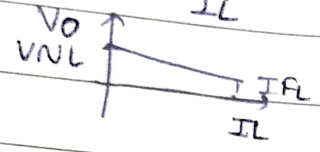
(Begin answer for each question on a

Ch.5 : Voltage Regulators

* Voltage regulator → removes ripples
→ keeps o/p vtg. constant irrespective of change in load or line vtg.

Load regulation

Vo → IL



$$\%LR = \frac{V_{NL} - V_{FL}}{V_{FL}} \times 100$$

Ideally LR = 0.

Line regulation

Vo → Vin

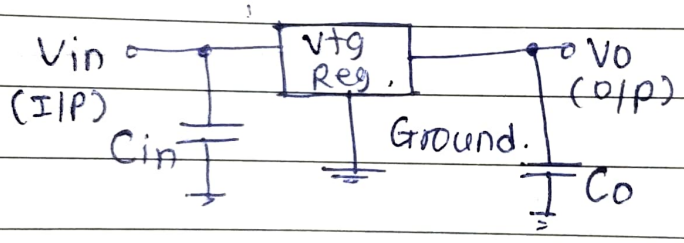
also called source reg.

$$\%SR = \frac{SR}{V_{nom}} \times 100$$

SR = V_L with high line vtg − V_L with low line vtg.

V_{nom} → nominal load vtg.

* 3-terminal fixed vtg. regulators:

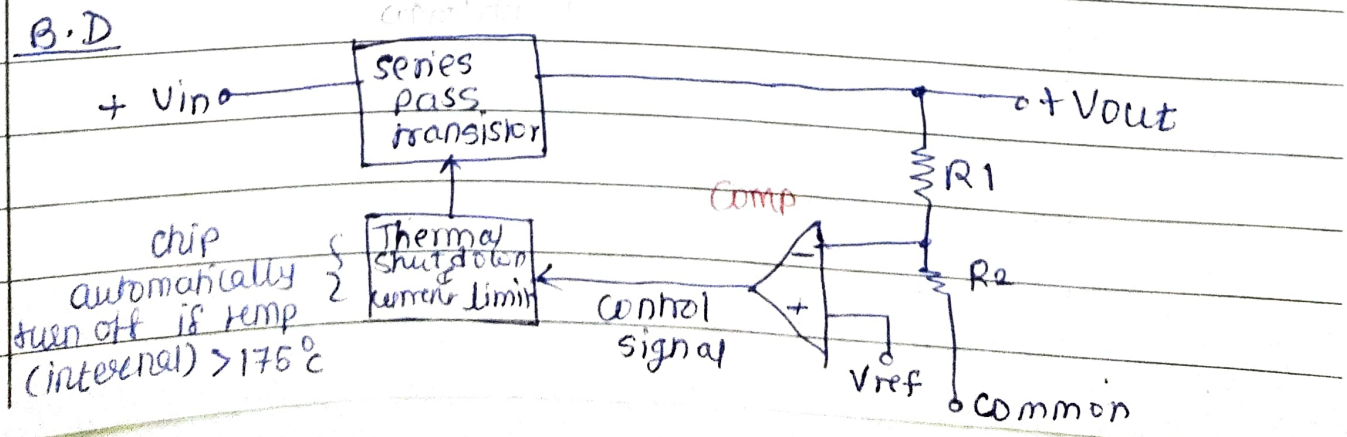


− no f/b, Cin → reg → if regulator is at more than 5cm dist. from PS.

