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D9A/47

LIC Assignment 1

1. With the help of a functional block diagram explain the working of voltage regulator LM317 to give an output voltage variable from 6V to 12V to handle maximum load current of 500mA

→ Given,

$V_o = 6V$ to $12V$

$V_{ref} = 1.25V$

$I_{adj} = 500mA$

Assume $R_1 = 240\Omega$

$$V_o = V_{ref} + \left(I_{ADJ} + \frac{V_{ref}}{R_1} \right) R_2$$

$$6 = 1.25 + \left(500\times10^{-3} + \frac{1.25}{240} \right) R_2$$

$$4.75 = (500\times10^{-3} + 5.2083\times10^{-3}) R_2$$

$$4.75 = 505.2083\times10^{-3} \cdot R_2$$

$$R_2 = \frac{4.75}{505.2083} \times 10^3$$

$$R_2 = 9\,\Omega$$

When

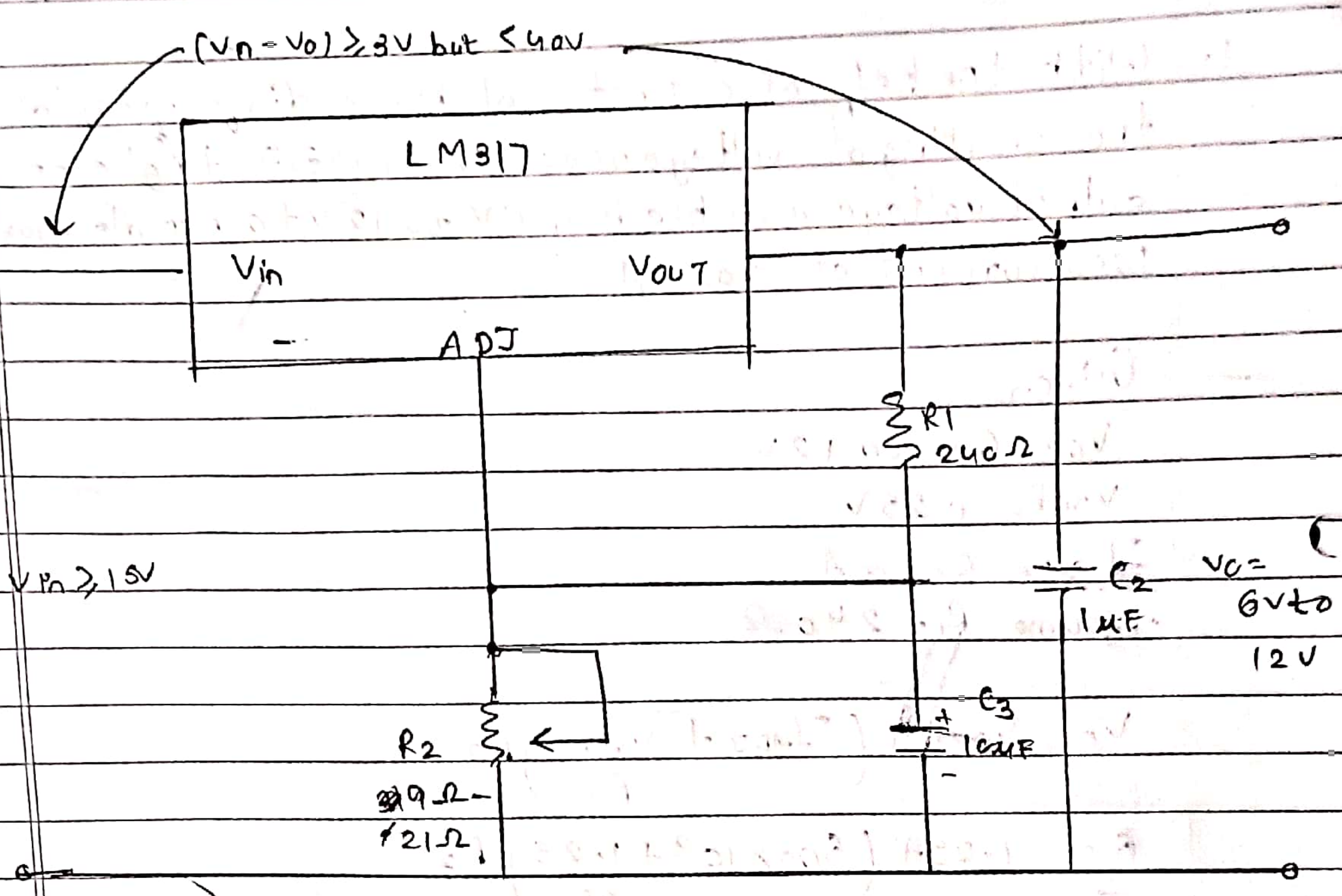
$V_o = 12V$

$$12 = 1.25 + \left(500\times10^{-3} + \frac{1.25}{240} \right) R_2$$

$$10.75 = (505.2083\times10^{-3}) R_2$$

$$R_2 = \frac{10.75\times10^3}{505.2083}$$

$$R_2 = 21.28\,\Omega$$



① Here as per calculations to obtain output voltage of 6V to 12V we need to vary R_2 from 9Ω to 21.3Ω, respectively.

② To accomplish this, we will use a 3kΩ potentiometer for R_2.

