



8 Pages

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1	Student Number		List the numbers of the questions you have attempted	Office Use
2	Title of Examination Paper	CLASS TEST 1	1	0
			2	0
3	Module Code	PSDE 5008		
4	Date and Time of Examination			
5	Examination Venue			
6	Seat Number			
7	Number of Answer Books handed in			
			Total	0

(Gweler yr ochr arall am y fersiwn Cymraeg)

Please complete this section and SEAL before the examination starts.

Surname Edy EDGELL (Block Capitals) Forename(s) ALEO CHARLES

PATENT PENDING
IN INFORMATION

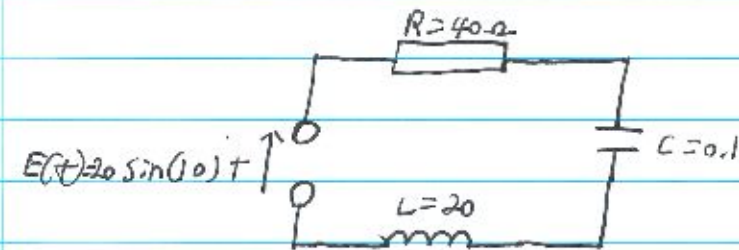
1. Derive the differential equation for an RL Circuit, supplied by a source E which is switched on at $t = 0$, given:

$$R = 40 \Omega, L = 0.5 H, E = 30V \text{ and } I(0) = 0$$

~~to find the current~~

~~when the switch is closed~~

2. By considering Kirchhoff's voltage law, show that the differential equation for the current $I(t)$ in the RLC circuit supplied by a voltage source $E(t)$ switch on at $t=0$



with $I(0) = 0$ and $I'(0) = 0$, is given by

$$I'' + 2I' + 0.5I = 10 \cos(10t)$$

Derivative

~~$$10 \cos(10t) = 10 \sin(10t)$$~~

~~$$I'' + 2I' + 0.5I = 10 \cos(10t)$$~~

~~$$I'' + 2I' + 0.5I = 10 \cos(10t)$$~~

no case on no case

At 4W ~~Ques~~ ~~in~~ ~~the~~ ~~problem~~

$$1 \frac{d^2 I}{dt^2} + 2 \frac{dI}{dt} + 0.5 I = 10 \cos(10t)$$

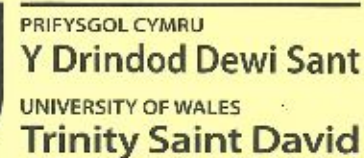
$$I = I_C + I_P$$

I_P is found by substituting $10 \cos(10t)$

$$I_P = (10 \sin(10t) + D) \cos(10t)$$

$\frac{1}{2}$

$\frac{0}{30}$



8 Pages

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List the numbers of the questions you have attempted	Office Use
1	0.
2	1
Total	1

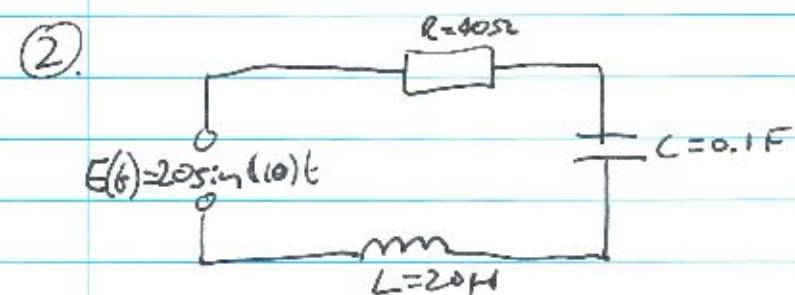
PATENT PENDING

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Surname MILNER (Block Capitals) Forename(s) CHRISTOPHER

(Gweler yr ochr arall am y fersiwn Cymraeg)

① $R = 40\Omega$
 $L = 0.5H$
 $E = 30V$
 $I(0) = 0$



$I(0) = 0$ and $I'(0) = 0$.

$$I'' + 2I' + 0.5I = 10 \cos(10t)$$

$$\frac{d^2 I}{dt^2} + 2 \frac{dI}{dt} + 0.5I = 10 \cos(10t)$$

$$m^2 + 2m + 0.5 = 0$$

$$m = \frac{-2 \pm \sqrt{2^2 - 4(0.5)}}{0}$$

=

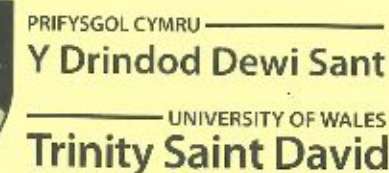
0

1/2

1

1/30

1 1/2 / 30



8 Pages

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6	Seat Number	

7	Number of Answer Books handed in	
---	----------------------------------	--

List the numbers of the questions you have attempted	Office Use
1	20
2	29
Total	49

