M. Tech. Electrical Power System (CBCS Pattern) Semester-II

PEPS21 - Advanced Power Electronics

P. Pages : 4 **GUG/S/25/11021**

Time : Three Hours * 1 1 5 1 * Max. Marks : 70

Notes :
1. All questions carry equal marks.
2. Due credit will be given to neatness and adequate dimensions.
3. Assume suitable data wherever necessary.
4. Illustrate your answers wherever necessary with the help of neat sketches.
5. Use of slide rule, Logarithmic tables, Steam tables, Mollier's chart, Drawing instruments, Thermodynamic tables for moist air, Psychrometric charts and Refrigeration charts is permitted.
6. Answer **any five** questions as per internal given choice.
7. Use of slide rule, Logarithmic Tables, Steam Tables, Mollier's Chart, Drawing Instruments, Thermodynamic tables for moist air, Psychometric Charts and Refrigeration charts is permitted.

1. a) Consider the buck-Bost converter. The input voltage to this converter is $E_{dc} = 10$ V. The duty cycle $\alpha = 0.3$ and the switching frequency is 25 kHz. The inductance I = 150 μH and filter-capacitance C = 220 μF. The average load current I_0 = 1.2 A. Determine: **7**

a) The average output voltage, E_0,

b) The peak-to-peak output voltage ripple, ΔV_C,

c) The peak-to-peak current of inductor, ΔI, and

d) The peak current of the transistor I_p.

b) For a Boost converter, derive the expressions for peak-to-peak ripple current and ripple voltage in terms of circuit components, frequency supply voltage and duty ratio. **7**

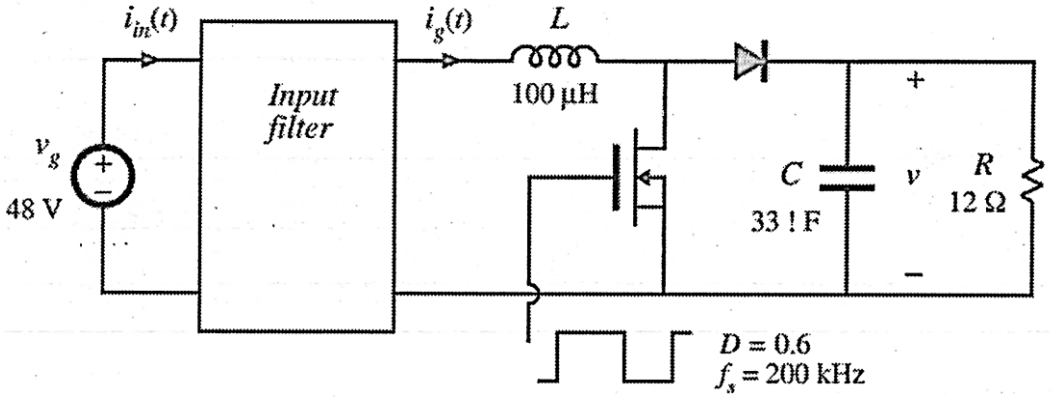
OR

2. a) The Buck-converter has an input voltage of $E_{dc} = 16$ V. The required average output voltage is $E_0 = 8$ V, and the peak-to-peak output ripple voltage is 10 mV. The switching frequency is 25 kHz. If the peak-to-peak ripple current of inductor is limited to 0.7 A. Determine : (a) duty-cycle α, (b) filter inductance, L, and (c) the filter capacitor C. **7**

b) Derive the expression for peak-to-peak ripple current and ripple voltage in case of Buck-Boost converter. **7**

3. a) with the help of neat structural diagram and suitable waveforms, explain the operation of isolated push pull converter. **7**

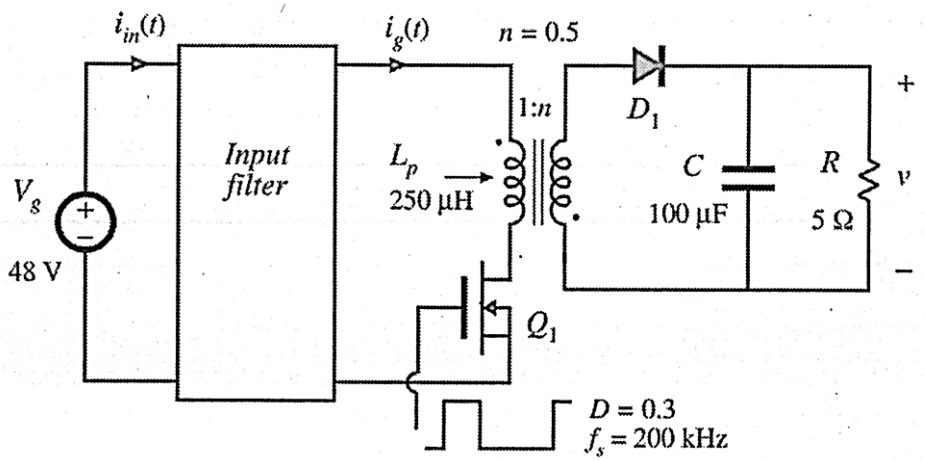
b) In the Boost converter of Fig. the input filter is designed so that the maximum amplitude of switching harmonics of $i_{in}(t)$ is not greater than 10 μA rms. Find the required attenuation of the filter at the switching frequency. **7**



