ELG4139 Quiz Assignment 2

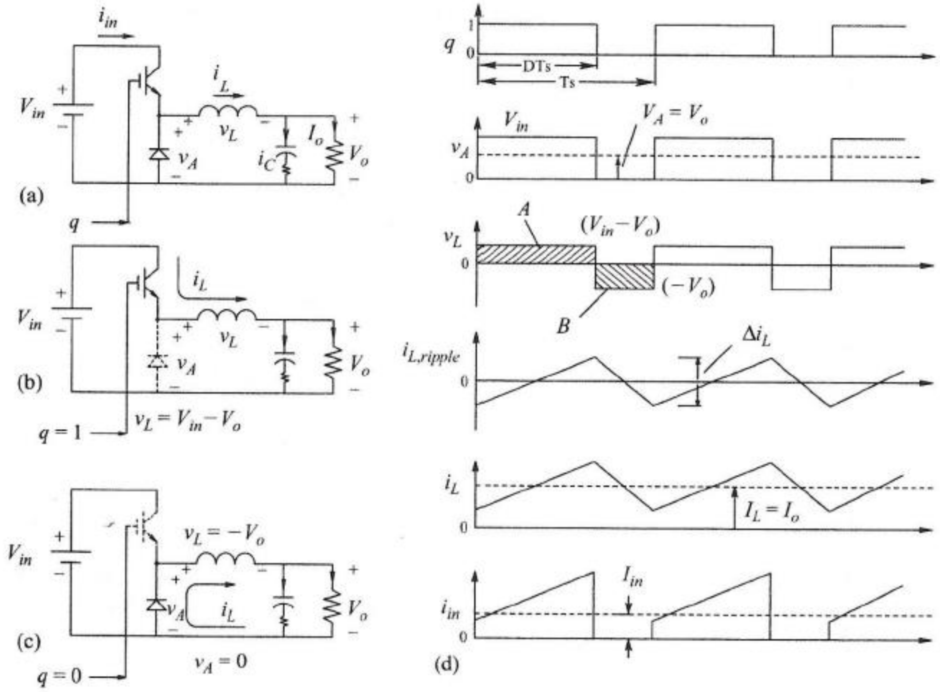
Question 1:
Propose a proper switch (MOSFET/Thyristor/GTO/IGBT) for the following applications

An inverter for the light-rail train (LRT) locomotive operating from a DC supply of 750 V. The locomotive is rated at 150 kW. The induction motor is to run from standstill up to 200 Hz, with power switches frequencies up to 10 kHz.	
A switch-mode power supply (SMPS) for remote telecommunication equipment is to be developed. The input voltage is obtained from a photovoltaic array that produces a maximum output voltage of 100 V and a minimum current of 200 A. The switching frequency should be higher than 100 kHz.	
A HVDC transmission system transmitting power of 300 MW from one AC system to another AC system both operating at 50 Hz, and the DC link voltage operating at 2.0 kV.	
A variable frequency drive (VFD) for a vacuum cleaner using a three phase AC motor.	
An ordinary compact fluorescent lamp (CFL).	
An induction heater.	
Battery charger up to 40 A.	
An industrial motor drive of more than 1000 kW and more than 2000 kV.	

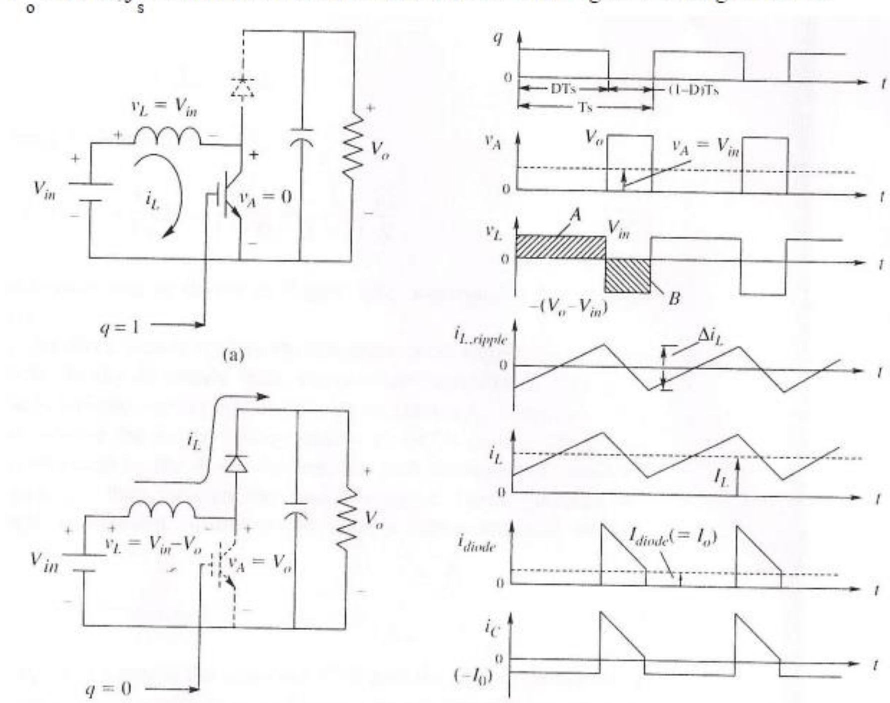
Question 2: Draw a block diagram for the following energy systems.