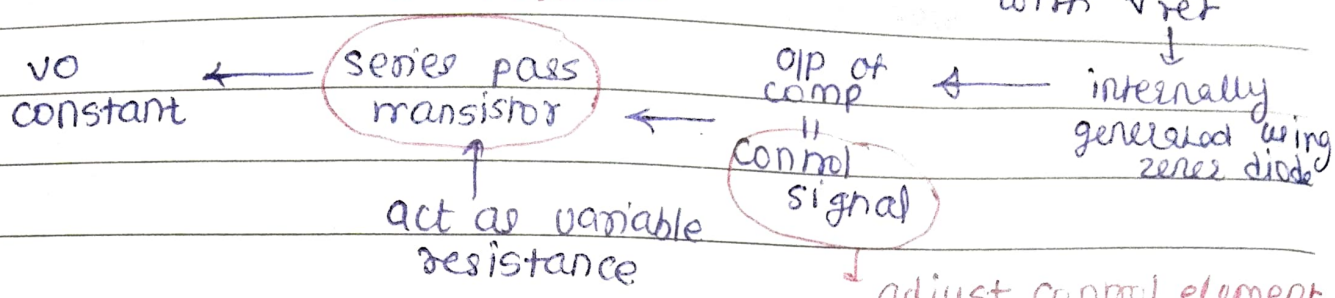
Co → improves transient response of regulator.
→ also ↓ noise at o/p.

(Vin − Vo)ᵐⁱⁿ = dropout vtg. = 2V → for proper fun^c of regulator.

* B.D



- part of o/p vtg. is taken using vtg. divider (R_1, R_2) → compared with V_{ref}



Thermal shutdown → chip automatically turn off if internal temp exceeds 175°C.

* Performance Para. for Regulator ICs :-

- line regulation = $\Delta V_o / \Delta V_i$ → % or mV.
- load regulation = $\Delta V_o / V_{HL} - V_{NL}$ → mV or %.
- ripple rejection → regulator's ability to reject ripple vtg present in i/p → dB.
- R_o → dV_o / dI_o → ↓ as possible.
- Dropout vtg = min vtg. exist betⁿ V_{in} & V_o ≈ 2 to 3 V.
- $V_{in\,max}$ → can be applied to regulator safely.
- $P_{D\,max}$ → max power regulator dissipate without damage.
- I_Q → quiscent current → min current the regulator to perform satisfactorily.
- I_o → $I_{o\,max}$ → rated o/p current.

* 78XX & 79XX :→

78XX → +ve vtg regulators

79XX → -ve vtg regulators.

XX → o/p vtg. rating of IC.

e.g 7805 → 5V , 7905 → −5V

7806 → 6V .. } extra 2 & 5·2

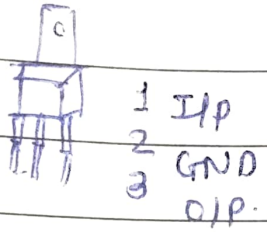
8, 12, 15, 18, 24

(Begin answer for each qu

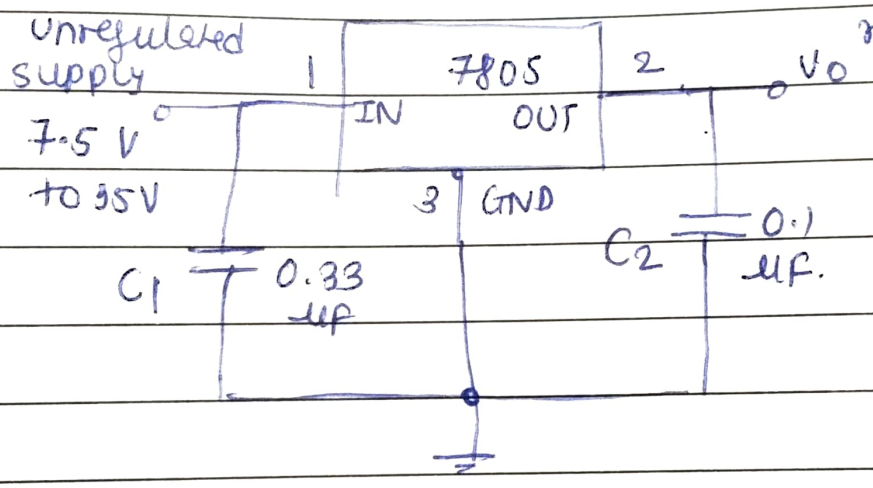
- These ICs does not req. ext components
- internal thermal protection, overload & SC protection.