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Surname INCE (Block Capitals) Forename(s) DANIEL

FOLD → Complete section, remove strip, fold as indicated and SEAL

PATENT PENDING

1. RL $R=40\Omega$, $L=0.5H$ $E=30V$ and $I(0)=0$

$$E=RI + L\frac{dI}{dt} \rightarrow 30 = 40I + 0.5\frac{dI}{dt}$$

rearrange:

$$0.5\frac{dI}{dt} + 40I = 30$$

divide by 0.5:

$$\frac{dI}{dt} + 80I = 60$$

Int. fact: $\int \frac{dI}{dt} \rightarrow \int 80dt \rightarrow 80t$ so e^{80t}

so...

$$Ie^{80t} = \int e^{80t} \times 60 \rightarrow Ie^{80t} = \int 60e^{80t}$$

Int:

$$Ie^{80t} = 0.75e^{80t} + C$$

Insert Boundary cond.: when $I=0$, $t=0$

so...

$$Ie^0 = 0.75e^0 + C \rightarrow C = -0.75$$

so,

$$Ie^{80t} = 0.75e^{80t} - 0.75$$

so...

$$I = 0.75 - 0.75e^{-80t}$$

20/20

2. RLC $R=40$, $L=20$ $C=0.1$ $E=20\sin 10t$
 $I(0)=0$ and $I'(0)=0$

$$E_{(t)} = RI + L \frac{dI}{dt} + \int \frac{1}{C} I dt$$

$$\text{diff: } \frac{dE}{dt} = R \frac{dI}{dt} + L \frac{d^2 I}{dt^2} + \frac{1}{C} I$$

when $E(t) = 20\sin 10t$, $\frac{dE}{dt} = 200\cos 10t$

so, $200\cos 10t = 40 \frac{dI}{dt} + 20 \frac{d^2 I}{dt^2} + 10 I$

Rearrange: $20 \frac{d^2 I}{dt^2} + 40 \frac{dI}{dt} + 10 I = 200\cos 10t$ ✓

sim. $\div 20$: $\frac{d^2 I}{dt^2} + 2 \frac{dI}{dt} + 0.5 I = 10\cos 10t$ ✓

so, $m^2 + 2m + 0.5 = 0$

using Quadratic: $\frac{-2 \pm \sqrt{2^2 - 4(1)(0.5)}}{2(1)}$ $m_1 = -0.293$ ✓
 $m_2 = -1.707$ ✓

Real and different: (case 1)

$$I = I_c + I_p$$

$$I_c = Ae^{-0.293t} + Be^{-1.707t}$$
 ✓

As.. $E = a\cos 10t \rightarrow$ Trial solution = $C\sin 10t + D\cos 10t$

so: $C\sin 10t + D\cos 10t$
 Diff: $10C\cos 10t - 10D\sin 10t$
 Diff2: $-100C\sin 10t - 100D\cos 10t$

Sub into $\frac{d^2 I}{dt^2} + 2 \frac{dI}{dt} + 0.5 I = 10\cos 10t$

$$1[-100C\sin 10t - 100D\cos 10t] + 2[10C\cos 10t - 10D\sin 10t] + 0.5[C\sin 10t + D\cos 10t] = 10\cos 10t$$

Expand:

$$-100C\sin 10t - 100D\cos 10t + 20C\cos 10t - 20D\sin 10t + 0.5C\sin 10t + 0.5D\cos 10t = 10\cos 10t$$

Compare $\sin 10t$ terms:

$$-100C - 20D + 0.5C = 0$$

$$-99.5C - 20D = 0$$

$$-99.5C = 20D$$

$$C = \frac{20D}{-99.5} \quad C = -0.201D$$
 ✓

Compare $\cos 10t$ terms

$$-100D + 20C + 0.5D = 10$$

$$-99.5D + 20C = 10$$

Sub C into $-99.5D + 20C = 10 \rightarrow -99.5D + 20(-0.201D) = 10$
 $\rightarrow -99.5D - 4.02D = 10 \rightarrow -103.52D = 10$

so, $D = \frac{10}{-103.52} \quad D = -0.0966$ ✓

Sub D into $C = -0.201D \rightarrow C = -0.201(-0.0966)$
 $C = 0.0194$

so...

