UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2007/2008

October/November 2007

EEE 542 – INDUSTRIAL POWER ELECTRONICS

Duration: 3 hours

Please check that this examination paper consists of SIX pages of printed material before you begin the examination.

This paper contains FOUR questions.

Instructions: Answer **FOUR (4)** questions.

Answer to any question must start on a new page.

Distribution of marks for each question is given accordingly

All questions must be answered in English.

1. (a) Describe the importance of freewheeling diode in any electronic power circuit.

(50 marks)

(b) A single phase transformer is connected to a full bridge diode to light up a high current lamp $400V_{dc}$, 10Ω. By assuming there is no smoothing filter in this circuit, calculate;

(i) The voltage and current rating of diodes in the bridge.

(ii) The voltage and current rating of the single phase transformer.

(50 marks)

2. (a) A power BJT and an IGBT are two power transistors commonly used in any electronic power system. States three differences between these power transistors.

(40 marks)

(b) A red warning lamp system was installed at Penang Harbour for shipping navigation. This system will relay a high power lamp by means of power BJT switch connected to $220V_{dc}$ power supply. Actually the high power lamp is a kWatt dc lamp with impedance 20Ω. This lamp should turn ON and turn OFF over 0.016s and 0.004s, respectively. The power switch been used in this system has voltage drop of 1.5V.

Based on the statement:

(i) Sketch the expected waveform at the high power lamp.
(ii) The average voltage at the lamp.
(iii) The rms voltage of lamp.
(iv) The efficiency of this warning system.
(v) What are your comments about this efficiency.
(vi) The effective input impedance of the system.

(60 marks)

3. Figure 1 shows a boost regulator with the following parameters:

Input voltage V_s : 5 V
Output voltage V_a : 12 V
Average load current I_a : 0.5 A
Switching frequency f_s : 25 kHz
Inductor L : 150 uH
Capacitor C : 220 uF

(a) Using the boost regulator circuit diagram as shown in Figure 1, prove that the output voltage V_a can be related to input voltage V_s by

$$V_a = \frac{V_s}{1-k}$$

where k is the duty cycle; (25 marks)

(b) Estimate the ripple current of the inductor ΔI (25 marks)

(c) Estimate the peak current of the inductor I_2 (25 marks)

(d) Estimate the critical values of inductor *L* and capacitor *C*.

(25 marks)

