ECE 4643: Power Electronics

Assignment 2

Q1:

1. What is the main concept of AC rectification ?
2. The inductance behaves in steady-state as a short circuit to DC currents and voltages, why do inductive loads represent a major operational concern in AC-DC converters ?
3. What are the main differences between the diodes used in an AC-DC rectifier and the freewheeling diodes ?
4. What are the main requirements for operating and controlling AC-DC thyristor-based converters ?
5. When designing input filters for AC-DC converters, what are the main trade-offs in selecting the components ?
6. What are the main differences between designing input and output LC filters for 1ϕ and 3ϕ full-wave rectifiers ?

Q2

A 1ϕ full-wave rectifier supplies an inductive load ($R_L = 4\,\Omega$ and $L_L = 9$ mH) from a 60 Hz AC supply. Design an input LC filter that will limit the RF to $FF \leq 6\%$, and an output LC filter that will allow a voltage ripple as $\Delta v_o \leq 5\%$.

Q3:

A 3ϕ full-wave rectifier supplies a 25 kW, 300 Vdc load. If this rectifier is supplied from a 3ϕ 60 Hz feeder determine:

a) The input AC line and phase rms and peak voltages;

b) The values of $(I_O)_{rms}$, I_{dc}, and $(I_s)_{rms}$;

c) The values for average and rms currents per diode;

d) PIV for each diode;

e) peak-to-peak ripple in $v_O(t)$ and its frequency;

Q4

A 3ϕ full-wave rectifier supplies an inductive load $R_L = 9\,\Omega$ and $L_L = 3$ mH. The input AC voltage is supplied from a feeder at 660 V, 60 Hz. Design an input LC filter that will ensure an input side RF of $RF \leq 6\%$, and an output LC filter for a ripple voltage $\Delta v_o \leq 8\%$.

Q5

A 3ϕ full-wave controlled rectifier supplies a resistive load with 12 kW at 80% of the maximum possible output DC voltage. The input AC voltage is supplied from a Δ-connected feeder at 340 V, 60 Hz. For this controlled rectifier, determine:

a) The firing angle α;

b) The values of $(I_O)_{rms}$, I_{dc}, and average current in each thyristor;

c) the efficiency of this controlled rectifier;

d) The input power factor and commutation angle u.

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