OR

4. a) An isolated buck or forward converters has 150 turns in primary winding and 120 turns in the secondary winding. The dc input voltage is 160 V. Find the duration and the voltage across the primary and feedback windings during on and off periods. The converter operates at 25% duty ratio and 25 kHz. The number of turns of feedback winding, $N_f = 180$. **7**

b) It is required to design an input filter for the flyback converter of Fig. The maximum allowed amplitude of switching harmonics of $i_{in}(t)$ is 10μA rms. Calculate the required attenuation of the filter at the switching frequency. **7**



5. a) Explain the State-Space Averaging of a Nonideal Buck-Boost Converter. **7**

b) A simple buck converter with a 50 kHz switching frequency and a dc input voltage of $V_g = 40\,V$. The output voltage is V = 20 V. The load resistance is $R \geq 4\Omega$. **7**

a) Determine the value of the output filter inductance L such that the peak-to-average inductor current ripple Δi is 10% of the dc component I.

b) Determine the peak steady-state inductor current I_{max}.

c) Design an inductor which has the values of L and I_{max} from parts (a) and (b) Use a ferrite EE core, with B_{max} = 0.25T. Choose a value of winding resistance such that the inductor copper loss is less than or equal to 1 W at room temperature. Assume $K_u = 0.5$. Specify : core size, gap length, wire size (AWG), and number of turns.

OR

6. a) Derive the small-signal dynamic equation that model the ideal Cuk converter. **7**

b) A boost converter operates at the following quiescent point : **7**
$V_g = 28V,\ V = 48V,\ P_{load} = 150\,W,\ f_s = 100$ kHz . Design the inductor for this converter.
Choose the inductance value such that the peak current ripple is 10% of the dc inductor current. Use a peak flux density of 0.225T and assume a fill factor of 0.5. Allow copper loss equal to 0.5% of the load power, at room temperature. Use a ferrite PQ core. Specify : core size, air gap length, wire gauge, and number of turns.

7. a) With the help of neat circuit diagram and associated waveforms, explain the operation of class-E resonant inverters. **7**

b) What are the methods for voltage control of series resonant inverters? Explain them. **7**

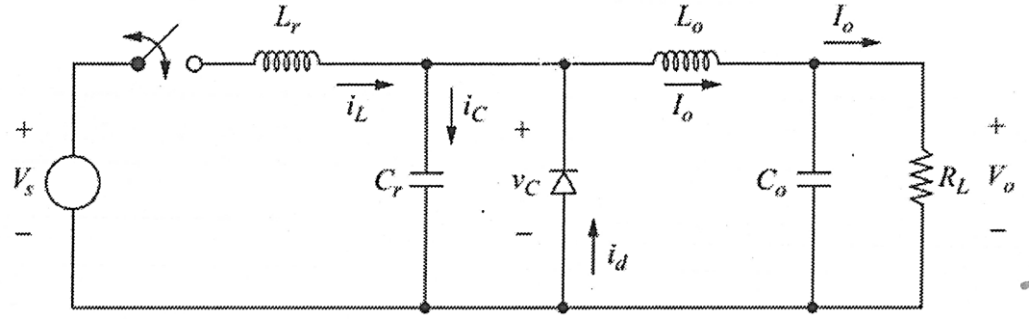
OR

8. a) Draw and explain briefly the operation of resonant dc link inverter. **7**

b) What is quasi-resonant converter? Differentiate briefly between resonant and quasi-resonant converter. **7**

9. a) Explain Parallel resonant converter in discontinuous conduction mode. **7**

b) In the circuit of Fig. **7**



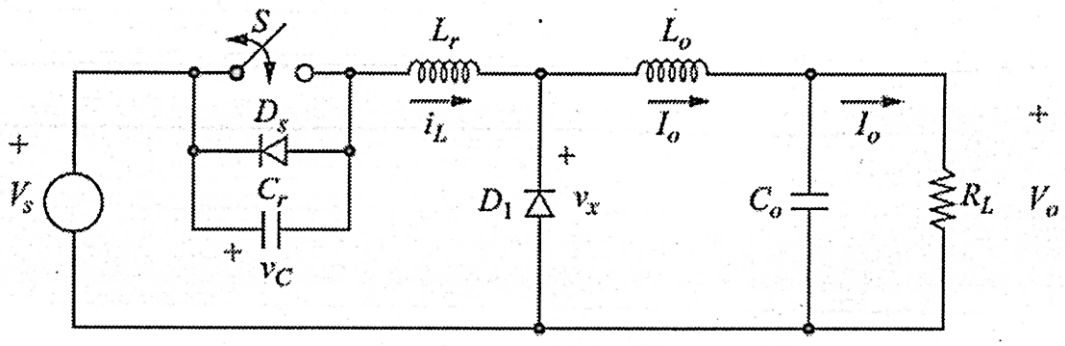
$V_s = 12$ V $\quad C_r = 0.1\ \mu$F $\quad L_r = 10\ \mu$H $\quad I_o = 1$ A $\quad f_s = 100$ kHz

a) Determine the output voltage of the converter.
b) Determine the peak current in L_r and the peak voltage across C_r
c) What is the required switching frequency to produce an output voltage of 6 V for the same load current?
d) Determine the maximum switching frequency.
e) If the load resistance is changed to 20Ω, determine the switching frequency required to produce an output voltage of 8 V.

OR

10. a) Draw and explain the various types of zero current switch topology. **7**

b) In the circuit of Fig. **7**



$V_s = 20\ \text{V}$ $L_r = 1\ \mu\text{H}$ $C_r = 0.047\ \mu\text{F}$ $I_o = 5\ \text{A}$

a) Determine the switching frequency such that the output voltage is 10V.

b) Determine the peak voltage across D_S when it is reverse-biased.

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