low power → like transistors

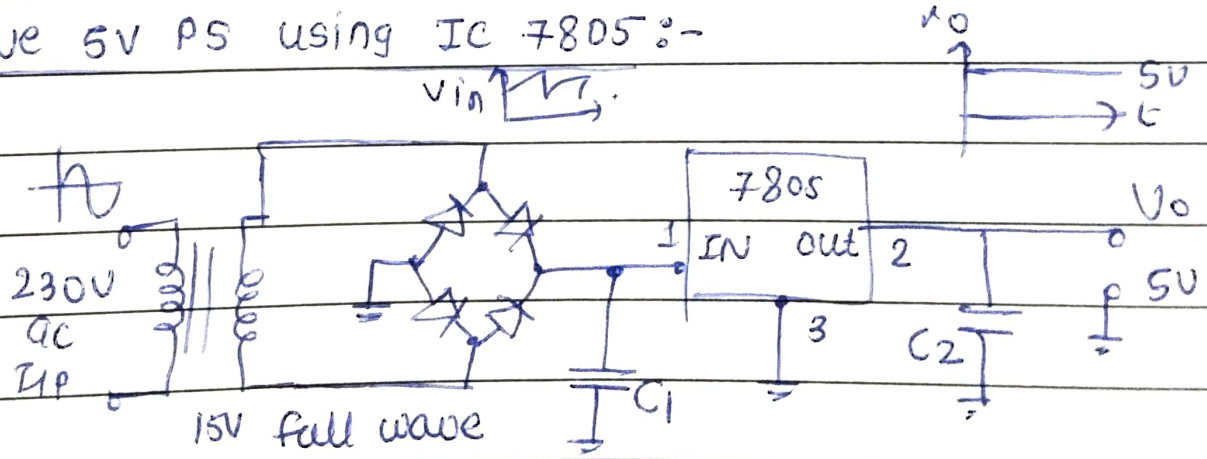
high power → metal cans



★ 7805 regulator:



★ +ve 5V PS using IC 7805 :-



→ 230V → step down to 15V

→ C → V_L → ac + dc → 7805 → regulated O/P V/g

↘ remover ac

IC voltage Regulator

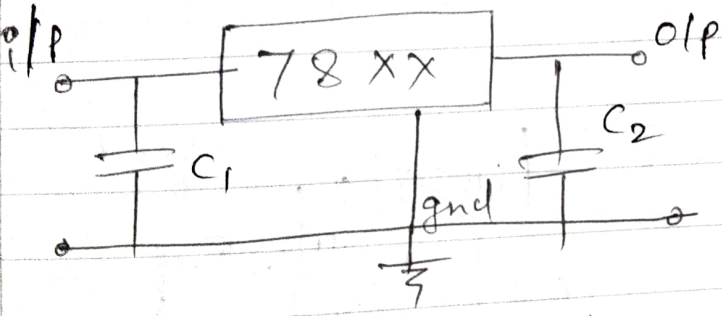
IC voltage regulator is an electronic integrated device which provides constant voltage regardless of changes in load circuits.

Advantages of IC voltage Regulator

→ Compact size & Light in weight
→ Power supply design becomes easy & quick.
→ Very cheap due to mass production.
→ most efficient & reliable.

