sub-network, three end-users connected to a wireless media via smart-phones. These users download data using the internet connection of the wireless router. In a time interval, internet data download speed statistics (KB/sn) of these three users recorded and modelled with functions for each user. Modelled functions for data download speed statistics of these users are given in the following lines.

$$F_{USER1}(t) = -0.0189t^2 + 1.3406t + 80.7743$$
$$F_{USER2}(t) = -0.0043t^2 + 0.4259t + 105.2688$$
$$F_{USER3}(t) = 0.0181t^2 - 0.8689t + 105.9157$$

Data download speed functions are avaible for a time interval is 100 seconds. Considering the given functions answer the following questions;

a) Using single Trapezoidal rule calculate the downloaded data size (kilobytes) in [10,70] time range for each smart-phone user.
b) Calculate the true errors and absolute relative true errors considering the values you find in section (a).
c) Using multiple Trapezoidal rule calculate data sizes (kilobytes) in [10,70] time range for each smart-phone user by getting Trapezoidal segment counts as 2,4,6,10,20.
d) Calculate the true errors and absolute relative true errors considering the values you find in section (c).
e) Write your segments, approximate values, true values, true errors, absolute true errors as tabulated form. (Segments : 1,2,4,6,10. Note that you should use previous section results, do not calculate necessary elements again.)
f) Plot the data download speeds of users for time range [0, 100] and compare your calculations with graphics.
g) Using Simpson's method for integration solve section (a), (b), (c), (d), (e).

Answers

3)

a) $\int_a^b f(x)dx \approx Area\,of\,trapezoid$ $\qquad$ $\int_a^b f(x)dx \approx (b-a)\left[\frac{f(a)+f(b)}{2}\right]$

$$F_1(t) = -0.0189t^2 + 1.3406t + 80.7743 \quad [10,70]$$
$$\int_{10}^{70} F_1(t)dt \approx (70-10)\left[\frac{82.0063 + 92.2903}{2}\right] = 5228.8980$$

$$F_2(t) = -0.0043t^2 + 0.4259t + 105.2688 \quad [10,70]$$

$$\int_{10}^{70} F_1(t)dt \approx (70-10)\left[\frac{114.0118+109.0978}{2}\right] = 6693.2880$$

$$F_3(t) = 0.0181t^2 - 0.8689t + 105.9157 \qquad [10,70]$$

$$\int_{10}^{70} F_1(t)dt \approx (70-10)\left[\frac{133.7827+99.0367}{2}\right] = 6984.5820$$

True integration results;

$$F(t) = -0.0063t^3 + 0.6703t^2 + 80.7743t \quad [10,70]$$

$$\int_{10}^{70} F_1(t)dt = F(70) - F(10) = 6777.7710 - 868.4730 = 5909.2980$$

$$F(t) = -0.00143t^3 + 0.21295t^2 + 105.2688t \qquad [10,70]$$

$$\int_{10}^{70} F_1(t)dt = F(70) - F(10) = 7921.7810 - 1072.5530 = 6849.2280$$

$$F(t) = 0.00603t^3 - 0.43445t^2 + 105.9157t \qquad [10,70]$$

$$\int_{10}^{70} F_1(t)dt = F(70) - F(10) = 7.3535840 - 1.0217420 = 6331.8420$$

b)

	True Error	**Relative Abs. True Error**
User - 1	$5909.2980 - 5228.8980 = 680.4$	$(680.4 / 5909.2980) x100 = \%11.5140$
User - 2	$6849.2280 - 6693.2880 = 155.94$	$(155.94 / 6849.2280) x100 = \%2.2767$
User - 3	$6331.8420 - 6984.5820 = -652.74$	$(652.74 / 6331.8420) x100 = \%10.3088$

c) $$\int_a^b f(x)dx \approx \frac{(b-a)}{2n}\left[f(a) + 2\left\{\sum_{i=1}^{n-1} f(a+ih)\right\} + f(b)\right]$$

$$F_1(t) = -0.0189t^2 + 1.3406t + 80.7743 \qquad [10,70]$$

$$\int_a^b f(x)dx \approx \frac{(70-10)}{2(2)}\left[f(10) + 2\{f(40)\} + f(70)\right]$$

$$\int_a^b f(x)dx \approx \frac{(70-10)}{2(4)}\left[f(10)+2\left\{f(25)+f(40)+f(55)\right\}+f(70)\right]$$

$$\int_a^b f(x)dx \approx \frac{(70-10)}{2(6)}\left[f(10)+2\left\{f(20)+f(30)+f(40)+f(50)+f(60)\right\}+f(70)\right]$$

