Assessment B-1

Q1

Consider a 2kW, MOSFET half-bridge converter powered from a $230V_{RMS}$ ac-source. A center-tapped secondary winding is used.

Draw a circuit diagram of the converter showing all the components required as well as the drivers. Pay special attention to the reference potentials of the drivers and output voltage. [3]

Q2

M/C

Consider a 2kW, MOSFET half-bridge converter powered from a $230V_{RMS}$ ac-source. A center-tapped secondary winding is used.

You have a large number of 1000 µF (250V) electrolytic capacitors in stock and the total bus capacitance needs to be equal to or slightly higher than 2500 µF. How many of the capacitors will you need? [3]

Q3

Consider a 100W center-tap converter, fed from a 24V supply.

Draw a circuit diagram of the converter. [3]

Q4

M/C

Consider a 100W center-tap converter, fed from a 24 V supply and the output voltage is 300 V. The transformer efficiency is 85% but all other components may be assumed to be ideal.

The converter rectifier diodes should be rated at a minimum of: [3]

Q5

A maximum power point tracker (MPPT) comprises of an 18V, 95 W (power output capability) solar panel with an efficiency of 30%, a buck converter with an efficiency of 85% and a buck-boost converter with an efficiency of 80%. The load voltage should be maintained at 12 V, 50 W all the time.

Draw a block diagram of the system indicating the efficiencies of each of the subsystems on it. [3]

Q6

A maximum power point tracker (MPPT) comprises of a 12V, 95 W solar panel with an efficiency of 30%, a buck converter with an efficiency of 85% and a buck-boost converter with an efficiency of 80%. The load voltage should be maintained at 12 V, 50 W all the time.

The maximum power point (not necessarily 95W) operation of the panel is achieved at a specific point in time where the buck converter output is 7V. Calculate the current produced by the buck converter. [5]

Q7

A diode and MOSFET are mounted on the same heatsink. The diode dissipates 5 W and the MOSFET dissipates 10 W under specific operating conditions. The diode has a junction to case thermal resistance of 0.2 K/W and the MOSFET has a junction to case thermal resistance of 0.4 K/W. Both of them have case to sink thermal resistances of 1 K/W and the heatsink thermal resistance is 0.8 K/W. The ambient temperature is 35^{O}C.

Draw an equivalent circuit with all the given information of the thermal problem. [3]

Q8

A diode and MOSFET are mounted on the same heatsink. The diode dissipates 5 W and the MOSFET dissipates 10 W under specific operating conditions. The diode has a junction to case thermal resistance of 0.2 K/W and the MOSFET has a junction to case thermal resistance of 0.4 K/W. Both of them have case to sink thermal resistances of 1 K/W and the heatsink thermal resistance is 0.8 K/W. The ambient temperature is 35^{O}C.

Calculate the junction temperature of the MOSFET. Present your answer in degrees Celcius to two decimals. [5]

Q9

The efficiency of a 12 V output, buck converter is equal to 84 % at 50W output power. The input voltage varies from 15 V to 18 V. Calculate the difference in percentage duty cycle which will maintain the output voltage at 12 V. [2]