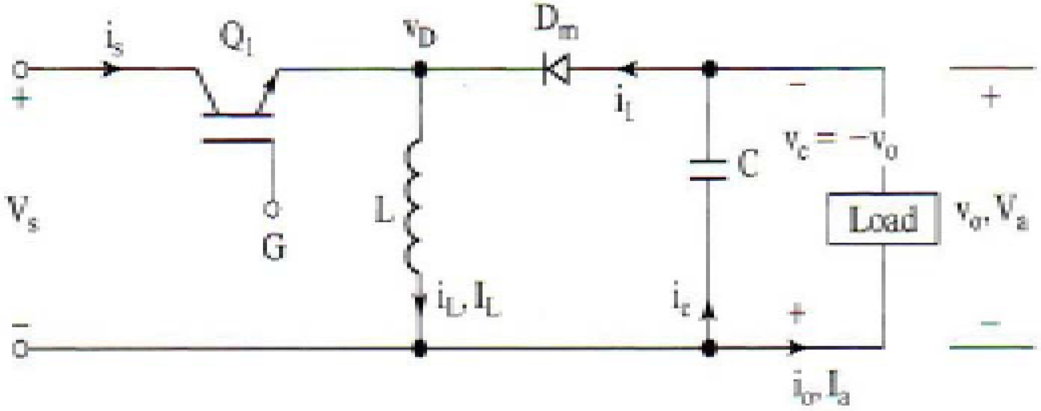
Buck – Boost Regulators

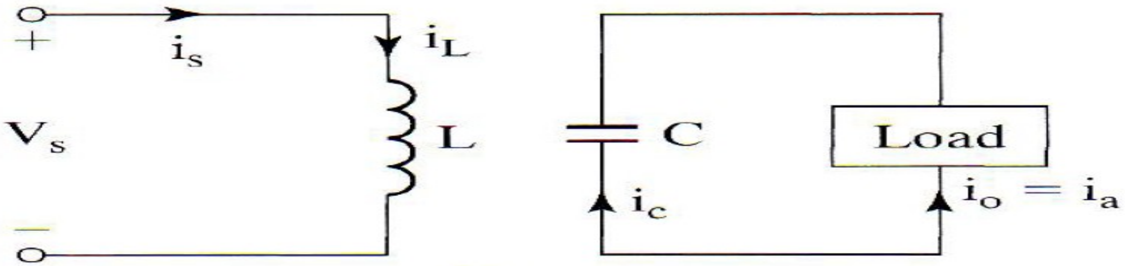
- A buck – boost Regulator provides an output voltage that may be less than or greater than the input voltage- hence the name "buck-boost"; the output voltage polarity is opposite to that of the input voltage. this regulator is also known as an *inverting regulator*.

- The circuit operation can be divided into two modes. during mode 1, transistor Q1 is turned on and diode Dm is reversed biased. the input current, which rises flows through inductor L and transistor Q1. During mode 2, transistor Q1 is switched off and the current, which was flowing through inductor L, would flow through L, C, Dm, and the load. The energy stored in inductor L would be transferred to the load and the inductor current would fall until transistor Q1 is switched on again in the next cycle. The equivalent circuit for the modes are shown in the next slide.

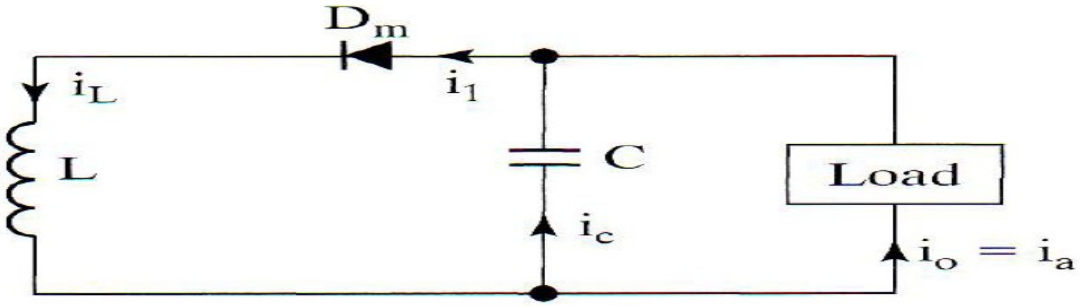
  The wave-forms for steady state voltages and currents of the buck-boost regulator are also shown for a continuous load current.