Gen Sol $\Rightarrow I = Ae^{-0.293t} + Be^{-1.707t} + 0.0194\sin 10t + 0.0966\cos 10t$ ✓

Insert Boundary conditions ① $I=0$ when $t=0$

so:

$$0 = Ae^0 + Be^0 + 0 - 0.0966$$

$$0 = A + B - 0.0966$$
 ①

Diff Gen Sol:

$$\frac{dI}{dt} = -0.293Ae^{-0.293t} - 1.707Be^{-1.707t} + 0.194\cos 10t - 0.966\sin 10t$$
 ✓

Insert Boundary conditions ② $I'(0)=0$ so $\frac{dI}{dt}=0$ when $t=0$

so:

$$0 = -0.293Ae^0 - 1.707Be^0 + 0.194 - 0$$

$$0 = -0.293A - 1.707B + 0.194$$
 ✓ ②

simultaneous.

multiply ① by -0.293 :

$$0 = -0.293A - 0.293B + 0.0283$$
 ③

$$0 = -0.293A - 1.707B + 0.194$$

subtract ③ from ②

$$0 = 0 - 1.414B + 0.1657$$

$$-0.1657 = -1.414B$$

$$B = \frac{-0.1657}{-1.414} \quad B = 0.1172$$
 ✓

Sub B into ①:

$$0 = A + 0.1172 - 0.0966$$

$$0 = A + 0.0206$$

$$A = -0.0206$$

so,

$$I = -0.0206e^{-0.293t} + 0.1172e^{-1.101t} + 0.094\sin 10t - 0.0966\cos 10t$$

find the voltage drop, $t=0$

so,

$$I = 0.0206e^0 + 0.1172e^0 + 0 - 0.0966$$

$$I = 4.2 \times 10^{-3} \text{ A}$$

$$V = I \times R$$

$$V = 4.2 \times 10^{-3} \times 40 = \underline{1.648 \text{ V}}$$

$$\frac{29}{30}$$

$$\frac{27}{30}$$



8 Pages

40% ✓

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3	Module Code	PSDE 5008
4	Date and Time of Examination	
5	Examination Venue	
6	Seat Number	
7	Number of Answer Books handed in	

List the numbers of the questions you have attempted	Office Use
1	5
2	15
Total	20

20

Please complete this section and SEAL before the examination starts.

Surname DANIELS Forename(s) IRYSTAN (Block Capitals)

Complete
section,
remove
strip, fold as
indicated
and SEAL

$$1) R = 40\Omega \quad L = 0.5H \quad E = 30V$$

$$I(0) = 0$$

$$E = RI + L \frac{dI}{dt}$$

$$E = L \frac{dI}{dt} + RI$$

$$30 = 0.5 \frac{dI}{dt} + 40I \quad \checkmark$$

divide by 0.5

$$1 \frac{dI}{dt} + 80I = 60 \quad \checkmark$$

5.

