(17) 00092

# The Open University of Sri Lanka
# Faculty of Engineering Technology
# Department of Mechanical Engineering

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|---|---|
| Study Programme | : Bachelor of Technology Honours in Engineering |
| Name of the Examination | : Final Examination |
| **Course Code and Title** | **:DMX5570/MEX5270-Power electronics and motor drives** |
| Academic Year | : 2017/18 |
| Date | :12th February 2019 |
| Time | : 13:30 – 16:30 hrs |
| Duration | : **3 hours** |

**General Instructions**

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Seven (7)** questions in **Seven (7)** pages.
3. Answer **five (05)** question only.
4. Answer for each question should commence from a new page.
6. This is a Closed Book Test (CBT).
7. Answers should be in clear hand writing.
8. Do not use Red colour pen.

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Q1

(a) Power electronics system consists of input, output, processor, controller and load. Draw the block diagram and explain the function of each block. [Marks 5]

(b) List two applications in each of power electronics in utility, domestic and industrial. [Marks 6]

(c) Draw the symbol of power electronic components listed in Table Q1. [Marks 9]

| |
|---|
| Diode |
| Thyristor |
| GTO |
| MCT |
| Triac |
| IGBT |

Table Q1

Q2

(a) Give the definition of the following power converters and draw their general block diagrams.

i. Rectifier
ii. Chopper
iii. Inverter

[Marks 6]

(b) Explain the advantages of Schottky diode in terms of recovery time as compared to standard diode and fast recovery diode. [Marks 5]

(c) Draw a typical V-1 characteristics of a thyristor and briefly explain the following parameters.

i. Holding current
ii. Latching current
iii. The effects of gate current on forwards breakover voltage [Marks 9]

**Q3.**

(a) Find the average and effective values, $V_{1,avg}$ and, $V_{1,rms}$ of the periodic waveform $v_1(t)$ shown in figure Q3a.

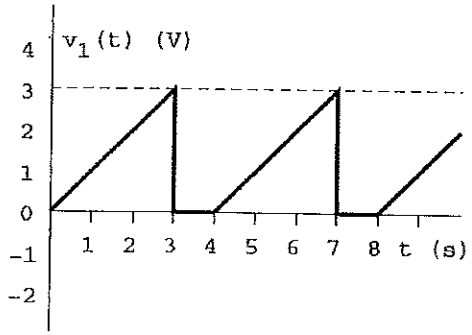



Figure Q3a

[10 marks]

(b) Find the average and effective values, , $V_{2,avg}$ and, $V_{2,rms}$ of the periodic waveform $v_2(t)$ shown in figure Q3b.

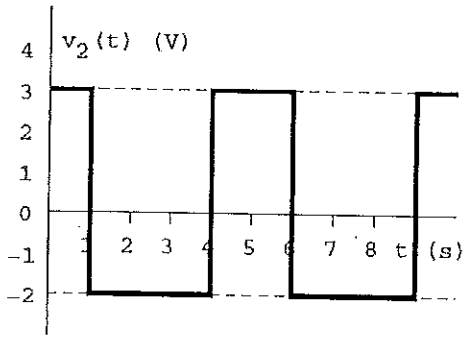



Figure Q3b

[10 marks]

**Q4**

The dc/dc converter is shown in Figure Q4 takes in an input voltage $V_1$, and generates an output current $I_2$. Derive an averaged model for this converter in continuous conduction under duty ratio control. You may derive such a model by either direct circuit averaging or by state space averaging, but you should express your results as a pair of state-space equations in terms of the local averages of state variables $i_L$ and $v_C$.