(a) Circuit diagram

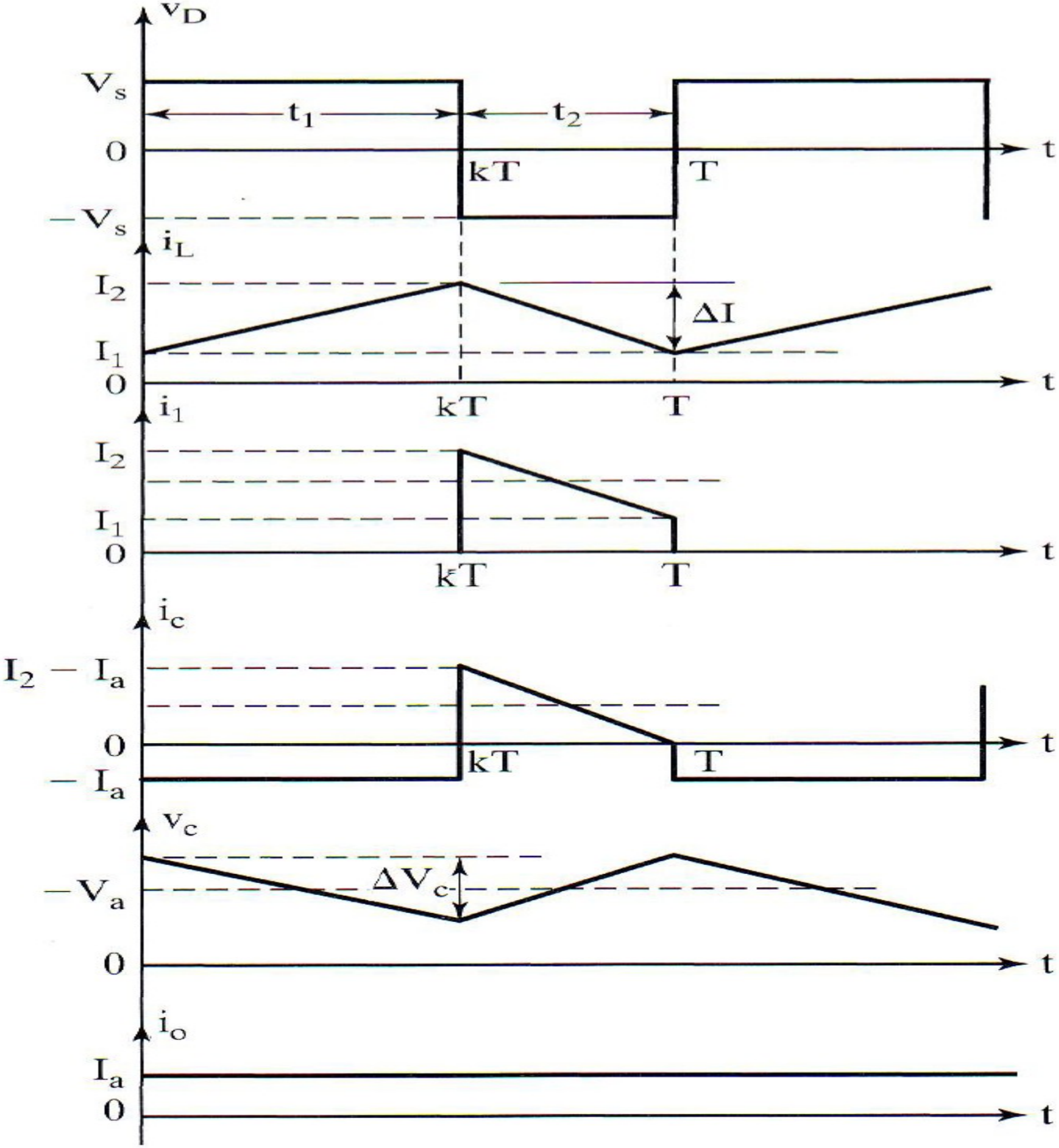


Mode 1



Mode 2

(b) Equivalent circuits


v_D
V_s
t_1
t_2
0
t
kT
T
−V_s
i_L
I_2
ΔI
I_1
0
t
kT
T
i_1
I_2
I_1
0
t
kT
T
i_c
I_2 − I_a
0
t
kT
T
− I_a
v_c
ΔV_c
−V_a
0
t
i_o
I_a
0
t