3 pin voltage Regulator

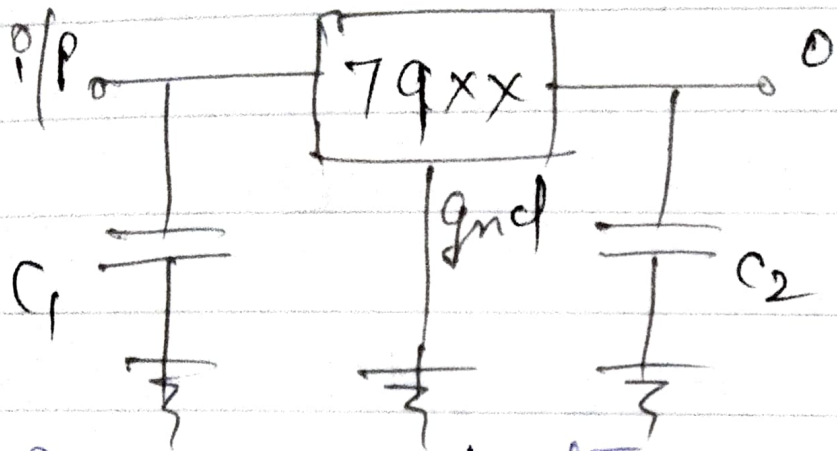
Fixed positive voltage regulator



→ The 7800 series of IC voltage regulators is representative of three terminal device that are available with several fixed positive o/p voltages.
→ The three terminals are i/p, o/p & ground. The last two digit 'XX' in the part number designate the i/p voltage. Eg → 7805 IC is +5V regulator similarly 7812 IC for +12V regulator.
→ C_1 is (0.33μf) required if power supply filter is located more than 3 inches from IC regulator. C_2 (0.01μf) is required to act as a line filter to improve transient response.

→ 78xx series IC regulator can produce o/p voltage ranging between +5 to +24 V.

