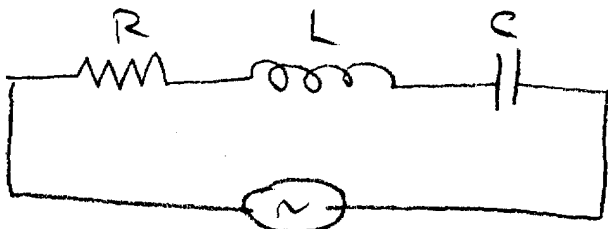


## Numerical solution of RLC series circuit



Given  $R, L, C, f$

$$v = V_{\max} \sin \omega t$$

$$v(t) = iR - L \frac{di}{dt} + q/c$$

Initial Conditions:

$$i = 0 \text{ at } t = 0$$

$$q = 0 \text{ at } t = 0$$

$$\therefore \frac{di}{dt} = \frac{1}{L} (v(t) - iR - q/c) \quad (1)$$

We also know that  $\frac{dq}{dt} = i, \omega = 2\pi f$

(2)

Procedure:

Set  $i = 0, q = 0, v = v(0) = V_{\max} \sin(\omega \cdot 0)$

evaluate  $\frac{di}{dt}$  from (1) using known values of  $i$  &  $q$ .

update  $i$ :  $i^{t+\Delta t} = i^t + \frac{di}{dt} \cdot \Delta t$  some small value  
(experiment!)

update  $q$ :  $q^{t+\Delta t} = q^t + i \cdot \Delta t$

Thus we have  $i$  &  $q$  at the new time.

Repeat to advance in time.

Initial conditions: i 0 Amperes di/dt=(1/L)\*(v - iR - q/C)  
 q 0 Coulombs dq/dt=i  
 f 60 Hz  
 Vmax 150 Volts  
 R 250 Ohms  
 L 0.6 Henries  
 C 3.50E-06 Farads  
 dt 0.0005 Seconds

v=Vmax\*sin(wt)  
 w=2\*pi\*f

Notes:

Calculation sequence:

Set initial values of t at 0, v(0), I and q in row 12. From this derive initial vR=iR, vC=q/C in row 12. Then calc di/dt from above, then calc dq/dt from above. Finally, calc vL=L\*di/dt.

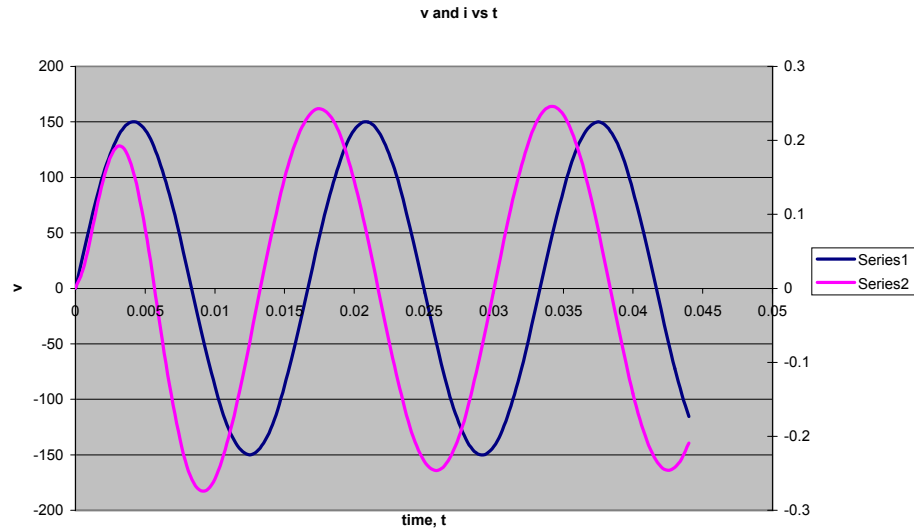
Update values of t=t+dt, v(t) in row 13. Use the old values for vR=iR, vC=q/C from row 12. Then calc di/dt from above formula, then calc dq/dt from above formula. Calc vL=L\*di/dt (just for curiosity; not needed for the calculation). Update I=I+di/dt, q=q+dqdt.