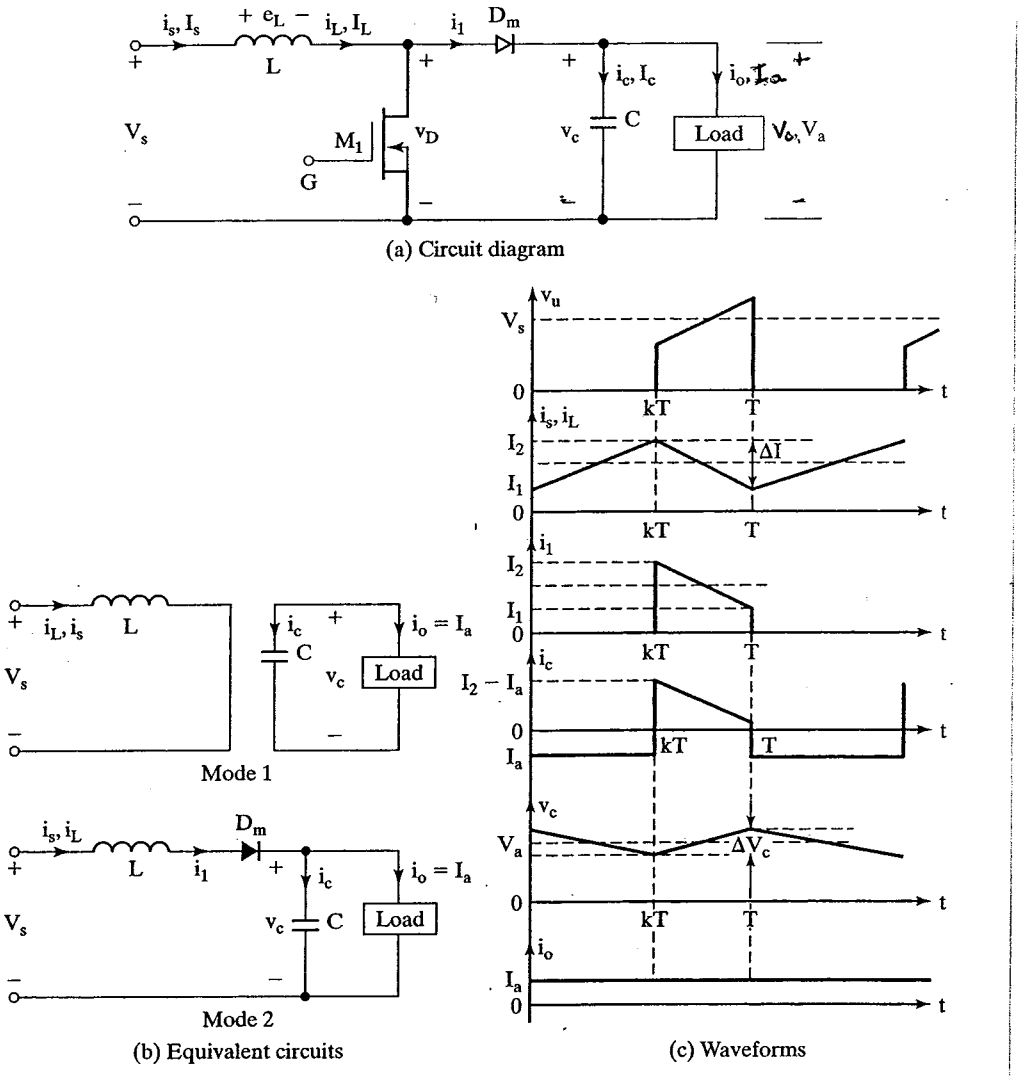

Figure 1 : Boost Regulator with a power Mosfet

4. Figure 2 shows a buck-boost regulator with the following parameters:

Input voltage V_s : 15 V
Duty cycle k : 0.7
Average load current I_a : 1.5 A
Switching frequency f_s : 25 kHz
Inductor L : 150 uH
Capacitor C : 220 uF

(a) Using the boost regulator circuit diagram as shown in Figure 2, prove that the output voltage V_a can be related to input voltage V_s by

$$V_a = -\frac{V_s k}{1-k}$$ (25 marks)

(b) Estimate the average output voltage V_a (25 marks)

(c) Estimate the peak-to-peak output ripple voltage ΔV_c (25 marks)

(d) Estimate the peak-to-peak output ripple current ΔI (25 marks)

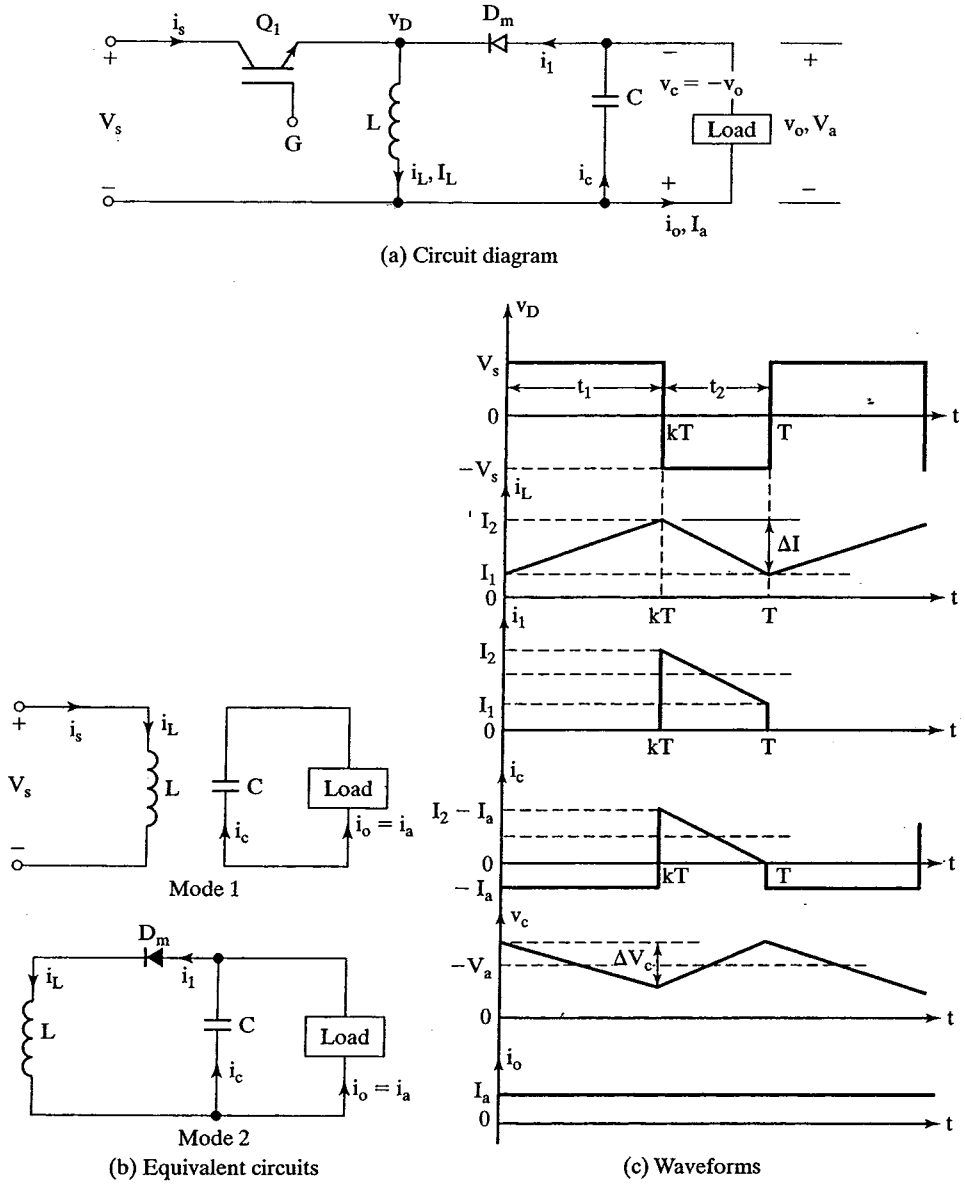

Figure 2 : Buck-boost Regulator

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