EE/KSSK/MON/27022023/T

Name:...Parvati.....
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DEPARTMENT OF ELECTRCAL ENGINEERING
MID-TERM TEST-WINTER SEMESTER 2022-23
EE6308D SWITCHED MODE & RESONANT CONVERTERS

Time: Two Hours **Maximum: 30 Marks**

*Answer **ALL** questions*

1. An Ideal Buck Converter runs from 120V DC Supply at a duty ratio of 0.4 at 50kHz and uses L = 576 µH and C = 10µF (Poly propelene non-polarised capacitor). (a) ***Find*** the output voltage, peak to peak ripple in inductor current and peak to peak ripple in output voltage if the output load is drawing a current of 5A DC. (b) ***Plot*** switch current, switch voltage, diode current, diode voltage, inductor voltage, inductor current, capacitor current and output voltage with d = 0.4 and I_o = 5A and mark all salient values and time intervals. (c) ***Find*** output voltage (after deriving the expression for it) if load current is reduced to 0.2A while duty ratio is maintained at 0.4. (4 Marks)

2. Mr. Zed designed a Boost Converter V_{in} = 12V, d = 0.75, f_s = 50kHz, L = 60µH, C=1000µF, CxESR = 30µs. The capacitor he had connected at the output has a voltage rating of 150V and the diode and switch he used has voltage rating of 100V. He wants to test the converter on open loop with d = 0.1. *(a) **Explain** why Zed ended up with a blown switch & diode when he tested the Converter on no load with d = 0.1? (b) **What is the** maximum value of resistive load he can have across the output? **Explain** your calculation.* (3 Marks)

3. In your capacity as a Design Engineer, you instructed your Technical Assistant to construct a 12V to 120VDC Converter to deliver a constant current source kind of load of 1A value. You did not tell her which topology to use. She designed a Boost DC-DC Converter and tested it to find that she is not able to get the required 120V at the output. She varied the duty ratio in the entire range of 0 to 1 and found that the maximum output voltage she could get is about 60V. *She wants to know what she did wrong. **Explain** it to her with supporting derivations and graphs.* (4 Marks)

4. A Buck Converter for 36V/5V, 10A was designed with a 60V, 25A, 40mΩ MOSFET. When this MOSFET was out of stock, it was substituted with a 300V, 75A, 20mΩ MOSFET with no other change made in the circuit board and heat sink. *The new MOSFET was found to run hotter than the old MOSFET despite the new MOSFET being a significantly over-rated one. **Explain** the possible reason/s for this with supporting arguments and expressions. **Also, suggest** a possible solution.* (2 Marks)

5. A 12 V input / 48 V Output Boost Converter is delivering a 4A load at its output. It uses an inductor of value 60 µH and switches at 50 kHz. Neglect switch drop, diode drop and resistance drops. The power MOSFET used follows square law and its saturation current at V_{GS} = 7.5 V is

48A and it has a threshold voltage of 3.5 V. It is driven by a Gate-Source voltage of 12V through a 47Ω resistance. C_{iss1} = 2000pF, C_{iss2} = 1300pF, C_{rss1} = 600pF, C_{rss2} = 200pF, C_{oss1} = 1200pF and C_{oss2} = 400pF for the MOSFET. The diode used has a minority carrier storage that is proportional to forward current and has a value of 0.8 μC when carrying 1 A forward current. Assume that parasitic inductances are negligible.

(a) ***Calculate*** the total switch-on time and switch-off time of MOSFET. ***Show*** *the relevant waveforms and calculations.* (4 Marks)

(b) ***Find*** the switching power loss in the MOSFET. (2 Marks)

6. ***Explain*** the effect of RCD Snubber and L-Snubber on switching loci, switching losses and total converter losses in a Buck Converter. ***Explain*** why when L-Snubber is used, a RC/RCD Snubber has to be used along with it. (3 Marks)

7. (a) ***Explain*** the function of tertiary winding in Forward Converter clearly. (1 Mark)
(b) Miss. X and Mr. W made one Forward Converter each; running from 240V input has primary winding self inductance of 2mH. The tertiary winding has same number of turns as that of primary and is tightly coupled with primary. The primary to secondary turns ratio is 8. The converter is switched at 35% duty ratio at 50kHz. The load taken from output is 5A DC. But Miss. X wound her transformer very carefully and achieved a coupling coefficient of 0.985 between primary and secondary whereas Mr. W who was not very good with his hands could achieve only 0.975. *(i)* ***Whose*** *Converter will generate higher output voltage and* ***why****? (ii)* ***What*** *will be difference between the output voltages in the two converters?* ***Derive*** *the expressions you use.* (3 Marks)

8. In a particular design of a 100V/12V, 100W Push-Pull DC-DC Converter, the switch transistors are mounted on separate heat sinks. Two 200V, 5A, 0.2Ω MOSFETs were used as switches in the original design. One of them went damaged and your Technical Assistant wants to know whether she can replace it by a 200V, 20A, 0.05Ω MOSFET since a 200V, 5A unit is not available. She feels that since it is a MOSFET with higher current rating there should not be any problem. She suggests that any possible difference in switching loss can be handled by adjusting the gate driver resistance.
(a) ***Explain*** to her why this is not a good idea from *the point of view of flux walking* and why replacing both old MOSFETs with 200V, 20A units will be a better idea. (2 Marks)
(b) After she understood why, she tells you that there is only one 200V 20A MOSFET available. Then you instructed her to put a high wattage resistor in series with this 200V, 20A MOSFET. ***What*** *should be the value and wattage of this resistor and* ***where*** *should she put it – in series with Drain or in series with Source?* ***Explain.*** (2 Marks)

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