③ We assume that regulator is situated close to power supply filter capacitors, therefore we will not use input bypass capacitor C_1. However to provide improved impedance and rejection of transients and to obtain high ripple rejection, we will use an output capacitor C_2 and an adjustment terminal capacitor C_3.

④ There is no need to use diodes because the output voltage is less than 25 V.

2) Explain PLL IC565.

(1) The PLL IC565 is usable over frequency range 0.1 Hz to 500kHz. It has highly stable centre frequency and is able to achieve a very linear FM detection.

(2) The output of VCO is capable of producing TTL compatible square wave. The dual supply is in range of ±6V to ±12V.

-V	1		14	NC
Input	2	L	13	NC
Input	3	M	12	NC
VCO o/p	4	5	11	NC
Input to phase det from vco	5	6	10	+V
Ref output	6	5	9	External C for VCO
Demodulation o/p	7		8	External R for VCO

(3) It is a 14 pin IC, operated from dual power supply +V and -V.

(4) Pin 2 & 3 → Signal input for phase detector

(5) Pin 4 → VCO output is available

(6) Pin 4 & 5 are shortened externally so that VCO o/p is applied for phase detection.

(7) Pin 6 → Ref DC voltage, Pin no 7 is demodulated output

(8) Pin no 8 and 9 → external R1 and C_1 for VCO

(9)

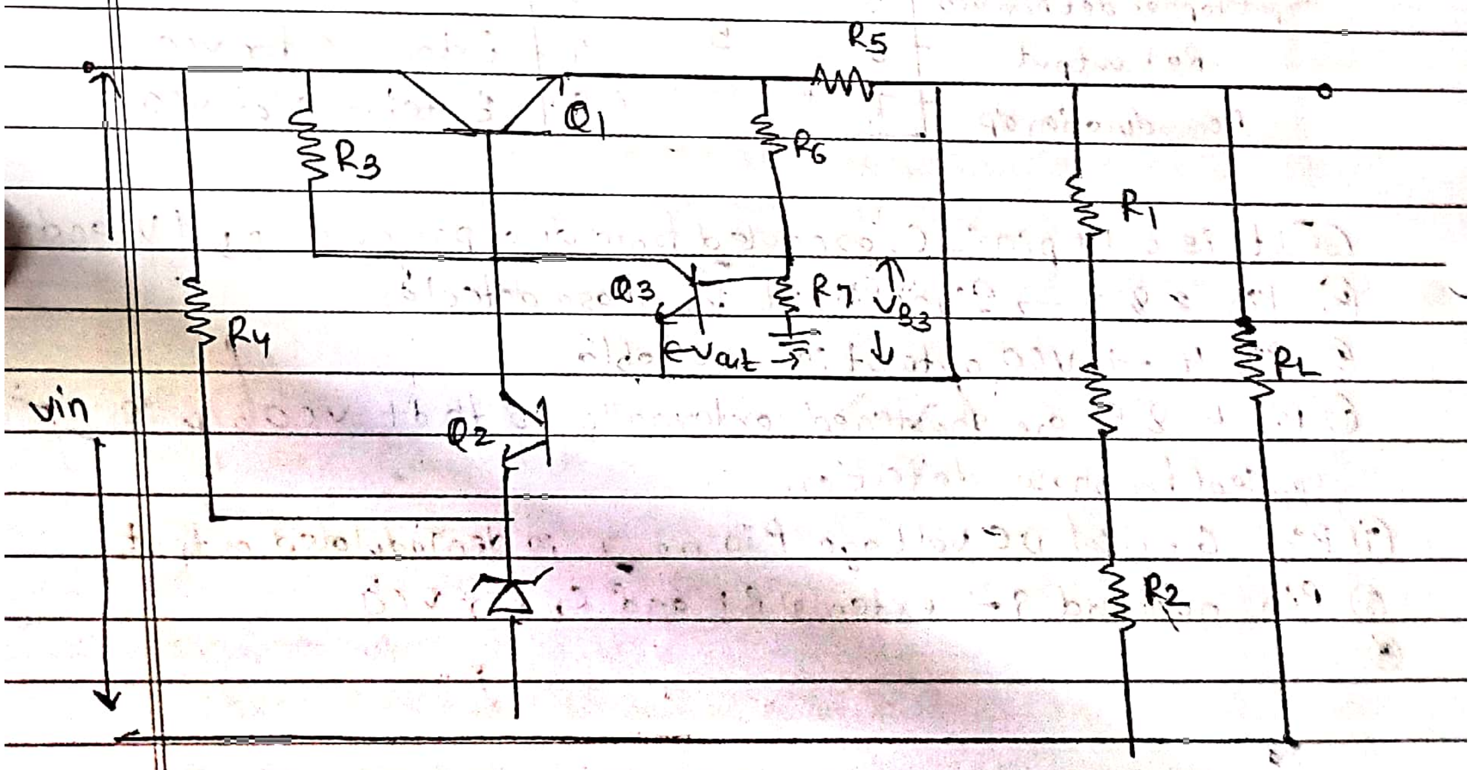
Features of IC 565:

1) Extreme stability of center frequency.
2) Wide range of operating voltage $\pm 6V$ to $\pm 12V$
3) Very high linearity of demodulated output typically 0.2%
4) TTL compatible square wave output.
5) Frequency adjustable love range 1:10 with single capacitor

3> Explain current foldback protection in Regulator

→ ① A drawback of simple current limiting circuit is that there is a large amount of power dissipation in series pass transistor Q_1 when regulated remains short circuited.

② Fold back current limiting is solution to above problem



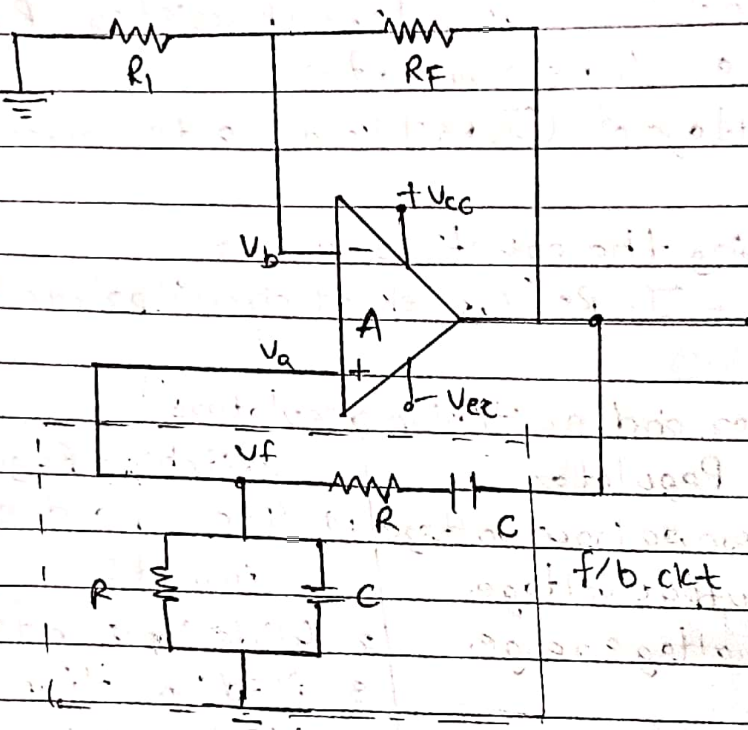
→ i) In this circuit base of Q_3 is biased by a voltage divider network consists of resistors R_6 and R_7.
ii) Load current I_L flows through resistor R_5 causing a voltage drop of $I_L R_5$ across it.
iii) Thus a voltage of $(I_L R_5 + V_{out})$ acts across volt divider $(R_6 - R_7)$.
iv) Further solving the equations, we get
$V_{BE3} = I_L R_5$ (for short circuit protection).