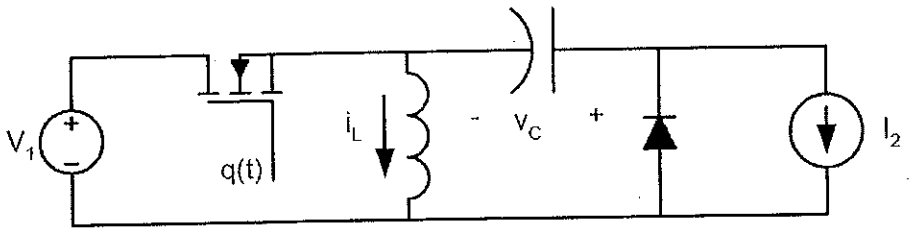



Figure Q4

[Marks 20]

**Q5**

The circuit shown in figure Q5 is a boost converter. This converter has an output voltage $V_o$ is 25v operated with the following MOSFET duty cycle and PWM switching frequency:

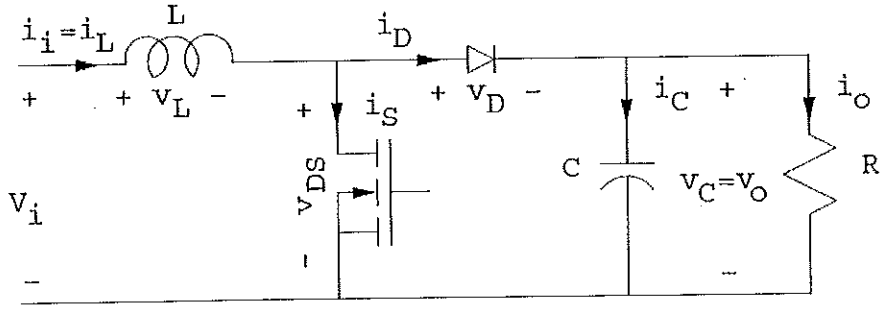



Figure Q5

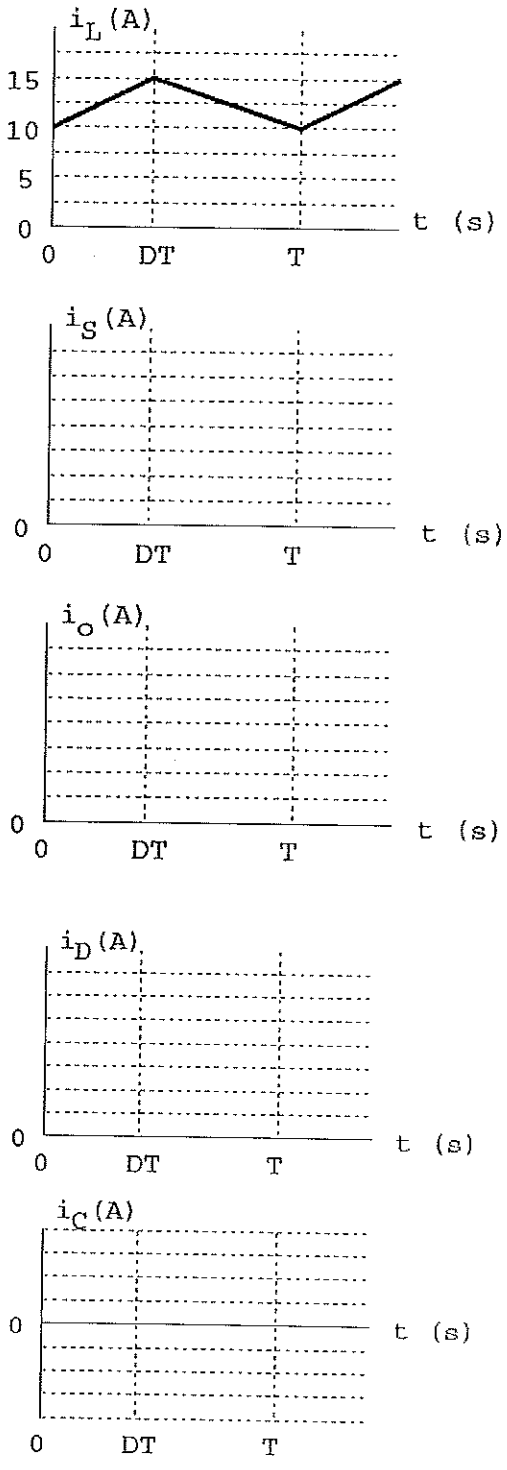
D=36%
F=25kHz

(a) Given the sketch of the inductor current $i_L(t)$ in figure Q5A(on page 06), sketch the waveforms for the MOSFET current $i_S(t)$, the output current $i_o(t)$ (assume that all of the ripple current is absorbed by the capacitor), the diode current $i_D(t)$, and the capacitor current $i_C(t)$. **(Note : draw relevant wave forms graph sheet given on page 06 (graph Q5) and attached it to answer script )**

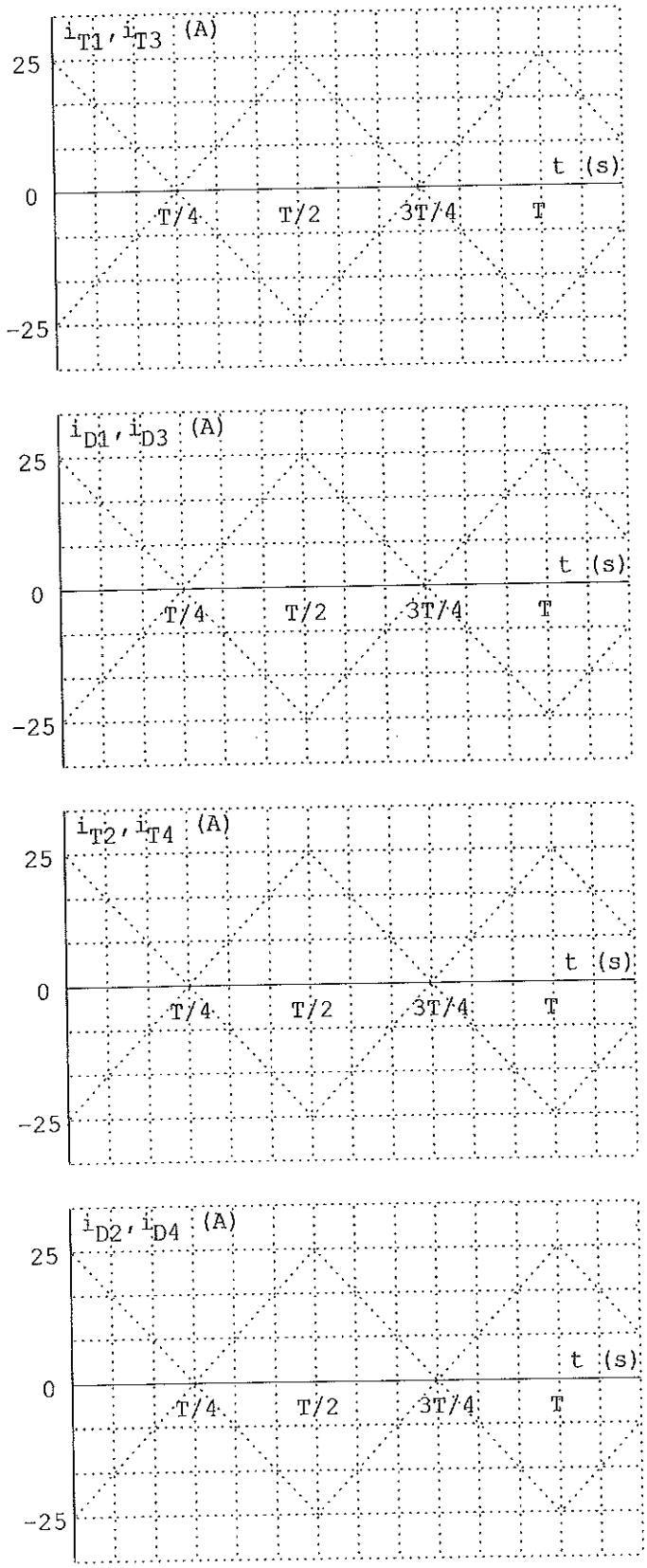
[Marks 10]

(b) Determine the pertinent average, rms, and peak values of the corresponding currents ($i_L(t)$, $is(t)$, $i_o(t)$ , $i_D(t)$ *and* $i_C(t)$.).