Repeat for subsequent rows.

vR=iR  
 vC=q/C

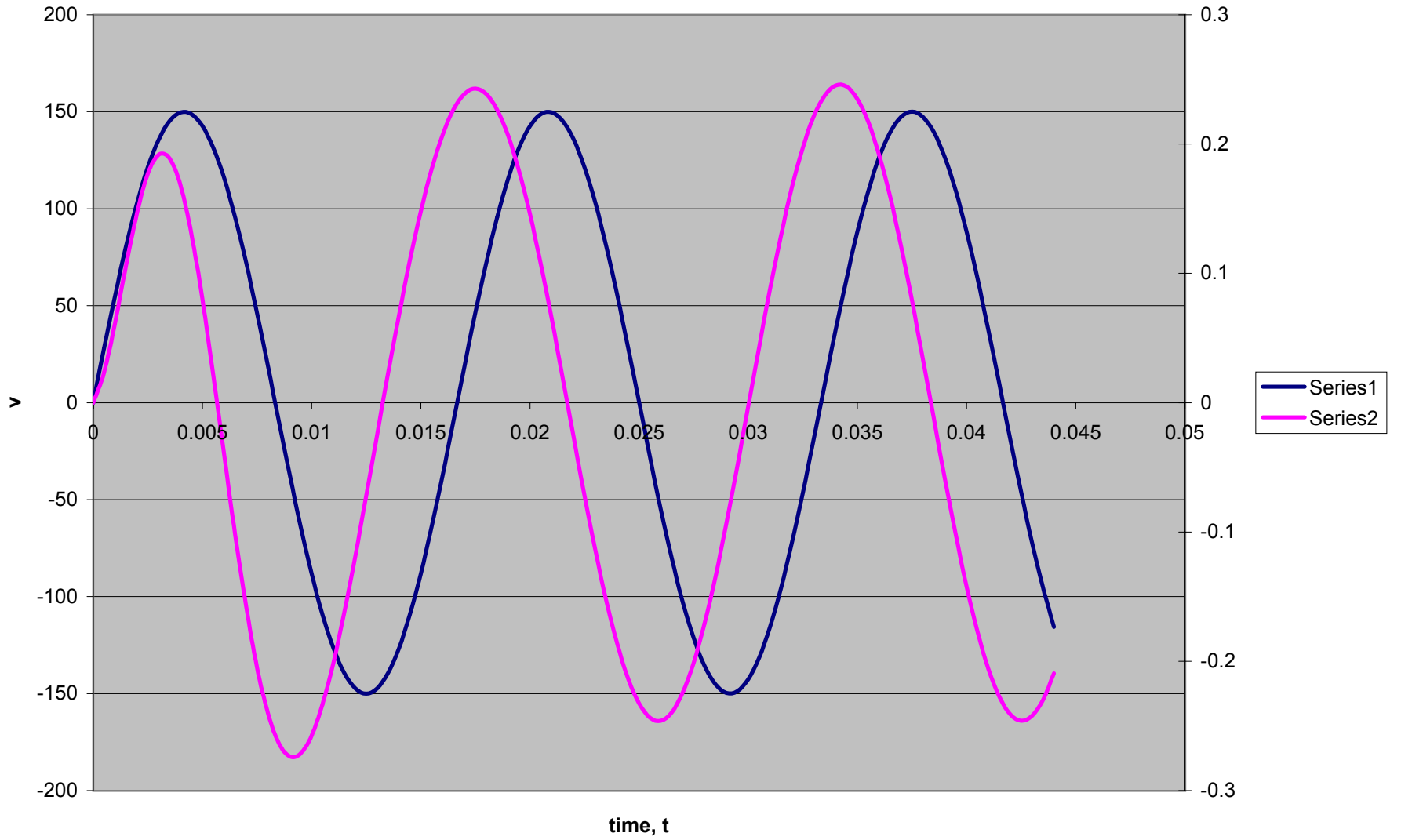
column C I (at t+dt) = I (at t) + di/dt\*dt  
 column D q = q+dq/dt\*dt

