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MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

VII SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, NOVEMBER 2017

SUBJECT: MODERN POWER CONVERTERS [ELE 4010]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 23 November 2017** **Max. Marks: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A. The inductor current for a boost converter working under discontinuous conduction mode is shown in Fig.1A. The DC input voltage to the converter is 20V. Determine (a) Output Voltage (b) Load Resistance (c) Filter inductor (d) Sketch the waveforms of diode current and capacitor current.

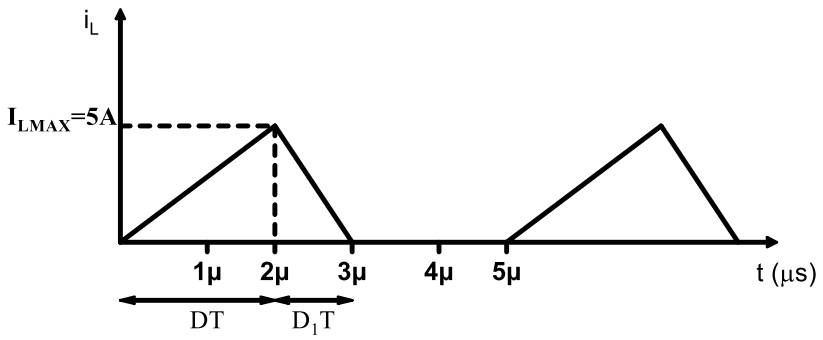

Fig.1A ***(04)***

1B. A non-ideal buck converter is modeled by including a switch voltage drop V_{SW}, an inductor resistance r_L and a diode voltage drop V_D.

(a) Derive the expression for V_O/V_{IN} that includes the above effects.

(b) Find Duty cycle and Efficiency. (Given specifications: V_{IN}=50V, V_O=20V, R_O=4Ω, V_{SW}=0.4V, r_L=0.06 Ω, V_D=0.9V.) ***(06)***

2A. Design a Cuk converter for the following specifications: V_s=45V, V_O=-15V, P_O=25W, fs=150kHz.

(a) Maximum inductor ripple currents should not exceed 10% of its average value.

(b) Maximum voltage ripple across C_1 should not exceed 5% of its average value.

(c) Maximum output voltage ripple is less than 1%. ***(05)***

2B. State the advantages and disadvantages of each isolated converter topologies. ***(05)***

3A. With a neat circuit diagram of a Flyback converter(operating in continuous conduction mode),

(a) Derive the expression for the voltage gain, magnetizing inductance L_M and filter capacitor.

(b) Sketch the waveforms of the magnetizing current, input current, diode current and the capacitor current. ***(06)***

3B. A forward converter operates from a dc voltage source varying from 190V to 245V. V_O=12V, I_O=10A, f_S=100kHz, N_1/N_2=4, N_1/N_3=1.

(a) Determine the range of duty cycle needed to maintain the constant output voltage.

(b) Find the inductor value to maintain continuous conduction. Given: I_{LMIN}=8.5A.

(c) Verify that the magnetizing current is reset to zero during each switching period. ***(04)***

4A. Consider a PLR dc- dc converter working in discontinuous conduction mode ($\omega_s < \frac{\omega o}{2}$).

(a) Draw the circuit diagram and the equivalent circuit.

(b) Sketch the waveforms of inductor current and capacitor voltage. Clearly mark the devices conducting in each interval.

(c) Show the changes in the equivalent circuit during the various intervals. ***(04)***

4B. Consider the resonant capacitor voltage and inductor current waveforms shown in Fig.4B for a ZVS buck converter. Determine Lr, Cr, t_2, t_3, V_O and $i_L(t_2)$.

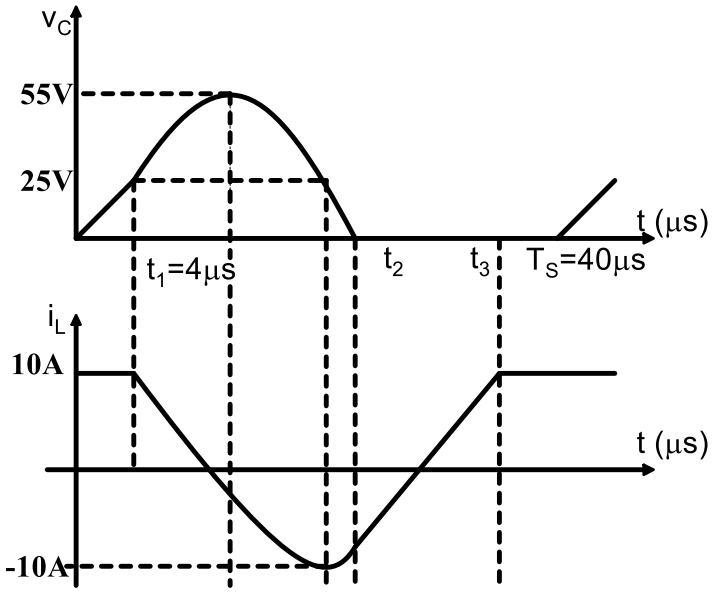

Fig.4B ***(06)***

5A. A ZCS buck converter has the following data: V_S=25V, I_O=1A, Lr=4μH, Cr=0.16μF. Determine time interval for each mode. ***(04)***

5B. Obtain the small signal model of buck converter using state space averaging technique. ***(06)***