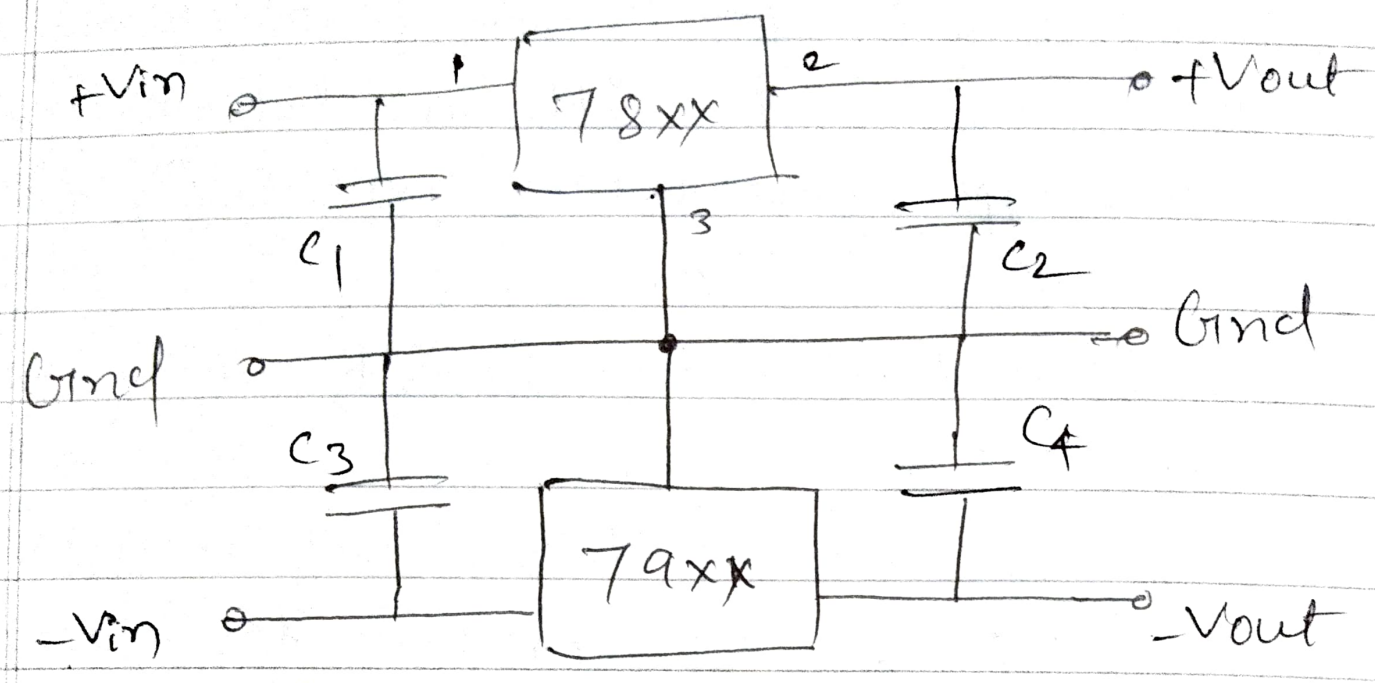
→ Fixed negative voltage regulator



→ 7900 series is typical of three terminal IC regulator that provide fixed -ve o/p voltage. Range is between -5 to -24 V.

→ Reason of C_1 & C_2 are same as previous. ie. C_1 (0.22 µf) is required only if power supply filter is located more than 3 inches away from IC regulator & C_2 (1 µf) is required for stability of o/p voltage.

→ Dual Tracking Regulator

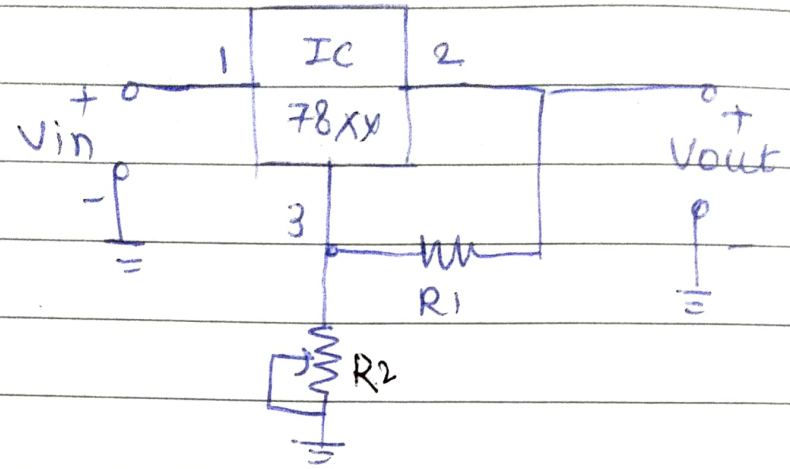


→ Dual tracking regulator is regulator whose o/p can be get by combining an 78xx & 79xx as shown.

→ 78xx regulates +ve o/p & 79xx handles -ve o/p. The i/p capacitor prevents oscillation & o/p capacitor improves transient response.

→ Dual tracking regulator contain +ve & -ve regulator in a single IC package.

* adjustable regulator using IC 78XX :-



$$V_{out} = V_{reg}\left[1 + \frac{R_2}{R_1}\right]$$

where V_{reg} = Regulated fixed vtg. of IC.

R_2 vary → variable o/p vtg.

* Appln →

1. to provide constant dc vtg to electric ckts
2. 5V → digital ckts.
3. 12V → OP-amp.

1 Calculate V_o of adjustable regulator with $R_1 = 5K\Omega$ $R_2 = 10K\Omega$. If R_2 → 1K to 10K find range of V_o. 7808 IC is used

→ $R_1 = 5K$, $R_2 = 10K$, V_{reg} ~~8V~~ 8V

$V_o = V_{reg}.[1 + R_2/R_1] = 8[1 + 10/5) = 8 \times 3 = 24V$

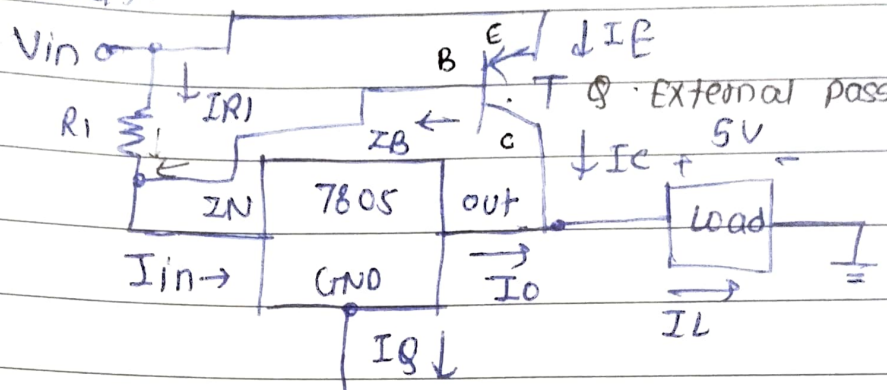
Now $R_2 = 1K$

$V_o = 9.6V$

V_o → 9.6 to 24V.