$$\int_a^b f(x)dx \approx \frac{(70-10)}{2(10)}\left[f(10)+2\begin{Bmatrix} f(16)+f(22)+f(28)+f(34)+f(40)+ \\ f(46)+f(52)+f(58)+f(64) \end{Bmatrix}+f(70)\right]$$

$$\int_a^b f(x)dx \approx \frac{(70-10)}{2(20)}\left[f(10)+2\begin{Bmatrix} f(13)+f(16)+f(19)+f(22)+f(25)+f(28)+f(31)+ \\ f(34)+f(37)+f(40)+f(43)+f(46)+f(49)+f(52)+ \\ f(55)+f(58)+f(61)+f(64)+f(67) \end{Bmatrix}+f(70)\right]$$

	Approximate values		
	User-1	User-2	User-3
2-segments	**5739.1980**	**6809.3880**	**6495.8820**
4-segments	**5866.7730**	**6838.4130**	**6373.7069**
6-segments	**5890.3980**	**6843.7880**	**6351.0820**
10-segments	**5902.4940**	**6846.5400**	**6339.4980**
20-segments	**5907.5970**	**6847.7009**	**6334.6109**

True values		
User-1	User-2	User-3
5909.2980	6849.2280	6331.8420

d) For user-1;

2-segment $5909.2980-5739.1980=170,01$

$(170,0100/5909.2980)*100=2.8769$

4-segment $5909.2980-5866.7730=42.525$

$(42.5250/5909.2980)*100=0.7196$

6-segment $5909.2980-5890.3980=18,9$

$(18,9000/5909.2980)*100=0.3198$

10-segment $5909.2980 - 5902.4940 = 6.804$

