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MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent Institution of MAHE, Manipal)

VII SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)
END SEMESTER EXAMINATIONS, NOVEMBER 2018
SUBJECT: MODERN POWER CONVETERS [ELE4010]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 24, November 2018** **Max. Marks: 50**

Instructions to Candidates:

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

1A. Derive a dc transformer model of a non-ideal Buck converter with an inductor having a winding resistance of R_L. Ignore all other sources of losses. ***(03)***

1B. It is desired that the non-ideal buck converter (with inductor resistance R_L) operates with at least 70% efficiency when the input voltage is 5V and the output is 1V at 1A. Ignore all other losses.

(i) At what duty cycle will the converter operate then?

(ii) How large can the inductor winding resistance be? ***(02)***

1C. A non-ideal boost converter has inductor winding resistance R_L, MOSFET on state resistance Ron, and the diode forward voltage drop V_D. All other losses can be ignored.

(i) Derive a dc transformer model of the converter.

(ii) Derive an expression to find the non-ideal voltage conversion ration V_O/V_S. ***(05)***

2A. Draw the circuit schematic of a SEPIC converter and derive an expression for output voltage Vo. (Apply inductor volt sec balance and capacitor charge sec balance.) ***(02)***

2B. A SEPIC converter has the following values

Input voltage Vs =48V

Output voltage Vo= 12V

Switching frequency fs =100KHz

Load resistance R=6Ω

Select values of L_1, L_2 and C_1 such that (i) the input peak current ripple $\mathbf{\Delta i_{L1}}$ = 20mA and $\mathbf{\Delta i_{L2}}$= 25mA (ii) peak voltage ripple on C_1, $\mathbf{\Delta v_{C1}}$ is 2% of the dc component V_{C1}. ***(03)***

2C. Draw the circuit schematic of a CUK converter and derive the expressions for output voltage Vo, inductors L_1 and L_2, Capacitors C_1 and C_2. (Apply inductor volt-sec balance and capacitor charge sec balance) ***(05)***

3A. Design a Flyback converter in continuous conduction mode for the following specifications: Vs= 165V, Vo= 15V, I_O=5A, fs =100kHz. Specified duty ratio is 0.42. Determine the (i) turns ratio (ii) Magnetizing inductance Lm and (iii) Filter capacitor. (Assume current ripple of 40% and output voltage ripple of 2%.) ***(04)***

3B. Calculate the filter inductor and capacitor values for Forward converter operating from a dc input of Vs= 325V, Vo= 10V±0.1V, I_O=20A, fs =100kHz. The transistor duty cycle D=0.4. Determine the numerical values of turns ratio N_3/N_1 and N_2/N_1.

(Assume continuous conduction mode and current ripple to be 40% of the average value). ***(04)***

3C. Draw the circuit schematic of Full bridge dc dc converter. Also sketch
(i) Gate pulses of the switches (ii) inductor voltage and inductor current ***(02)***

4A. Make a comparison between the isolated topologies of the dc dc converter ***(03)***

4B. A Series resonant Half bridge dc dc converter has the following specifications: dc input of Vs=550V, Lr=30μH, Cr=0.3μF, Ro=8Ω. The switching frequency fs= 150kHz. Determine output voltage V_0. ***(03)***

4C. Draw the circuit schematic of a Parallel resonant Half bridge dc dc converter. Sketch the waveforms of the inductor current and capacitor voltage in the tank circuit for discontinuous conduction mode. Show the devices conducting current for each subinterval. Also mention the type of switching for all the four devices. ***(04)***

5A. A buck converter is realized using a half wave ZCS switch. With a circuit schematic, sketch the waveforms of inductor current i_{Lr} and Capacitor voltage v_{Cr}. Clearly mark the four modes of operation. Also mention the switches conducting in each mode. ***(03)***

5B. A half wave ZVS buck converter has the following data: Vs= 20V, fs=360kHz. **Mode 1** operates for 0.2μs. **Mode 4** operates for 1.45μs. Determine the output voltage of the converter. Also sketch i_{Lr} and v_{Cr} . ***(02)***

5C. Obtain the state equation of the small signal model of a Buck converter using state space averaging technique ***(05)***