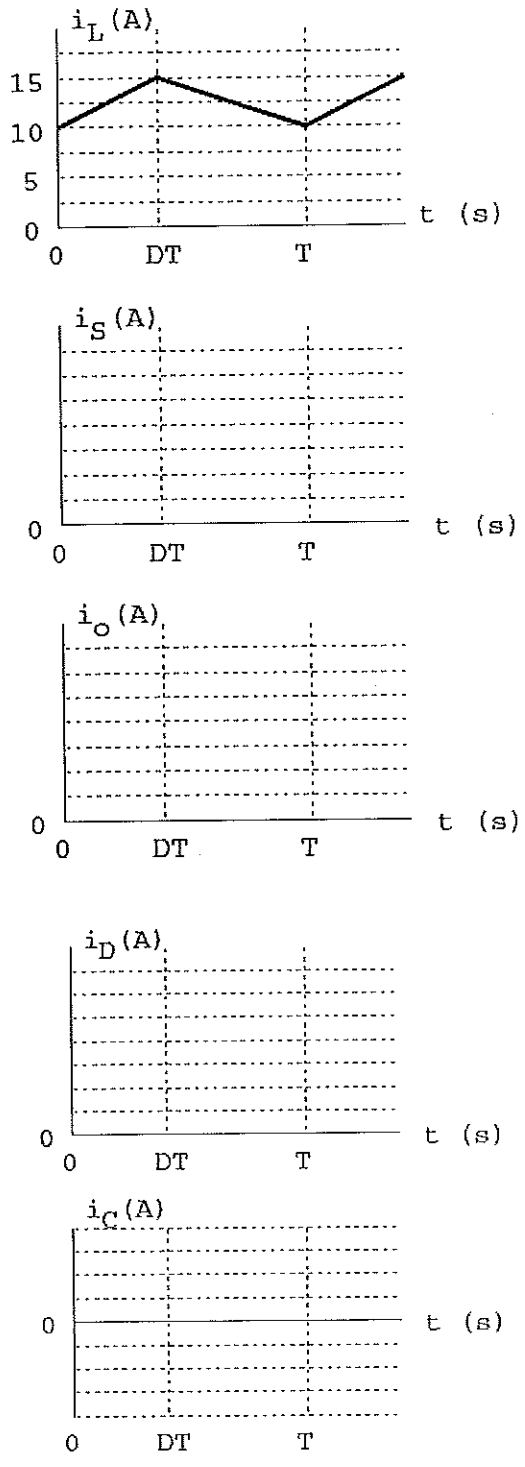
[Marks 10]


$i_L$ (A)
15
10
5
0
0
DT
T
t (s)
$i_S$ (A)
0
0
DT
T
t (s)
$i_o$ (A)
0
0
DT
T
t (s)
$i_D$ (A)
0
0
DT
T
t (s)
$i_C$ (A)
0
0
DT
T
t (s)

Graph Q5


$i_{T1}, i_{T3}$ (A)
25
0
-25
t (s)
T/4
T/2
3T/4
T
$i_{D1}, i_{D3}$ (A)
25
0
-25
t (s)
T/4
T/2
3T/4
T
$i_{T2}, i_{T4}$ (A)
25
0
-25
t (s)
T/4
T/2
3T/4
T
$i_{D2}, i_{D4}$ (A)
25
0
-25
t (s)
T/4
T/2
3T/4
T

Graph Q7


$i_L$ (A)
15
10
5
0
0
DT
T
t (s)
$i_S$ (A)
0
0
DT
T
t (s)
$i_o$ (A)
0
0
DT
T
t (s)
$i_D$ (A)
0
0
DT
T
t (s)
$i_C$ (A)
0
0
DT
T
t (s)

Graph Q5