$$E = e^{80t} \times 60$$

$$I^* = e^{80t} + 0.75 \quad \times$$

when $I(0) = 0$

$$0 = e^{80 \cdot 0} + 0.75$$

$$0 = e^0 + 0.75$$

$$I^* = 0.75 \quad \times$$

5
20
✓

2

$$E = RI + L \frac{dI}{dt} + \frac{1}{C} \int I dt$$

~~$$20 \sin(10t) = 40I + 20 \frac{dI}{dt} + \frac{1}{0.1} \int I dt$$~~

$$L \frac{d^2 I}{dt^2} + R \frac{dI}{dt} + \frac{1}{C} I = \frac{dE}{dt}$$

$$20 \frac{d^2 I}{dt^2} + 40 \frac{dI}{dt} + 10I = 10 \cos(10t)$$

$$2 \frac{d^2 I}{dt^2} + 4 \frac{dI}{dt} + I = 10 \cos(10t) \checkmark$$

$$2m^2 + 4m + 1 = 0$$

$$\frac{-4 \pm \sqrt{4^2 - 4(2)(1)}}{2(2)}$$

$$= \frac{-4 \pm \sqrt{8}}{4}$$

$$= -0.293 \text{ or } -1.707 \checkmark$$

= real + different

$$y = Ae^{m_1 x} + Be^{m_2 x}$$

$$= Ae^{-0.293t} + Be^{-1.707t} \checkmark$$

$$= Ae^{-0.293 \times 0} + Be^{-1.707 \times 0}$$

Trial Solution:-

$$C \sin 10t + D \cos 10t$$

$$\frac{dI}{dt} = 10 \cos 10t - 10 \sin 10t \checkmark$$

$$\frac{d^2 I}{dt^2} = -100(\sin 10t + \cos 10t) \checkmark$$

$$\begin{aligned} & 2(-100(\sin 10t + \cos 10t)) + 4(10(\cos 10t - \sin 10t)) \\ & + 1(C \sin 10t + D \cos 10t) \end{aligned}$$

4 ✓

2 ✓

2

1
2

2

X

2 continued.

$$-200\sin^{10t} - 200D\cos^{10t} + 40C\cos^{10t} - 40D\sin^{10t} + 1C\sin^{10t} - 1D\cos^{10t}$$

Sin:-

$$-200C - 40D + 1C = 0$$

$$-199C - 40D = 0$$

$$-199C = 40D$$

$$C = \frac{40D}{-199}$$

$$C = -0.201D$$

cos:-

$$-200D + 40C - 1D = 0$$

$$-201D + 40C = 0$$

$$-201D + 40(-0.201D) = 0$$

$$-201D - 8.04D = 0$$

$$-209.04D = 0$$

$$D = 209.04$$

$$C = -0.201(209.04)$$

$$C = -42.017$$

$$C = -42.017$$

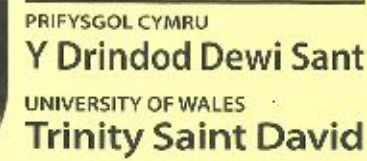
$$D = 209.04$$

$$= Ae^{-0.293t} + Be^{-1.707t} \cos^{209.04} + \sin^{-42.017}$$

-8361.6

X

15/30 ✓



8 Pages

48% ✓

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3	Module Code	ASDE5008		
4	Date and Time of Examination			
5	Examination Venue			
6	Seat Number			
7	Number of Answer Books handed in			
			Total	24

Please complete this section and SEAL before the examination starts.

Surname Davies (Block Capitals) Forename(s) Declan Lee

Complete
section,
remove
strip, fold as
indicated
and SEAL.

PATENT PENDING
 INFOSAFE®

$$1. R = 40 \Omega \quad L = 0.5 \text{ H} \quad E = 30 \text{ V} \quad \text{and } I(0) = 0$$

$$E(t) = RI + L \frac{dI}{dt} \quad \checkmark$$

$$30 = 40I + 0.5 \frac{dI}{dt} \quad \checkmark$$

rearrange to get $\frac{dI}{dt}$ on the left

$$0.5 \frac{dI}{dt} + 40I = 30 \quad \checkmark$$

get $\frac{dI}{dt}$ equal to zero (divide everything by 0.5)

$$\frac{dI}{dt} + 80I = 60 \quad \checkmark$$

$$\int P dx = \int e^{80t} = 60 \quad ?$$

$$Ie^{80t} = \int e^{80t} \cdot 60 \quad \checkmark$$

$$Ie^{80t} = \int 1.3 e^{80t} \quad \times$$

$$Ie^{80t} = 1.3 e^{80t} + C$$

When $I = 0$ and $t = 0$

$$0 = 1.3 e^{0t} + C$$

$$1.3 = C \quad \times$$

$$Ie^{80t} = 1.3 e^{80t} + 1.3$$

$$Ie = 1.3 + 1.3 e^{80t} \quad \times$$

$$\frac{8}{20} \quad \checkmark$$

2. $R = 40$ $E(t) = 20 \sin(10t)$ $L = 20$ $C = 0.1$

$$E = RI + L \frac{di}{dt} + \frac{1}{C} \int i dt$$

$$E = L \frac{d^2 i}{dt^2} + R \frac{di}{dt} + \frac{1}{C} i$$

in series values

$$20 \sin 10t = 20 \frac{di}{dt} + 40i + \frac{1}{0.1} i$$

differentiate E

$$20 \sin 10t = 200 \cos 10t$$

auxiliary equation

$$20m^2 + 40m + 10 = 0$$

use quadratic equation

$$m = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$= \frac{-40 \pm \sqrt{40^2 - 4(20)(10)}}{2(20)}$$