* Current boosting of regulator :- amplification of o/p current.

→ ↓ cost & size & ↑ current, connect an transistor with regulator itself.



Hence IL from 1A → 10A.

↓ Because

when IL – low, could not drive T ON

when IL ↑ beyond certain limit T-ON & provides excess current.

Io is shared by regulator & transistor.

for low IL → VR1 < 0.7V → T off → IL = Io.

when IL ↑ → VR1 ↑ > 0.7V, T ON → IC

∴ excess current req. is provided by T.

$$\text{as } I_C = \beta I_B$$

$$\therefore I_L = I_C + I_o = \beta I_B + I_o$$

$$\& \quad I_B = I_{in} - I_{R1} \quad (\because I_{in} = I_{R1} + I_B).$$

neglect IG, Iin = Io.

$$\therefore I_B = I_o - I_{R1}$$

$$\text{But } I_{R1} = \frac{V_{BE}}{R_1}$$

$$\therefore I_B = I_o - V_{BE}/R_1$$

$$\therefore I_L = \beta \left[I_o - \frac{V_{BE}}{R_1} \right] + I_o$$

$$\therefore \boxed{I_L = (1+\beta) \cdot I_o - \beta \cdot \frac{V_{BE}}{R_1}}$$

Thus current boosting → Value of β & Io max of regulator.

7805 → current boosting is provided by T with $V_{BE}=1V$ & $\beta=15$. Calculate max load current. Assume $R_1=7\Omega$

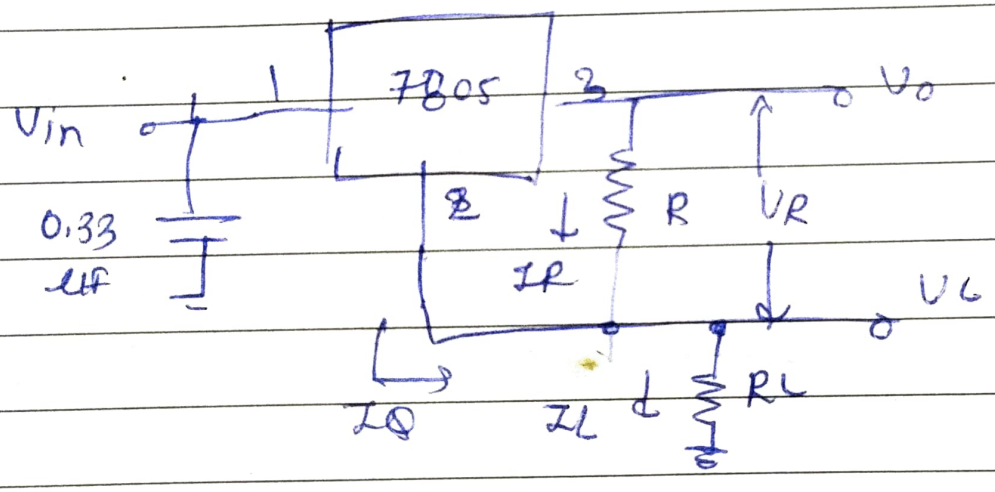
$$I_L = (1+\beta)\cdot I_O - \beta\cdot\frac{V_{BE}}{R_1}$$

$$\therefore I_{L\,max} = (1+\beta)\, I_{O\,max} - \beta\cdot\frac{V_{BE}}{R_1}$$

