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Programme: **M.Sc. Engg. /M.Engg. (EE)/Ph.D** Date: 15 May, 2024

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

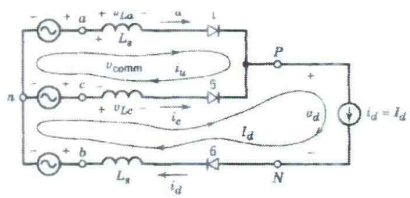
Summer Semester. A.Yr. 2022-2023
Time: 3 hours
Full Marks: 150

There are **8 questions**. Answer **any 6 questions**. All questions carry equal marks.

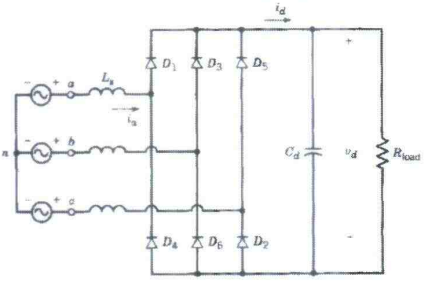
1.(a) Draw the circuit diagram of a three phase uncontrolled rectifier with resistive load. Explain why this rectifier is known as six pulse type. Drawing the output voltage wave shapes, find the expression of average output voltage.

(b) For the three phase rectifier with a purely resistive load, find the efficiency, FF, RF, TUF and PIV of each diode if the delivers a dc current of 60 A, average voltage 280.7 V with a source frequency of 50 Hz.

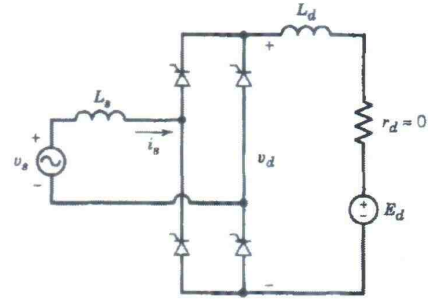
2.(a) The following figure shows the current commutation process of a three-phase uncontrolled rectifier with the highly inductive load. Derive the expression of A_u, commutation angle u and average output voltage V_d for this converter.



(b) For the following circuit, assume the ac-side inductance L_S to be negligible. Instead, an inductor L_d is placed between the rectifier output and the filter capacitor. Derive the minimum value of L_d in terms of V_{LL}, ω, and I_d that will result in continuous i_d, assuming that the ripple in v_d is negligible.

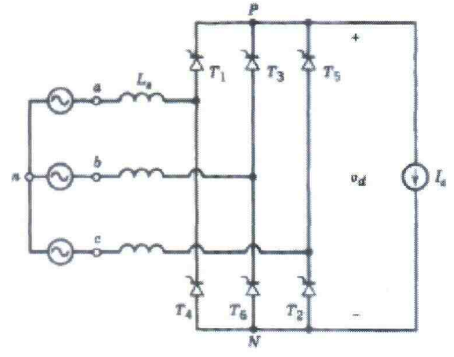


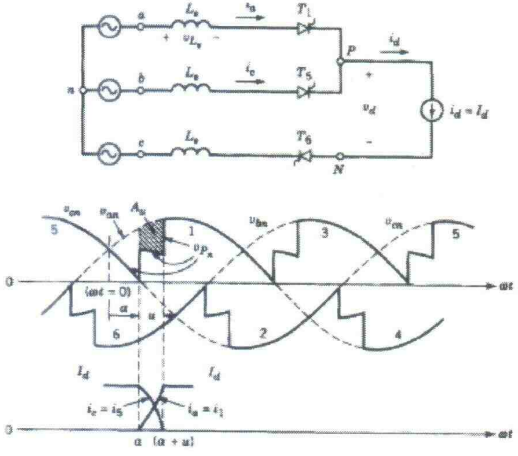
3. (a) Following is a circuit diagram of a practical single phase-controlled rectifier.



Draw the wave shapes of v_d and i_d with v_s for continuous i_d of this converter. Also derive the expression of the average output voltage V_d.

(b) From the following diagrams, find the expressions of commutation angle u and average output voltage V_d





4.(a) Draw the circuit diagram of a buck 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) With 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.

5. (a) For a buck-boost converter operating in discontinuous mode, the expression of D is given by

$$D = \frac{V_o}{V_d}\sqrt{\frac{I_o}{I_{oB,max}}}$$

Plot the converter characteristics that is draw D versus $(I_o/I_{oB,max})$ with V_o constant identify discontinous and continous mode of conduction.

(b) Draw the circuit diagram of a CUK converter. Explain the operation of the converter with proper derivations.

6.(a) 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 assuming constant voltage across C_1 or assuming constant currents i_{L1} and i_{L2}.

(b) For a three phase 50 Hz inverter, sketch the gating signals for 120 degree conduction and find the expressions of line to line voltage. If a Y load of R=10 ohm, and L= 10 mH per phase is connected to this inverter, calculate the line currents.

7. (a) Provide some practical applications of SMPS. For LED lamps, which converter is being used. Propose a new topology that may improve the performance of the converter.

(b) Why discontinuous mode of operation could provide better performance for a dc-dc converter? Find the expression of output voltage of a boost type converter.

8. (a) Describe the importance of the application of inverters with the context of using these in renewable energy systems. Draw a block diagram comprising all possible connection of converters to obtain a sustainable energy system. Describe the function of each converter in the block diagram.

(b) Write down the various advanced modulation techniques used in inverter operations. Explain any method that can be effectively used to reduce the unwanted harmonics at the output of an inverter.