Assignment 1

1) A train is having 8 coaches and is driven by a locomotive. The locomotive has 30 wheels out of which 20 are driving wheels. Each coach is having 30 wheels. This train has to be reconfigured as a suburban train having 8 coaches and no locomotive so that it can develop **four times** the maximum tractive effort that can be developed in the locomotive driven train. Further, each coach should have 30 wheels. Assume that the weight of a locomotive, a trailer coach and a motorized coach are equal and is not affected by the weight of the passengers being carried. Further, assume that each driving wheel generates equal tractive effort Determine the wheel configuration (number of motorized wheels, number of dummy wheels, number of motorized coaches, number of trailer coaches etc.) of the reconfigured train. Once designed do a confirmatory check on it and report its performance regarding its maximum tractive effort.

Q2) Consider the practical boost converter circuit shown in Figure 1 wherein the inductance, L has a series resistance, r (which represents the coil resistance of the inductor as well as iron losses of the inductor. Further, it also represents all the losses that are incurred in the circuit). The capacitor, C is large enough so that the ripple in the output voltage, V_0 of the converter can be neglected. Similarly it can be assumed that the inductor, L is large enough so that the current ripple in the inductor can be neglected i.e. $i_L \approx Average\ of\ i_L = I_L$. The converter is feeding a load having resistance, R, and it is operating in continuous mode of conduction with a switch duty ratio of D. A) Determine the relationship, $\frac{V_o}{V_d}$. Hence determine V_0 (i) D = 0 and (ii) D = 1. B) Find the value of D when V_0 is maximum, and hence determine the maximum value of V_0.

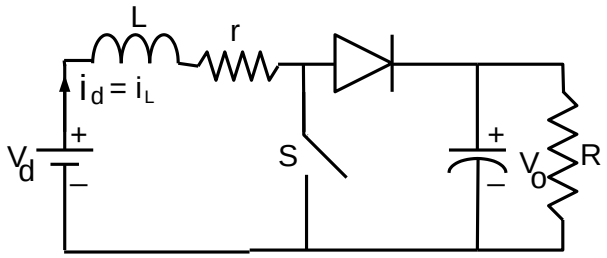

Figure 1

Q3) In Figure 2, the switch is operated at a switching frequency of 20kHz with a duty cycle, D. L= 100μH. 1) Find the value of D at the boundary of continuous and discontinuous mode of conduction. 2) For a value of D=0.5, find the power transferred from source V_1 to V_2. 3) Can the circuit operate at steady state under continuous mode of conduction?

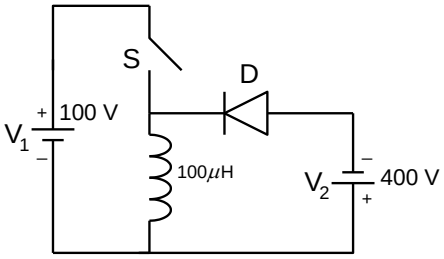

Figure 2

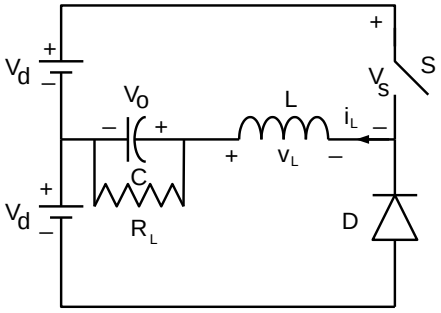

Figure 3

Q4) Consider the dc to dc converter circuit shown in Figure 3. The switch is operated with a switching time period, T and duty cycle, D. V_d is the source voltage and V_o is the output voltage. You may assume that the capacitor is large enough so that ripple in V_o can be neglected. 1) Draw V_s and i_L for a) continuous mode of conduction and b) for discontinuous mode of conduction. 2) For continuous mode of conduction find an expression for V_o in terms of V_d, D and T. 3) For continuous mode of conduction find an expression for peak to peak value of i_L in terms of V_d, D, T and L.

Q5) The buck-boost converter shown in Figure 4 is operated so as to maintain constant output voltage V_o=-10V, as the input voltage V_d is varied. The switching frequency is 50kHz. The value of the inductor is 50μH and the value of the capacitor can be assumed to be infinite as compared to other circuit parameters. 1) At the boundary of continuous and discontinuous mode of conduction, what is the value of V_d. At this boundary what is the magnitude of peak current flowing through the diode.

Q6) For the buck regulator shown in Figure 5, the switch, S is operated with a duty ratio of 0.5 at a switching frequency of 5kHz. The inductor, L is having a value of 2.5mH. Input voltage to the regulator is maintained at 100V. The output voltage, V_0 is found to be 80V. Find the value of load resistance R_L connected to the output of the regulator. Assume the output voltage of the regulator is ripple free.

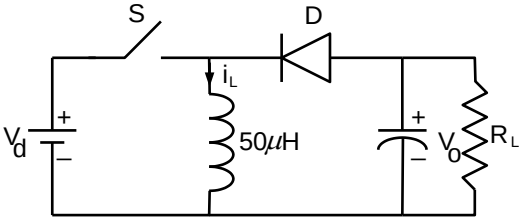

Figure 4

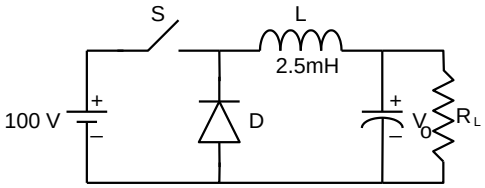

Figure 5