$(6.8040 / 5909.2980) * 100 = 0.1151$

20-segment $5909.2980 - 5907.5970 = 1.701$

$(1.7010 / 5909.2980) * 100 = 0.0287$

2-segment $6849.2280 - 6809.3880 = 39.84$

$(39.8400 / 6849.2280) * 100 = 0.5816$

4-segment $6849.2280 - 6838.4130 = 10.815$

$(10.8150 / 6849.2280) * 100 = 0.1579$

6-segment $6849.2280 - 6843.7880 = 5.44$

$(5.4400 / 6849.2280) * 100 = 0.0794$

10-segment $6849.2280 - 6846.5400 = 2.688$

$(2.6880 / 6849.2280) * 100 = 0.0392$

20-segment $6849.2280 - 6847.7009 = 1.5271$

$(1.5271 / 6849.2280) * 100 = 0.0222$

2-segment $6331.8420 - 6495.8820 = -164.04$

$(164.0400 / 6331.8420) * 100 = 2.5907$

4-segment $6331.8420 - 6373.7069 = -41.8649$

$(41.8649 / 6331.8420) * 100 = 0.6611$

6-segment $6331.8420 - 6351.0820 = -19.24$

$(19.2400 / 6331.8420) * 100 = 0.3038$

10-segment $6331.8420 - 6339.4980 = -7.656$

$(7.6560 / 6331.8420) * 100 = 0.1209$

20-segment $6331.8420 - 6334.6109 = -2.7689$

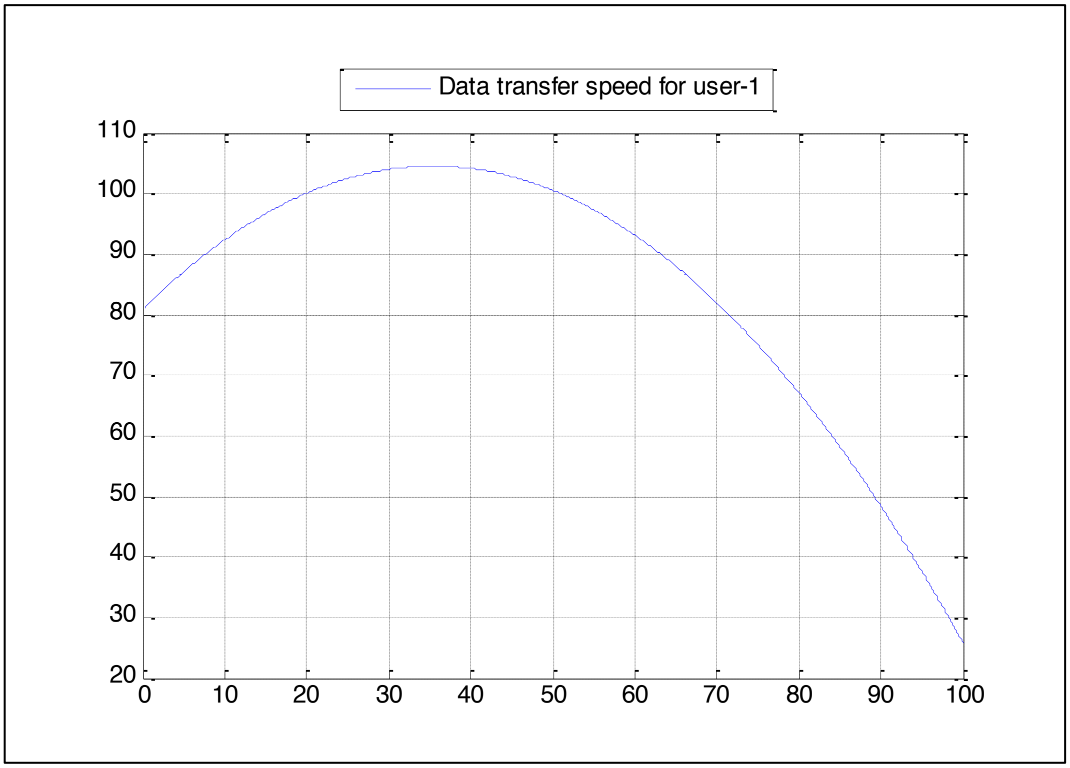
$(2.7689 / 6331.8420) * 100 = 0.0437$

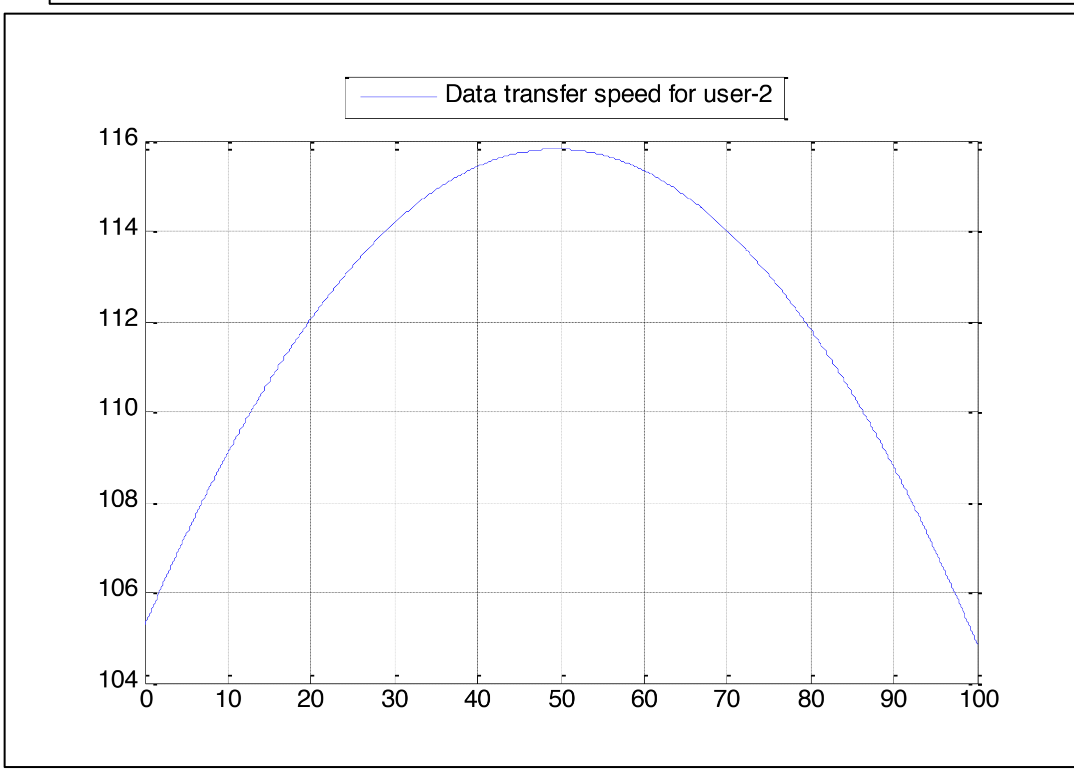
e)