Q. 4) Compare linear and switching regulators.

Linear Regulator	Switching Regulator
1) Only steps down, so input voltage is greater than output voltage.	1) Steps up and steps down, inverts
2) Narrow input voltage range.	2) Wide input voltage range.
3) Low ripple	3) Medium/High Ripple
4) Low to medium efficiency	4) High efficiency
5) Circuit is less complex as it requires only regulator and bypass capacitor of very low value.	5) Circuit is somehow complex because it requires external components and also FETs for high power applications.
6) High power dissipation.	6) Low power dissipation.
7) The output voltage may be fixed or adjustable.	
8) Voltage dropout is higher because of Darlington pass transistor as a switching device	8) Lower voltage dropout.

5) Derive frequency of oscillation of Wein bridge oscillator

→



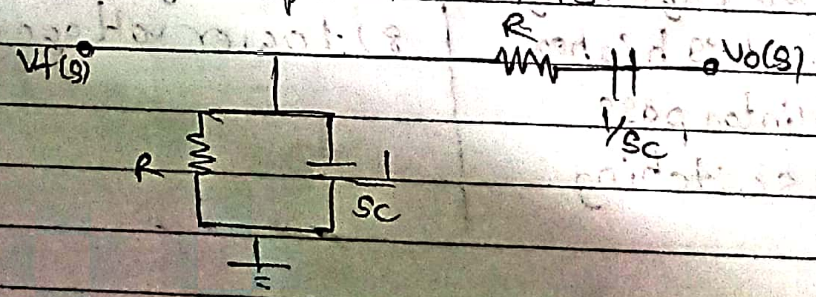
Derivation of Wein bridge oscillator

Prove that $f_0 = \frac{1}{2\pi RC}$ — (1)

$R_F = 2R_1$

First consider the feedback ckt of Wein bridge oscillator

The s domain representation is



According to voltage divider rule,

$$Vf(s) = \frac{Zp(s) \cdot Vo(s)}{Zp(s) + Zs(s)} \quad \text{—— (3)}$$

where $Zp(s) = R \parallel \frac{1}{sC} = \frac{R}{RSC+1}$

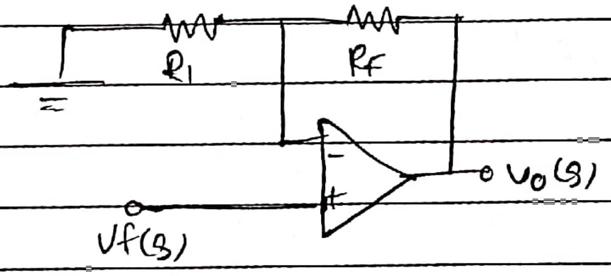
$$Zs(s) = R + \frac{1}{SC} = \frac{RSC+1}{SC}$$

Substitute $Zp(s)$ & $Zs(s)$ in (3),

$$\therefore Vf(s) = \frac{(RSC) \cdot Vo(s)}{(RSC+1)^2 + RSC}$$

or $$\beta = \frac{Vf(s)}{Vo(s)} = \frac{RSC}{R^2S^2C^2 + 3RCS + 1} \quad \text{—— (4)}$$

Let us consider opamp part of oscillator,



The voltage gain of op amp is

$$Av = \frac{Vo(s)}{Vf(s)} = 1 + \frac{R_F}{R_1} \quad \text{—— (4)}$$

Final requirement for oscillator is

$$Av\,\beta = 1$$

$\therefore$ Using eq^n (3) & (4),

$$\left(1 + \frac{R_F}{R_1}\right) \cdot \frac{RCS}{R^2C^2S^2 + 3RCS + 1} = 1$$

Substitute $s = j\omega$ & equate real & imag part

$$\left(1+\frac{R_F}{R_1}\right) jRC\omega = -R^2C^2\omega^2 + j\,3RC\omega + 1$$

Real part,

$$-R^2C^2\omega^2 + 1 = 0$$

$$\therefore R^2C^2\omega^2 = 1$$

$$\therefore \omega^2 = \frac{1}{R^2C^2}$$

$$\therefore \boxed{f_c = \frac{1}{2\pi RC}}$$

Imag part,

$$\left(1+\frac{R_F}{R_1}\right) RC\omega = 3RC\omega$$

$$1+\frac{R_F}{R_1} = 3$$

i.e. $\boxed{R_F = 2R_1}$