EE/KSSK/FRI/20032021/T1 **Name:…….....**
Roll No:…….....

DEPARTMENT OF ELECTRCAL ENGINEERING
National Institute of Technology Calicut

FIRST TEST-WINTER SEMESTER 2020-21

EE6308DSWITCHED MODE & RESONANT CONVERTERS

Time: Two Hours Maximum: 20 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. (3 Marks)

2. A Boost Converter has V_{in} = 12V, d = 0.75, f_s = 50kHz, L = 60µH, C=1000µF, CxESR = 30µs The switch ON resistance is 30mΩ, Inductor series resistance is 20mΩ, diode cut-in voltage is 0.5V and diode forward resistance is 30mΩ. Calculate the output voltage when delivering 4A DC at output accounting for the resistances and diode cut-in voltage. Derive the expression you use from basic principles. (2 Marks)

3. 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 suggest a possible solution. (1 ½ Marks)

4. A 48 V input / 12 V Output Buck Converter is delivering a 10A load at its output. It uses an inductor of value 100 µH and switches at 20 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 1.2µC when carrying 1 A forward current. Assume that parasitic inductances are negligible. (a) Calculate the switching delays in the voltage across the diode. (b)Find the switching power loss in the MOSFET. ***Show the relevant waveforms and calculations.*** (6 Marks)

5. 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)

6. (a) Explain why duty ratio of a forward converter should be kept below 0.5. (1 Mark)

(b) A Forward Converter, running from 240V input has primary winding self inductance of 2mH and coupling coefficient between primary and secondary is 0.985. 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. The load taken from output is 5A DC. Find out (i) the output voltage accounting for leakage inductance and (ii) the time interval during which the two output diodes conduct simultaneously when the switch on primary side is switched ON. Derive the expressions you use. (2 Marks)

7. In a particular design of a 200V/12V, 100W Push-Pull Converter, the two identical transistors are mounted on physically separate heat sinks. When the converter is on minimum load, it is found that one transistor works with a case temperature of $32^{o}C$ and the other with $50^{0}C$ with room temperature at 28^{o} C. Explain the possible reasons for this and suggest solutions to alleviate the problem. (1 ½ marks)