

Assessment A-3

Q1

The capacitor bank of a full- or H-bridge converter comprises of 5, 2200 μ F (450 V) capacitors. The converter is powered from a 220 Vrms, single phase outlet and the ripple voltage is 50 Vp-p.

The bank is allowed to charge up to 200 Vdc before the inrush-current protection circuit short-circuits the series resistor.

Draw a circuit diagram of the problem explained from the supply outlet up to the capacitor bank as well as the capacitor voltage waveform. [3]

Q2

The capacitor bank of a full- or H-bridge converter comprises of [n], 2200 μ F (450 V) capacitors. The converter is powered from a [V] Vrms, single phase outlet and the ripple voltage is 50 Vp-p.

The bank is allowed to charge up to 200 Vdc before the inrush-current protection circuit short-circuits the series resistor. Calculate the resulting peak capacitor current, to one decimal, the moment the resistor is short-circuited if the switching takes 1ms to complete. [5]

Q3

A MOSFET switches on in 50 ns and the average power dissipation for this switching event is 3 W when the switching frequency is 50 kHz. Calculate the total power dissipation if the MOSFET switches off in 58 ns and the frequency is increased to 75 kHz. Present your answer to two decimals. [5]

Q4

A coaxial transformer is manufactured by pushing 3 turns of Litz bundle (primary) through a copper pipe (secondary with $N_s = 1$). Toroidal cores are fitted onto the pipe before installing the primary winding since there is no way to fit them afterward. These toroidal cores have an effective area of 81 mm² and the inner diameter of 25 mm is large enough for the copper pipe to fit easily. Draw a rough sketch of the completed transformer indicating only one or two cores. [3]

Q5

A coaxial transformer is manufactured by pushing 3 turns of Litz bundle (primary) through a copper pipe (secondary with $N_s = 1$). Toroidal cores are fitted onto the pipe before installing the primary winding since there is no way to fit them afterward. These toroidal cores have an effective area of 81 mm² and the inner diameter of 25 mm is large enough for the copper pipe to fit easily. Draw a rough sketch of the completed transformer indicating only one or two cores. The primary single-phase voltage fluctuates between 290 Vrms and 311 Vrms. Calculate the number of cores required to the nearest integer number at a switching frequency of 45 kHz and a maximum flux density of 0.2T. [5]

Q6

An inductor is constructed using an EE55 core set with an effective area of 353 mm², a window area of 250 mm² and a 1mm air gap. The inductor has 5 turns and the Litz bundle comprises of 90 strands of 0.3 mm copper wire. Calculate the window fill factor as a percentage to 1 decimal and interpret this answer in your written work as a good or bad fit. [4]

Q7

A MOSFET is mounted on a heatsink. The MOSFET average current is 20 A at a frequency of 50 kHz and 50% duty cycle. The junction to case thermal resistance is 1 K/W, the case to sink thermal resistance is 1.4 K/W and the sink to ambient thermal resistance is 1.7 K/W. Draw the equivalent circuit of the given problem. [2]

Q8

A MOSFET is mounted on a heatsink. The MOSFET average current is 20 A at a frequency of 50 kHz and 50% duty cycle. The junction to case thermal resistance is 1 K/W, the case to sink thermal resistance is 1.4 K/W and the sink to ambient thermal resistance is 1.7 K/W. Calculate the maximum drain-source resistance of the MOSFET, in milli-Ohm to one decimal, if the case temperature should not exceed 100 degrees Celcius at an ambient temperature of 35 degrees Celcius. [3]