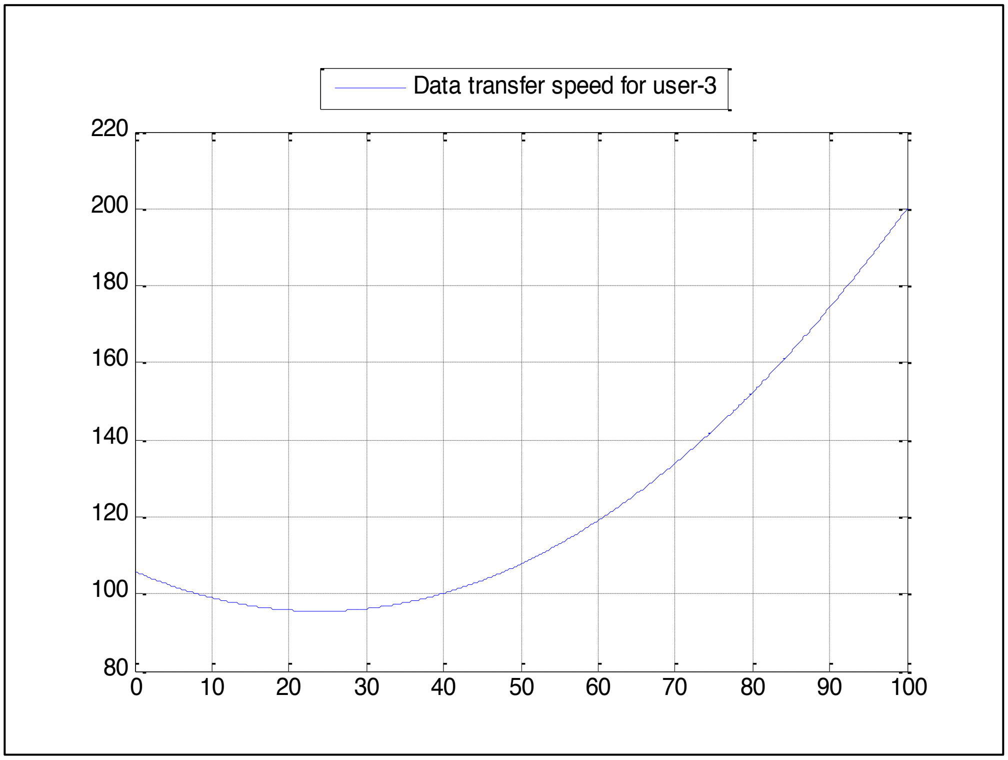
	Approximate values		
Segments	User-1	User-2	User-3
2	**5739.1980**	**6809.3880**	**6495.8820**
4	**5866.7730**	**6838.4130**	**6373.7069**

6	**5890.3980**	**6843.7880**	**6351.0820**
10	**5902.4940**	**6846.5400**	**6339.4980**
20	**5907.5970**	**6847.7009**	**6334.6109**
	True Errors		
2	**170.01**	**39.84**	**0.5816**
4	**42.525**	**10.815**	**0.1579**
6	**18.9**	**5.44**	**0.0794**
10	**6.804**	**2.688**	**0.0392**
20	**1.701**	**1.5271**	**0.0222**
	Abs. Rel. True Errors		
2	**2.8769**	**-164.04**	**2.5907**
4	**0.7196**	**-41.8649**	**0.6611**
6	**0.3198**	**-19.24**	**0.3038**
10	**0.1151**	**-7.656**	**0.1209**
20	**0.0287**	**-2.7689**	**0.0437**

f)


Data transfer speed for user-1
110
100
90
80
70
60
50
40
30
20
0
10
20
30
40
50
60
70
80
90
100


Data transfer speed for user-2
116
114
112
110
108
106
104
0
10
20
30
40
50
60
70
80
90
100



g) $$\int_a^b f_2(x)dx \approx \frac{h}{3}\left[f(a)+4f\left(\frac{a+b}{2}\right)+f(b)\right] \approx \frac{(b-a)}{6}\left[f(a)+4f\left(\frac{a+b}{2}\right)+f(b)\right]$$

$$F_1(t) = -0.0189t^2 + 1.3406t + 80.7743 \quad [10,70]$$

$$\int_{10}^{70} F_1(t)\,dt \approx \frac{70-10}{6}\left[82.0063+4f\left(40\right)+92.2903\right] = 10\left[82.0063+416.6332+92.2903\right] = 5909.2980$$

$$F_2(t) = -0.0043t^2 + 0.4259t + 105.2688 \quad [10,70]$$

$$\int_{10}^{70} F_1(t)dt \approx \left(70-10\right)\left[\frac{+}{2}\right] = 6693.2880$$

$$\int_{10}^{70} F_1(t)\,dt \approx \frac{70-10}{6}\left[114.0118+4f\left(40\right)+109.0978\right]=10\left[114.0118+461.6992+109.0978\right]=$$

6848.0880

$$F_3(t)=0.0181t^2-0.8689t+105.9157 \qquad [10,70]$$

$$\int_{10}^{70} F_1(t)dt \approx \frac{70-10}{6}\left[133.7827+4f\left(40\right)+99.0367\right]=10\left[133.7827+400.4788+99.0367\right]=$$

