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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
THE ORGANISATION OF THE ISLAMIC CONFERENCE (OIC)

DEPARTEMNT OF ELECTRICAL AND ELECTRONIC ENGINEERING

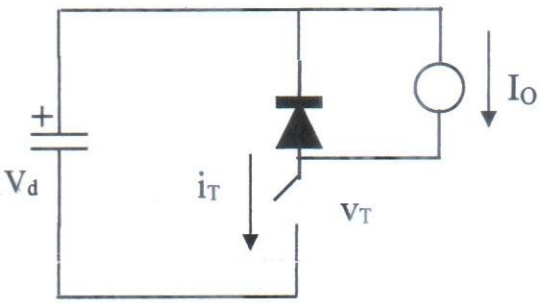
Semester Final Examination
Course No.: EEE 6801
Course Title: Power Electronics

Summer Semester. A.Yr. 2021-2022
Time: 3 Hours
Full Marks: 150

There are **8 questions**. Answer **any 6 questions**. All questions carry equal marks. Programmable calculators are not allowed. Do not write on this question paper.

1.(a) "Power Electronics is the ultimate choice for handling high power because it can mitigate the demand of users optimally". Justify the statement with examples. Also clearly mention how power electronics is playing a vital role in the transportation system.

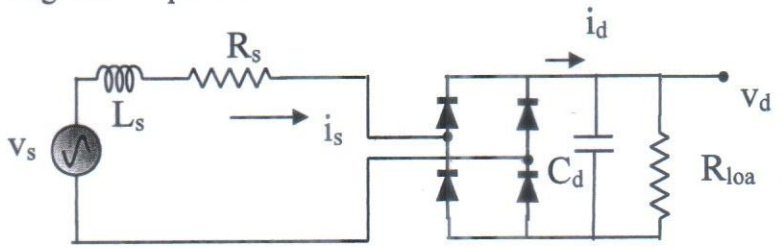
(b) The data sheets of a switching device specify the following switching times corresponding to the linearized switching characteristics for clamped-inductive switching: t_{ri}=100 ns, t_{fv}=50 ns, t_{rv}=100ns, t_{fi}=200 ns. Calculate and plot the switching power loss as a function of frequency in 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?

2.(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) Following is a figure of a practical diode rectifier. The circuit operating conditions are assumed to result in a highly discontinuous i_d, where i_d goes to zero prior to the zero crossing of v_s every half-cycle. Taking state variables i_d and v_d, analyze the circuit providing states equation.

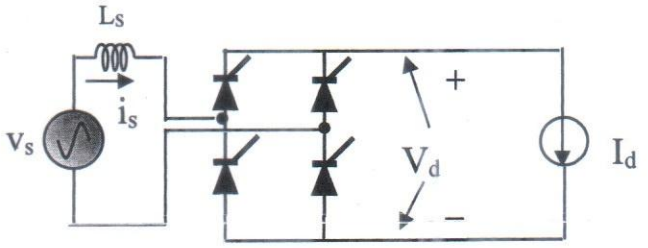


3.(a) Draw the circuit diagram of a three phase uncontrolled rectifier with resistive load. Explain why this rectifier known is known as six pulse type. Drawing the output voltage wave shapes, find the expression of average output voltage.

(b) Describe the current commutation process of a three phase uncontrolled rectifier with finite source inductance and a constant dc current. Derive the expression of the commutation angle.

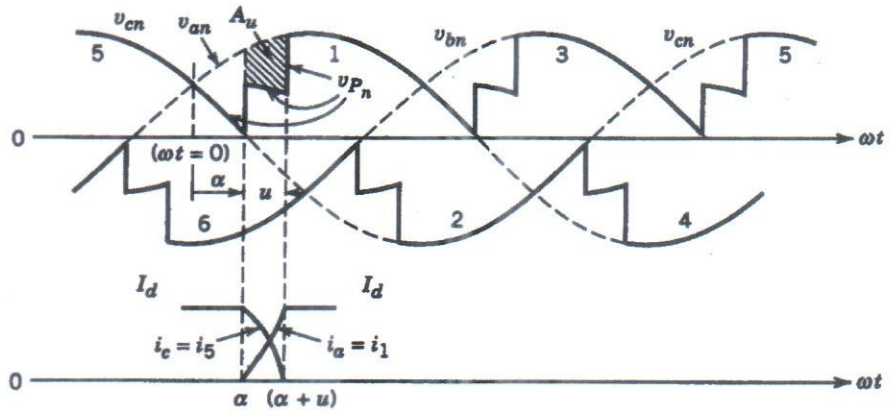
4.(a) Draw the output voltage and input current wave-shapes of a single phase controlled rectifier for highly inductive load and also for resistive load. On the basis of input currents of both cases, which one should provide more THD to the system? Suggest any system to improve the THD.

(b) For the following converter, L_S is 5% with rated voltage of 230 V at 50 Hz and the rated VA of 5 KVA. Calculate the commutation angle u and V_d for the power of 3 kW and $\alpha=30^0$.



5.(a) Describe the inverter mode of operation of a single phase thyristor converter. Give a practical example where this kind of operation can be performed to save energy of the system.

(b) The following figure shows the current commutation process of a three phase controlled rectifier with the highly inductive load. Derive the expression of A_u, commutation angle u and average output voltage V_d for this converter.



6.(a) Draw the circuit diagram of a boost converter. Plot the inductor current i_L, inductor voltage v_L on the same scale for boundary between continuous and discontinuous conduction of i_L. Derive the expressions of inductor current I_{LB} and output current I_{OB} at the boundary conditions. Derive the expressions of inductor current and duty cycle for this discontinuous mode of operation.

(b) In a boost converter, the duty cycle is adjusted to regulate the output voltage V_O at 48 V. The input voltage varies in a wide range from 12 to 36 V. The maximum output power is 120W. For stability reasons, it is always required to operate the converter in the discontinuous-current mode. The switching frequency is 50 kHz. Assuming ideal components and C as very large, Calculate the maximum value of L that can be used.

7.(a) Draw the circuit diagram of a Cuk converter. Explain its operation for both on and off positions of the switch.

(b) In a Cuk converter operating at 50 kHz, L_1=L_2=1 mH and C_1=5 μF. The output capacitance is sufficiently large to yield an essentially constant output voltage. Here V_d= 10 V and the output V_o is regulated to be constant at 5 V. It is supplying 5 W to a load. Assume ideal components. Calculate the percentage errors in assuming constant voltage across C_1 or in assuming constant currents i_{L1} and i_{L2}.

8.(a) Describe the operation of the discontinuous mode operation of a buck-boost converter. Plot the buck-boost converter characteristics keeping output voltage constant.

(b) Describe the inverter mode of operation of a single phase thyristor converter. Give a practical example where this kind of operation can be performed to save energy of the system.

(c) In a buck-boost converter operating at 20 kHz, L=0.05 mH. The output capacitor C is sufficiently large and input voltage V_d=15 V. The output is to be regulated at 10 V and the converter is supply a load of 10 W. Calculate the duty ratio D.