Grid-connected wind energy system using an induction generator	
Grid-connected Solar energy System (20 solar panels, each with 12.5 V)	
AC Motor Drive	
A switching mode power Supply with power factor Correction	

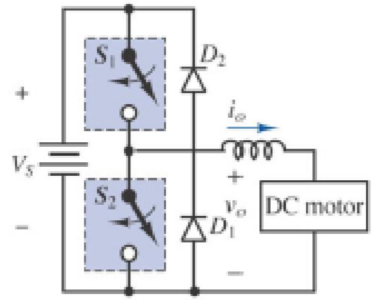
Question 3: Consider the following DC to DC converter. L = 24 μH. It is operating in DC steady-state under the following condition: V_{in} = 20 V, D = 0.6, P_o = 14 W and f_s = 200 kHz. Calculate the values of the generated signal forms.

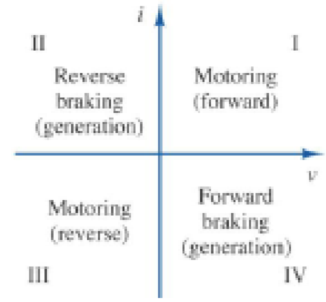


Question 4: Consider a boost converter, the inductor current has Δi_L = 2 A, V_{in} = 5 V, V_o = 12 V, P_o = 11 W, f_s = 200 kHz. Calculate L and values of the generated signal forms.



Question : Consider the following step-down and step-up chopper (two quadrant chopper). The circuit can provide both motoring forward operation (S_1 and D_1) and regenerating braking operation (S_2 and D_2).



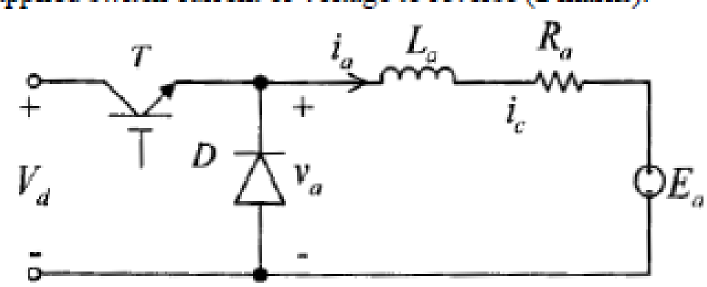


For the **Buck** circuit (S_1 and D_1), determine the duty cycle and turn-on time in the motoring mode if $n = 500$ r/min, and $i_o = 90$ A. Assume $V_s = 120$ V, $E_a = 0.1\ n$, $R_a = 0.2$ Ohm, $f_s = 300$ Hz.

Calculate the absorbed power in the motor armature winding and the power delivered by the voltage supply. What is the role of the diode (D_1)? Draw the Buck (step-down chopper) voltage waveform first with D_1 and second without D_1.

For the **Boost** (S_2 and D_2) circuit, determine the duty cycle and turn-on time in the motoring mode if $n = 380$ r/min, and $i_o = -90$ A. Assume $V_s = 120$ V, $E_a = 0.1\ n$, $R_a = 0.2$ Ohm, $f_s = 300$ Hz. Calculate the absorbed power in the motor armature winding and the power delivered by the voltage supply. Also draw the output voltage waveform.

Question : An IGBT- based one-quadrant chopper is used to power a DC motor. The motor armature winding $R_a = 0.25$ Ohm and winding inductance $L_a = 1$ mH. The input DC voltage $V_d = 250$ V. The armature constant of the DC motor is $K_a\varphi = 0.98$ V/rad/sec. When the duty cycle is 0.5, the motor is running at 1200 rpm. The switching frequency $f_s = 1$ kHz. Determine the operation mode of the converter and the ripple torque ΔT. Hint: The converter usually operates at two modes: discontinuous conduction mode (DCM) and continuous conduction mode (CCM). DCM occurs because switching ripple in inductor current or capacitor voltage causes polarity of applied switch current or voltage to reverse (2 marks).



Use: $E_a = K_a\varphi\omega$; $\Delta T = K_a\varphi\Delta I$; $I_{min} = \frac{V_d}{R_a}\frac{e^{ton/\tau}-1}{e^{ts/\tau}-1} - \frac{E_a}{R_a}$; $I_{max} = \frac{V_d - E_a}{R_a}(1-e^{ton/\tau})$