(c) Waveforms

Assuming that the inductor current rises linearly from I_1 to I_2 in time t_1

$$V_s = L\,\frac{I_2 - I_1}{t_1} = L\,\frac{\Delta I}{t_1}$$

or

$$t_1 = \frac{\Delta I L}{V_s}$$

and the inductor current falls linearly from I_2 I_1 **in time** t_2

$$V_\alpha = -L\frac{\Delta I}{t_2}$$ **or** $$t_2 = \frac{-\Delta I L}{V_\alpha}$$

where $\Delta I = I_2 - I_1$ **is the peak-to-peak ripple current of inductor L,From Eqs,**

$$\Delta I = \frac{V_s t_1}{L} = \frac{-V_\alpha t_2}{L}$$

Substituting $t_1 = kT$ and $t_2 = (1-k)T$, the average output voltage is

$$V_\alpha = -\frac{V_s K}{1-k}$$

Substituting $t_1 = kT$ and $t_2 = (1-k)T$ into eq(5.78) yields

$$(1-k) = -\frac{-V_s}{V_\alpha - V_s}$$

Substituting $t_2 = (1-k)T$, and $(1-k)$ from eq(5.79) into eq(5.78) yields

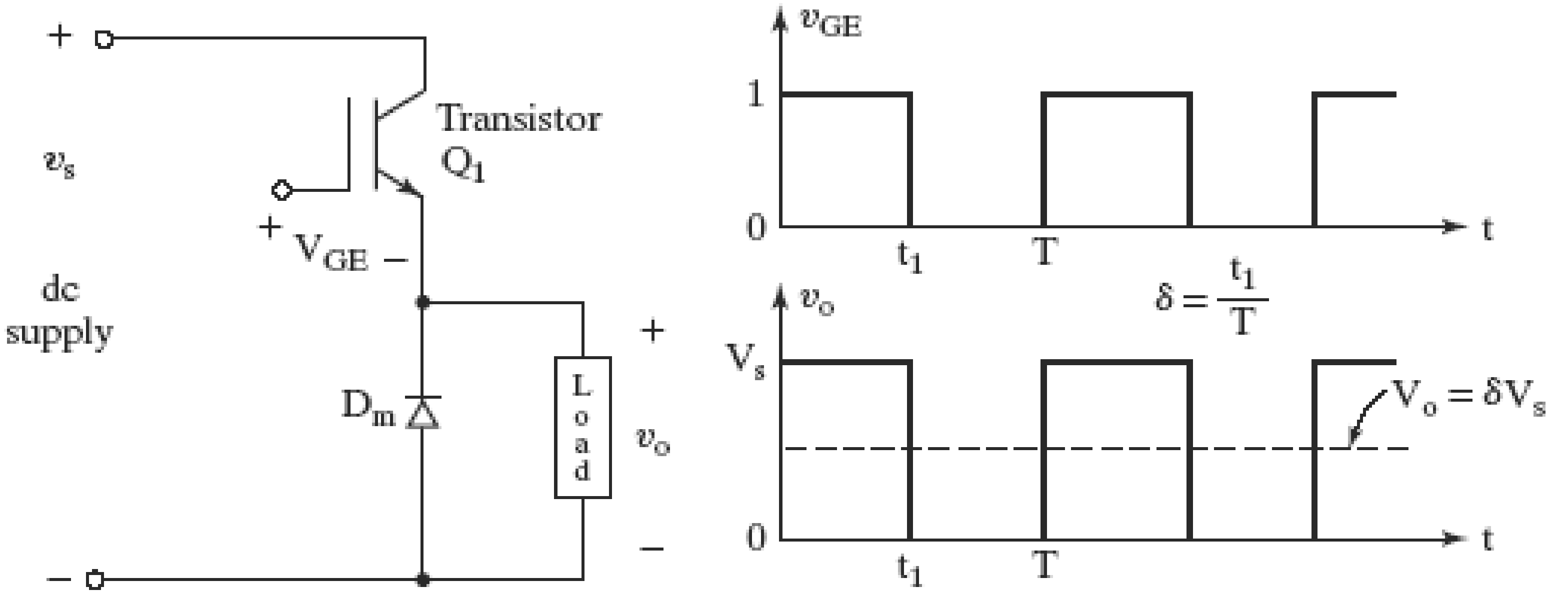
$$t_1 = -\frac{V_\alpha}{(V_\alpha - V_s)f}$$

Assuming a lossless circuirt, $V_s I_s = -V_\alpha I_\alpha = V_s I_\alpha k/(1-k)$

and the average input current I_s is related to the average output current by

$$I_s = \frac{I_\alpha k}{1-k}$$

IGBT in dc-dc Converter



(a) Circuit diagram (b) Voltage waveforms

$$V_{o(average)} = \delta V_S$$

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