$$= \frac{-40 \pm \sqrt{800}}{40}$$

$$= -0.293 \text{ or } -1.707 \text{ (real and different)}$$

$$C.F = Ae^{-0.293t} + Be^{-1.707t}$$

Next need to find the PI

$$\text{Trial solution} = C \sin Kx + D \cos Kx$$

$$\text{Sub value in} = C \sin 10t + D \cos 10t$$

$$\text{differentiate} = 10C \cos 10t + 10D \sin 10t$$

$$\text{differentiate again} = -100C \sin 10t - 100D \cos 10t$$

$$\text{Substitute into } 20 \frac{di}{dt} + 40i + \frac{1}{0.1} i = 200 \cos 10t$$

$$20[-100C \sin 10t - 100D \cos 10t] + 40[C \sin 10t + D \cos 10t] = 200 \cos 10t$$

~~Compare sin 10t~~ Multiply out of the brackets

$$-2000C \sin 10t - 2000D \cos 10t + 40C \sin 10t + 40D \cos 10t = 200 \cos 10t$$

Compare sin 10t

$$-2000C - 400D + 10C = 0$$

$$-1990C - 400D = 0 \quad (1)$$

Compare cos 10t

$$-2000D + 400C + 10D = 200$$

$$-1990D + 400C = 200 \quad (2)$$

Calculate value C in terms of D

$$-1990C - 400D = 0$$

$$-1990C = 400D$$

$$C = \frac{400D}{1990}$$

$$C = 0.201D$$

Sub value of C into (2)

$$-1990D + 400C = 200$$

$$-1990D + 400(0.201D) = 200$$

$$-1990D + 80.4D = 200$$

$$-1909.6D = 200$$

$$D = \frac{200}{1909.6}$$

$$= 0.1045$$

$$= 0.1045$$

Sub value of D to get C

$$C = 0.201D$$

$$C = 0.201(0.1045)$$

$$C = 0.021$$

$$I_p = 0.021 \sin 10t + 0.1045 \cos 10t$$

general solution is :-

$$g_s = Ae^{-0.293t} + Be^{-1.707t} + 0.021 \sin 10t + 0.1045 \cos 10t$$

$$\text{At } t=0, I=0$$

$$0 = Ae^0 + Be^0 + 0.10255$$

$$0 = A + B + 0.10255 \quad (3)$$

differentiate g_s

$$0 = -0.293Ae^{-0.293t} - 1.707Be^{-1.707t} + 0.21 \cos 10t - 1.0455 \sin 10t$$

Simplify

$$0 = -0.293A - 1.707B - 0.835 \quad (4)$$

Simplify

Simultaneous equation (3) and (4)

$$0 = A + B + 0.10255$$

$$0 = -0.293A - 1.707B - 0.835$$

get A equal same multiply by 0.293

$$0 = 0.293A + 0.293B + 0.03$$

$$0 = -0.293A - 1.707B - 0.835$$

$$0 = A - 1.414B - 0.805$$

0.

16/30



PRIFYSGOL CYMRU
Y Drindod Dewi Sant
UNIVERSITY OF WALES
Trinity Saint David

Examination Answer Book

8 Pages

Instructions to candidates

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List the numbers of the questions you have attempted	Office Use
①	15.
②	7
Total	22

Please complete this section and SEAL before the examination starts.

PHILIP

(First Name) Forename(s)

Surname
Rowe

PATENT PENDING

$$\textcircled{1} \quad R = 40 \Omega \quad L = 0.5 \text{ H} \quad E = 30 \text{ V} \quad I(0) = 0$$

$$E = RI + L \frac{di}{dt}$$

$$E = E_R + E_L$$

$$E = RI + L \frac{di}{dt}$$

$$0.5 \frac{di}{dt}$$

$$L \frac{di}{dt} + RI + E$$

$$L \frac{di}{dt} + RI + E$$

$$0.5 \frac{di}{dt} + 40I + 30$$

$$\div 0.5$$

$$\frac{di}{dt} + 80I + 60 = 0$$

$$am^2 + bm + c = 0$$

$$m = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$m = \frac{-80 \pm \sqrt{80^2 - 4(1)(60)}}{2} = \frac{-80 \pm \sqrt{6400 - 240}}{2}$$