time, t	v	I	q	vR	vL	vC	di/dt
0	0	0	0	0	0	0	0
0.0005	28.1072	0.02342266	1.17E-05	0	28.1072	0	46.84533
0.001	55.21868	0.0617701	4.26E-05	5.855666	46.01692	3.346095	76.69487
0.0015	80.37402	0.10573768	9.55E-05	15.44252	52.7611	12.17039	87.93517
0.002	102.6821	0.14654757	0.000169	26.43442	48.97187	27.27578	81.61978
0.0025	121.3525	0.176968	0.000257	36.63689	36.50451	48.21115	60.84085
0.003	135.7241	0.19195947	0.000353	44.242	17.98977	73.49229	29.98295
0.0035	145.2875	0.18894492	0.000448	47.98987	-3.617464	100.9151	-6.029106
0.004	149.704	0.1677454	0.000532	47.23623	-25.43942	127.9072	-42.39904
0.0045	148.8172	0.13025376	0.000597	41.93635	-44.98998	151.8708	-74.98329
0.005	142.6585	0.0799342	0.000637	32.56344	-60.38347	170.4785	-100.6391
0.0055	131.446	0.02123817	0.000647	19.98355	-70.43523	181.8977	-117.392
0.006	115.577	-0.040982	0.000627	5.309543	-74.66426	184.9317	-124.4404
0.0065	95.6136	-0.1019971	0.000576	-10.24551	-73.21802	179.0771	-122.03
0.007	72.26305	-0.1576169	0.000497	-25.49926	-66.7438	164.5061	-111.2397
0.0075	46.35255	-0.2044774	0.000395	-39.40422	-56.23265	141.9894	-93.72108
0.008	18.79999	-0.2401933	0.000275	-51.11936	-42.85901	112.7784	-71.43169
0.0085	-9.418578	-0.2633894	0.000143	-60.04832	-27.83529	78.46503	-46.39215
0.009	-37.30348	-0.2736345	6.12E-06	-65.84734	-12.29413	40.83798	-20.49021
0.0095	-63.86689	-0.2713058	-0.00013	-68.40861	2.794377	1.747344	4.657294
0.01	-88.16779	-0.2574147	-0.000258	-67.82645	16.66929	-37.01063	27.78216
0.0105	-109.3453	-0.2334209	-0.000375	-64.35368	28.79255	-73.78416	47.98759
0.011	-126.6492	-0.2010576	-0.000475	-58.35524	38.83606	-107.13	64.72676
0.0115	-139.4665	-0.1621822	-0.000557	-50.26439	46.65044	-135.8525	77.75073
0.012	-147.3431	-0.1186623	-0.000616	-40.54555	52.22387	-159.0214	87.03978
0.0125	-150	-0.0722967	-0.000652	-29.66558	55.63874	-175.9732	92.73123
0.013	-147.3431	-0.0247697	-0.000664	-18.07417	57.03235	-186.3013	95.05391
0.0135	-139.4665	0.02236839	-0.000653	-6.192434	56.56576	-189.8398	94.27626
0.014	-126.6492	0.06770425	-0.000619	5.592099	54.40302	-186.6443	90.6717
0.0145	-109.3453	0.10995501	-0.000564	16.92606	50.70092	-176.9723	84.50153
0.015	-88.16779	0.14796158	-0.00049	27.48875	45.60787	-161.2644	76.01312
0.0155	-63.86689	0.18068638	-0.0004	36.99039	39.26976	-140.127	65.4496
0.016	-37.30348	0.2072194	-0.000296	45.17159	31.83963	-114.3147	53.06605
0.0165	-9.418578	0.22679316	-0.000183	51.80485	23.48851	-84.71194	39.14751
0.017	18.79999	0.23880533	-6.37E-05	56.69829	14.41461	-52.31291	24.02435
0.0175	46.35255	0.24284624	5.77E-05	59.70133	4.849082	-18.19787	8.081804
0.018	72.26305	0.2387271	0.000177	60.71156	-4.942961	16.49445	-8.238268



