Ex/PG/EE/T/116B/14/2017

MASTER OF ENGINEERING IN ELECTRICAL ENGINEERING

EXAMINATION, 2017

(1st Semester)

SOLID STATE POWER SUPPLIES

Time: Three hours | Full Marks: 100

Answer *any five* questions

1. a) Sketch a simple Series type of voltage regulator and briefly explain its operation. 6

   b) In the above, assuming the input to be supplied from a transformer and rectifier, with Vdmin/Vdmax = 0.85, if the output rms voltage from the transformer secondary is 15V, what is the maximum output regulated voltage possible from the regulator. Make suitable assumptions. 8

   c) Switching Power Loss in semiconductors. 6

2. a) Explain how the average value of a DC voltage can be controlled through Pulse Width Modulation (PWM). Further, compare the two different methods for PWM. 10

   b) Sketch and explain a typical control scheme for PWM control, using a PI controller. Use voltage feedback control with current limit. 10

3. a) Using circuit diagram and waveforms, explain the operation of a Buck converter. Explain the operation of the LC low-pass filter at its output. 8

   b) Using circuit diagram and waveforms, explain the operation of a Boost converter. Derive the expression of output voltage in terms of input. 12

4. a) Using circuit diagram and waveforms, explain the operation of a single-transistor Forward converter with additional winding for flux reset. 10

   b) A simple Forward converter, switching at 70kHz, uses a transformer with a 15:1 step-down ratio. For an input of 325V dc, what is the ON-time to obtain 12V average output. What is the highest obtainable dc output voltage with 325V dc input ? Make suitable assumptions. 10

5. a) Using circuit diagram and waveforms, explain the operation of a single-transistor Flyback converter.

10

b) A Flyback converter operates from 200V dc input to supply 12V dc output. If the maximum voltage across the switch is to be restricted to 320V, what should be the turns ratio of the transformer ? What is the maximum Duty Cycle and ON-time for Discontinuous Conduction if the switching frequency is 50kHz. If the maximum Duty Cycle is to be 0.5, what design change is needed and what will be the maximum voltage across the switch ? Make suitable assumptions.

10

6. a) Sketch and explain the operation of a Half Bridge converter. Highlight its advantages and disadvantages.

8

b) Sketch and explain the operation of Full Bridge converter in both PWM and Phase-shift PWM mode of operation. Highlight its advantages and disadvantages of the converter.

12

7. a) Sketch and explain the operation of a Push-Pull converter. Highlight its advantages and disadvantages.

8

b) Explain the basic principle of Current Mode control and how is it different from Voltage Mode Control.

12

8. Write short notes on all the following three:

a) Skin Effect in Conductors.

6

b) Generation of Auxiliary power supply for control circuit.

6

c) Methods of isolation for MOSFET gate drive.

8