M.Sc. Engg. /Ph.D. (EE) Date: 16 February, 2023 (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination
Course No.: EEE 6801
Course Title: Power Electronics

Summer Semester, A.Y. 2021-2022
Time: 90 Minutes
Full Marks: 75

There are **4 (four) questions**. Answer **any 3 (three) questions**. All questions carry equal marks. Programmable calculators are not allowed. Do not write on this question paper.

1.(a) "The power electronics revolution is giving the ability to shape and control large amounts of power with ever-increasing efficiency". With reference to this statement, briefly explain how the power crisis in Bangladesh can be improved by proper use of the power electronic systems.

(b)

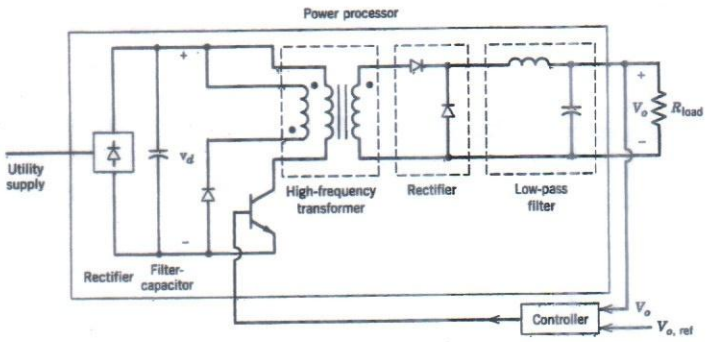


Fig. 1(b)

The above figure demonstrates the use of power electronic system for SMPS. Clearly identify the advantage of using power electronic rather than linear electronic systems for the above SMPS.

(c) Consider a switch-mode dc power supply as shown in Fig. 1(c). The input dc voltage V_d = 20 V, duty ratio D = 0.75, switching frequency f_s = 300 kHz and the resistive load draws 240 W. The filter data are L = 1.3μH and C = 50 μF. The attenuation in V_{oi} in decibels can be calculated by the formula, $attenuation = 20 \log_{10} \dfrac{V_o(s)}{V_{oi}(s)}$, where $s = j\omega_h = j(2\pi h f_s)$, h is the number of harmonic. Calculate the attenuation in V_{oi} at h = 1, 2 and 3.

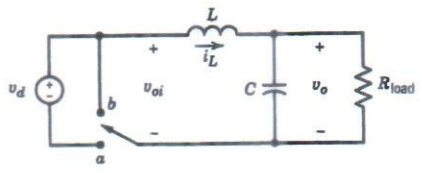
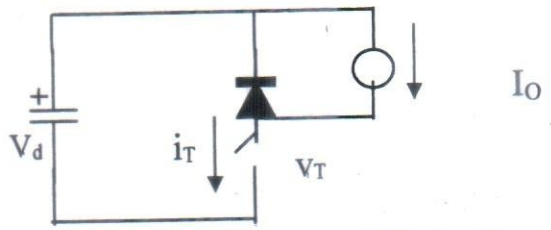


Fig. 1(c)

2.(a) (i) Describe some of the main industrial applications of power electronics.
(ii) Describe desirable characteristics of a controllable switch.

(b) The data sheets of a switching device specify the following switching times corresponding to the linearized switching characteristics for clamped-inductive switching:
t_{ri}=100 ns, t_{fv}=50 ns, t_{rv}=100ns, t_{fi}=200 ns. Calculate and plot the switching power loss as a function of frequency in a range of 25 to 100 kHz. Assume V_d=400 volt, I_O=6 amp in the following circuit:



Comment on the switching power loss of the on-state and off-state of the power electronic switch. If the switching power loss increases with the switching frequency, what trade-off do you think to take for efficient switching operation?

3.(a) Explain why line current is more distorted in an uncontrolled ac to dc converter without a finite source than that of the converter with finite value of source inductance for a highly inductive load. Calculate the loss of output voltage due to source inductance of an ac to dc converter for a highly inductive load.

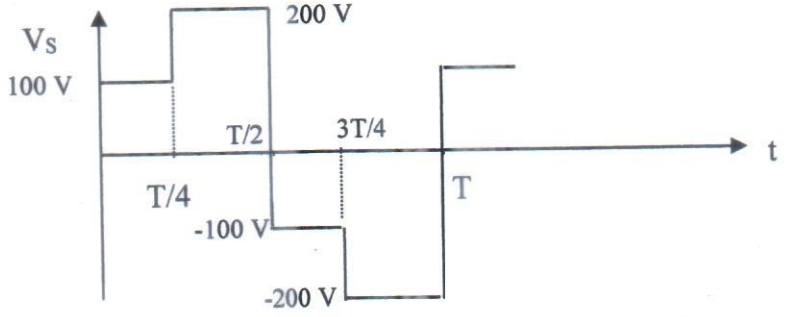
(b) An ac to dc converter is used to charge a battery. The converter has a source inductance L_S. Draw the wave-shape of the load current for a discontinuous mode of operation. Also draw the wave-shape of the voltage drop across the source inductance. The output current can be determined by the following expression:

$$i_d(\theta) = \frac{1}{\omega L_S}\int_{\theta_b}^{\theta} (\sqrt{2}V_S \sin \omega t - V_d)\, d(\omega t)$$

How can you determine initial and final values of θ? Find the expression of the average value of the output current.

4.(a) Describe the current commutation process of a single phase full-wave rectifier with finite source inductance and a constant dc current. Derive the expression of the commutation angle.

(b) A single phase bridge rectifier with a finite source inductance L_S=5 mH has a load of constant current of 10 amp. It has a frequency of 50 Hz. The input voltage has the following wave-shape.



(i) Draw the wave shapes of source current and output voltage. (ii) Calculate the commutation angle and average value of the output voltage