0.0185	95.6136	0.22650502	0.00029	59.68178	-14.6665	50.59832	-24.44417
0.019	115.577	0.20650047	0.000394	56.62625	-24.00545	82.95618	-40.00909
0.0195	131.446	0.17930433	0.000483	51.62512	-32.63537	112.4563	-54.39228
0.02	142.6585	0.14577203	0.000556	44.82608	-40.23876	138.0712	-67.0646
0.0205	148.8172	0.10700409	0.00061	36.44301	-46.52154	158.8957	-77.53589
0.021	149.704	0.06431322	0.000642	26.75102	-51.22904	174.182	-85.38174
0.0215	145.2875	0.0191795	0.000651	16.0783	-54.16046	183.3696	-90.26744
0.022	135.7241	-0.0268042	0.000638	4.794874	-55.18038	186.1096	-91.9673
0.0225	121.3525	-0.0719932	0.000602	-6.701038	-54.22681	182.2804	-90.37802
0.023	102.6821	-0.1147559	0.000545	-17.99829	-51.3153	171.9957	-85.52551
0.0235	80.37402	-0.1535384	0.000468	-28.68898	-46.53896	155.602	-77.56493
0.024	55.21868	-0.1869256	0.000374	-38.38459	-40.06463	133.6679	-66.77438
0.0245	28.1072	-0.213697	0.000268	-46.73139	-32.12566	106.9643	-53.54277
0.025	-1.01E-12	-0.2328735	0.000151	-53.42424	-23.01188	76.43612	-38.35313
0.0255	-28.1072	-0.2437546	2.92E-05	-58.21838	-13.05729	43.16847	-21.76215
0.026	-55.21868	-0.2459433	-9.38E-05	-60.93865	-2.626421	8.346386	-4.377368
0.0265	-80.37402	-0.2393598	-0.000213	-61.48582	7.900167	-26.78837	13.16695
0.027	-102.6821	-0.2242427	-0.000326	-59.83995	18.14051	-60.98263	30.23418
0.0275	-121.3525	-0.2011382	-0.000426	-56.06068	27.72543	-93.0173	46.20904
0.028	-135.7241	-0.1707873	-0.000512	-50.28455	36.31181	-121.7513	60.51969
0.0285	-145.2875	-0.1345495	-0.000579	-42.71959	43.59463	-146.1625	72.65771
0.029	-149.704	-0.0934518	-0.000626	-33.63737	49.31723	-165.3839	82.19539
0.0295	-148.8172	-0.0490519	-0.00065	-23.36295	53.27987	-178.7341	88.79978
0.03	-142.6585	-0.0029302	-0.000652	-12.26297	55.34604	-185.7415	92.2434
0.0305	-131.446	0.04327538	-0.00063	-0.73255	55.44669	-186.1601	92.41115
0.031	-115.577	0.08792714	-0.000586	10.81884	53.58212	-179.9779	89.30353
0.0315	-95.6136	0.12944509	-0.000521	21.98178	49.82154	-167.4169	83.0359
0.032	-72.26305	0.16636213	-0.000438	32.36127	44.30045	-148.9248	73.83408
0.0325	-46.35255	0.19737519	-0.000339	41.59053	37.21567	-125.1588	62.02612
0.033	-18.79999	0.22139062	-0.000229	49.3438	28.81851	-96.9623	48.03086
0.0335	9.418578	0.23756227	-0.00011	55.34765	19.40599	-65.33507	32.34332
0.034	37.30348	0.24532103	1.28E-05	59.39057	9.310512	-31.3976	15.51752
0.0345	63.86689	0.24439468	0.000135	61.33026	-1.111629	3.648264	-1.852715
0.035	88.16779	0.23481745	0.000252	61.09867	-11.49267	38.56179	-19.15445
0.0355	109.3453	0.21692894	0.000361	58.70436	-21.46621	72.10714	-35.77701
0.036	126.6492	0.19136225	0.000457	54.23224	-30.68004	103.097	-51.13339
0.0365	139.4665	0.1590218	0.000536	47.84056	-38.80854	130.4345	-64.6809
0.037	147.3431	0.12105162	0.000597	39.75545	-45.56421	153.1519	-75.94036
0.0375	150	0.07879508	0.000636	30.2629	-50.70784	170.4449	-84.51307
0.038	147.3431	0.03374753	0.000653	19.69877	-54.05706	181.7014	-90.09511
0.0385	139.4665	-0.0124965	0.000647	8.436882	-55.49287	186.5225	-92.48811
0.039	126.6492	-0.0582998	0.000617	-3.124132	-54.96392	184.7372	-91.60653
0.0395	109.3453	-0.1020402	0.000566	-14.57495	-52.48845	176.4087	-87.48076
0.04	88.16779	-0.1421683	0.000495	-25.51004	-48.1537	161.8315	-80.25617
0.0405	63.86689	-0.1772623	0.000407	-35.54206	-42.11282	141.5218	-70.18804
0.041	37.30348	-0.2060786	0.000304	-44.31557	-34.57955	116.1986	-57.63258
0.0415	9.418578	-0.2275957	0.00019	-51.51964	-25.82059	86.7588	-43.03431
0.042	-18.79999	-0.2410509	6.93E-05	-56.89893	-16.14619	54.24513	-26.91031
0.0425	-46.35255	-0.2459668	-5.37E-05	-60.26272	-5.899123	19.80929	-9.831872
0.043	-72.26305	-0.2421689	-0.000175	-61.4917	4.557474	-15.32882	7.59579
0.0435	-95.6136	-0.2297914	-0.00029	-60.54223	14.85301	-49.92438	24.75502
0.044	-115.577	-0.2092726	-0.000394	-57.44785	24.62259	-82.75173	41.03765