$$= -40 \text{ or } 3080 \text{ rad/sec}$$

$$y = Ae^{-15t} + Be^{3080t}$$

Start

9/13

① $R = 40 \Omega$ $L = 0.5 H$ $E = 30 V$ $I(0) = 0$

$$E = E_R + E_L$$

$$L \frac{di}{dt} + RI + E = 0$$

$$0.5 \frac{di}{dt} + 40I + 30 = 0$$

$$\div 0.5$$

$$\frac{di}{dt} + 80I + 60 = 0$$

$$am^2 + bm + c = 0$$

$$(m + 15)(m + 4)$$

$$y = Ae^{m_1 x} + Be^{m_2 x}$$

$$y = Ae^{-15t} + Be^{-4t}$$

$$I(0) = 0$$

$$0 = Ae^0 + Be^0$$

$$0 = A + B$$

Start

$$\textcircled{2} \quad R = 40 \, \Omega \quad C = 0.1 \quad L = 20 \quad E(t) = 20 \sin(10)t$$

$$E = E_R + E_L + E_C$$

$$E = RI + L \frac{di}{dt} + \frac{1}{C} \int I dt \quad \checkmark$$

$$\frac{d^2 i}{dt^2} + R \frac{di}{dt} + \frac{1}{C} I = 20 \sin(10)t$$

$$\frac{di}{dt} = 200 \cos 10t \quad \checkmark$$

$$20 \frac{d^2 I}{dt^2} + 40 \frac{di}{dt} + 10 I = 200 \cos 10t \quad \checkmark$$

$$m = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$m = \frac{-40 \pm \sqrt{40^2 - 4(20)(10)}}{40}$$

$$m = \frac{-40 \pm \sqrt{1600 - 800}}{40} \quad \checkmark$$

-1 or 20
real + differe $\times$

$$y = Ae^{m_1 x} + Be^{m_2 x}$$

$$y = Ae^{-1x} + Be^{20x}$$

$$I = \cancel{20 \sin 10t} + \cancel{200 \cos 20t}$$

$$\frac{dI}{dt} = \cancel{-10 \cos 10t} + \cancel{4000 \sin 20t}$$

$$\frac{d^2 I}{dt^2} = \cancel{10 \sin 10t} + \cancel{8000 \cos 20t}$$

$$20 \frac{d^2 I}{dt^2} + 40 \frac{dI}{dt} + 10I = 200 \cos 10t$$

$$I = \underline{20 \sin 10t} + \underline{200 \cos 10t}$$

$$\frac{dI}{dt} = 200 \cos 10t - 2000 \sin 10t$$

$$\frac{d^2 I}{dt^2} = -2000 \sin 10t - 20000 \cos 10t$$

$$20 [-2000 \sin 10t - 20000 \cos 10t] + 40 [200 \cos 10t - 2000 \sin 10t] + 10 [20 \sin 10t + 200 \cos 10t] = 200 \cos 10t$$

Compare $\sin 10t$

$$-2000C - 2000D + 20C = 0$$

$$-1980C - 2000D = 0$$

$$-1980C = 2000D$$

$$C = \frac{2000D}{-1980}$$

$$C = -1.01D \quad \textcircled{1}$$

Compare $\cos 10t$

$$-20000D + 200C + 200D = 200C$$

$$-19800D + 200C = 200C$$

$$-19800D = 0$$

$$-19800(-1.01) = 0$$

$$19998 = 0 \quad \textcircled{2}$$

Sub $\textcircled{2}$ in $\textcircled{1}$

$$D = -1.01(19998)$$

$$C = 2017.9 \quad \times$$

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$$\textcircled{1} \quad R = 40 \, \Omega \quad L = 0.5 \text{ H} \quad E = 40 \quad I(0) = 0$$

$$E = E_R + E_L$$

$$L \frac{di}{dt} + RI + E = 0$$

$$0.5 \frac{di}{dt} + 40I + 40 = 0 \quad \checkmark$$

$$\div 0.5$$

$$\frac{di}{dt} + 80I + 80 = 0 \quad ?$$

$$\int 80 dt = 80t = 80t \quad \checkmark$$

$$I F = e^{80t} \quad \checkmark$$

$$I e^{80t} = e^{80t} \cdot 60$$

$$I e^{80t} = 0.75 e^{80t} + C$$

$$I(0) = 0$$

$$0 = 0.75 e^0 + C$$

$$0 = 0.75 + C$$

$$-0.75 = C \quad \checkmark$$

$$\therefore I e^{80t} (-0.75t) \quad \times$$

$$\frac{15}{20}$$