6332.9820

True integration results;

$$F(t)=-0.0063t^3+0.6703t^2+80.7743t \quad [10,70]$$

$$\int_{10}^{70} F_1(t)dt = F(70)-F(10)=6777.7710-868.4730=5909.2980$$

$$F(t)=-0.00143t^3+0.21295t^2+105.2688t \qquad [10,70]$$

$$\int_{10}^{70} F_1(t)dt = F(70)-F(10)=7921.7810-1072.5530=6849.2280$$

$$F(t)=0.00603t^3-0.43445t^2+105.9157t \qquad [10,70]$$

$$\int_{10}^{70} F_1(t)dt = F(70)-F(10)=7.3535840-1.0217420=6331.8420$$

	True Error	**Relative Abs. True Error**
User - 1	5909.2980-5909.2980=0	$(0\ /\ 5909.2980)$x$100=\%0.00$
User - 2	6849.2280-6848.0880=1.14	$(1.14/6849.2280)x100=\%0.0166$
User - 3	6331.8420-6332.9820=−1.14	$(1.14/6849.2280)x100=\%0.0166$

$$\int_a^b f(x)dx \approx \frac{(b-a)}{3n}\left[f(x_0) + 4\sum_{\substack{i=1\\i=odd}}^{n-1} f(x_i) + 2\sum_{\substack{i=2\\i=even}}^{n-2} f(x_i) + f(x_n) \right]$$

$$F_1(t) = -0.0189t^2 + 1.3406t + 80.7743 \qquad [10,70]$$

	Approximate values		
	User-1	User-2	User-3
2-segments	**5909.2980**	**6848.0880**	**6332.9820**
4-segments	**5909.2980**	**6848.0880**	**6332.9820**
6-segments	**5909.2980**	**6848.0880**	**6332.9820**
10-segments	**5909.2980**	**6848.0880**	**6332.9820**
20-segments	**5909.2980**	**6848.0880**	**6332.9820**

True values		
User-1	User-2	User-3
5909.2980	**6849.2280**	**6331.8420**

For user-1;

2-segment $5909.2980 - 5909.2980 = 0$ $(0/5909.2980)*100 = \%0$

4-segment $5909.2980 - 5909.2980 = 0$ $(0/5909.2980)*100 = \%0$

6-segment $5909.2980 - 5909.2980 = 0$ $(0/5909.2980)*100 = \%0$

10-segment $5909.2980 - 5909.2980 = 0$ $(0/5909.2980)*100 = \%0$

20-segment $5909.2980 - 5909.2980 = 0$ $(0/5909.2980)*100 = \%0$

For user-2;

2-segment $6849.2280 - 6849.2280 = 0$ $(0/6849.2280)*100 = \%0$

4-segment $6849.2280 - 6849.2280 = 0$ $(0/6849.2280)*100 = \%0$

6-segment	$6849.2280-6849.2280=0$	$(0/6849.2280)*100=\%0$
10-segment	$6849.2280-6849.2280=0$	$(0/6849.2280)*100=\%0$
20-segment	$6849.2280-6849.2280=0$	$(0/6849.2280)*100=\%0$

For user-3;

2-segment	$6331.8420-6331.8420=0$	$(0/6331.8420)*100=\%0$
4-segment	$6331.8420-6331.8420=0$	$(0/6331.8420)*100=\%0$
6-segment	$6331.8420-6331.8420=0$	$(0/6331.8420)*100=\%0$
10-segment	$6331.8420-6331.8420=0$	$(0/6331.8420)*100=\%0$
20-segment	$6331.8420-6331.8420=0$	$(0/6331.8420)*100=\%0$

	Approximate values		
Segments	User-1	User-2	User-3
2	**5909.2980**	**6849.2280**	**6331.8420**
4	**5909.2980**	**6849.2280**	**6331.8420**
6	**5909.2980**	**6849.2280**	**6331.8420**
10	**5909.2980**	**6849.2280**	**6331.8420**
20	**5909.2980**	**6849.2280**	**6331.8420**
	True Errors		
2	**0.00**	**0.00**	**0.00**
4	**0.00**	**0.00**	**0.00**
6	**0.00**	**0.00**	**0.00**
10	**0.00**	**0.00**	**0.00**
20	**0.00**	**0.00**	**0.00**
	Abs. Rel. True Errors		
2	**0.00**	**0.00**	**0.00**
4	**0.00**	**0.00**	**0.00**
6	**0.00**	**0.00**	**0.00**

10	**0.00**	**0.00**	**0.00**
20	**0.00**	**0.00**	**0.00**