v and i vs t



```
#pragma hdrstop
#include <condefs.h>
#include <stdio.h>
#include <math.h>

#define PI 3.14159

//-----
#pragma argsused
int main(int argc, char* argv[])
{
    float i, di, q, v, t=0.0, dt, tfin;
    float R, L, C, f, w, Vmax;
    FILE *fp_in, *fp_out;

    if (( fp_in = fopen("input.txt","r")) == NULL)
    {
        /* File did not exist. Print message */
        printf("\nCould not open the input file\n");
        return 1;
    }

    if (( fp_out = fopen("results.dat","w")) == NULL)
    {
        /* File did not exist. Print message */
        printf("\nCould not open the output file\n");
        return 1;
    }
    fscanf(fp_in, "%f %f %f %f %f %f %f %f %f", &R, &L, &C, &f, &i, &q, &Vmax,
        &tfin, &dt);

    w=2*PI*f;

    v=Vmax*sin(w*t);
    fprintf(fp_out, "time voltage current\n");
    fprintf(fp_out, "%f %f %f\n",t, v, i);

    while (t<tfin)
    {
        v=Vmax*sin(w*t);
        di=(v-i*R-q/C)/L*dt;
        i=i+di;
        q=q+i*dt;
        t=t+dt;
        fprintf(fp_out, "%f %f %f\n",t, v, i);
    }
    fclose(fp_in);
    fclose(fp_out);
    return 0;
}
```

RLC circuit

R := 250.0      L := 0.6      C :=  $3.5 \cdot 10^{-6}$       f := 60.0

tfin := .1      dt := .0001      Vmax := 150      i := 0.0      q := 0.0

Input := (R L C f i q Vmax tfin dt)

Input = (250 0.6  $3.5 \times 10^{-6}$  60 0 0 150 0.1  $1 \times 10^{-4}$ )

Step1

Step 2

Step 3

  
D:\..\input.txt

Run the code

Read :=

  
D:\..\results.dat

Input

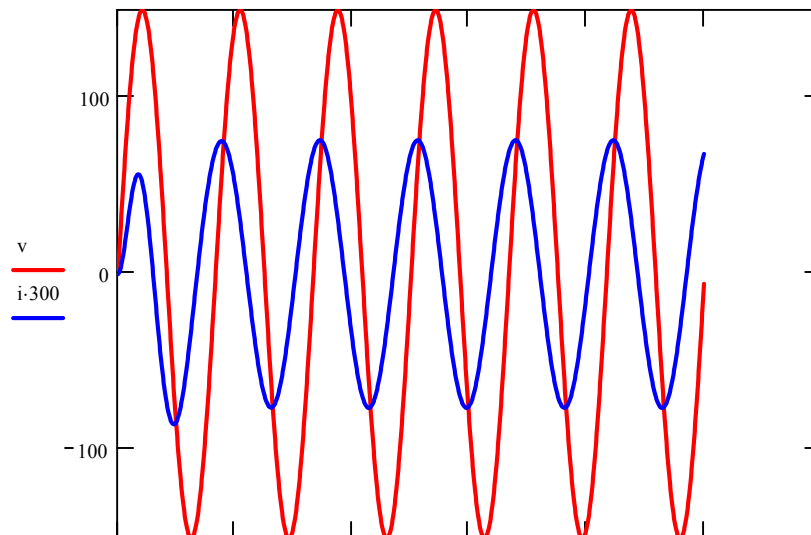
cols(Read) = 3

rows(Read) =  $1.002 \times 10^3$

t := Read<sup>(0)</sup>

i := Read<sup>(2)</sup>

v := Read<sup>(1)</sup>



0 0.02 0.04 0.06 0.08 0.1 0.12  
t