$$= (1+15)\times 1 - \frac{15\times 1}{7} = 13.85\,A$$

* Current Source

Design a 0.5A current source using IC 7805, $R_L=10\Omega$



$$I_L = I_R + I_O = \frac{V_R}{R} + I_Q \quad (\because I_Q = 4.2\,mA \text{ for } 7805$$

$$I_L = 5/R + 4.2\times 10^{-3} \quad \& \; V_R = 5V \text{ for } 7805$$

$$0.5 = 5/R + 4.2\times 10^{-3} \qquad I_L = 0.5A \text{ - given}$$

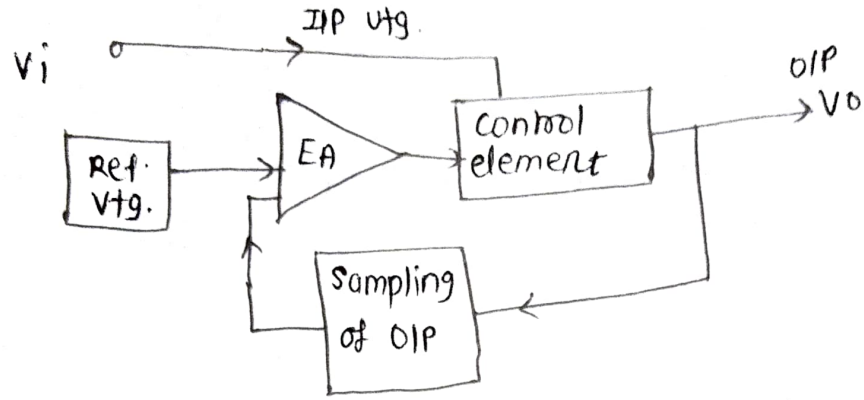
$$R = 10.0847\,\Omega \approx 10\Omega$$

$$V_O = V_R + V_L = 5 + I_L R_L = 5 + 0.5\times 10 = 10V$$

$$V_{in} = V_O + \text{Drop out } V_{reg} = 10+2 = 12V.$$

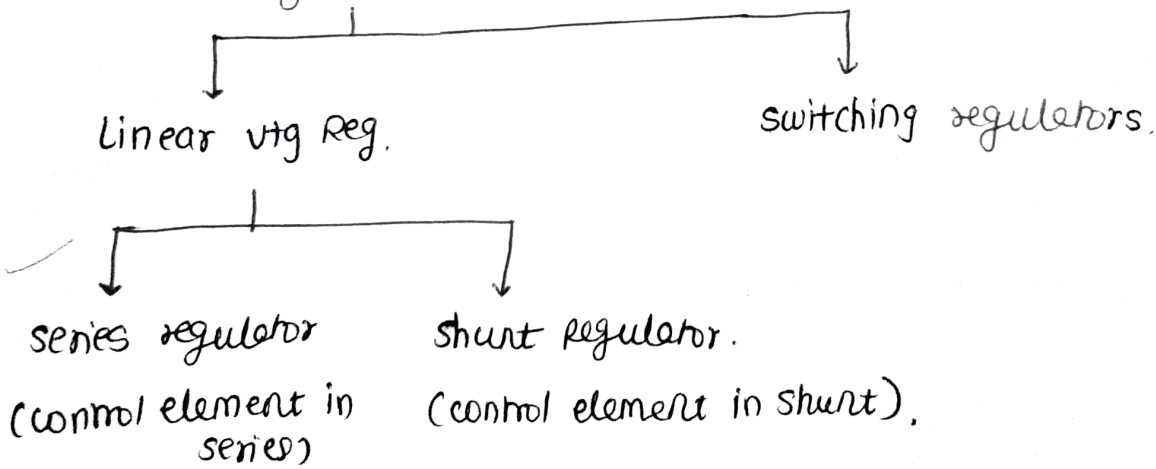
Voltage Regulators :- converts AC-dc at constant level.

a] Linear vtg regulator :-

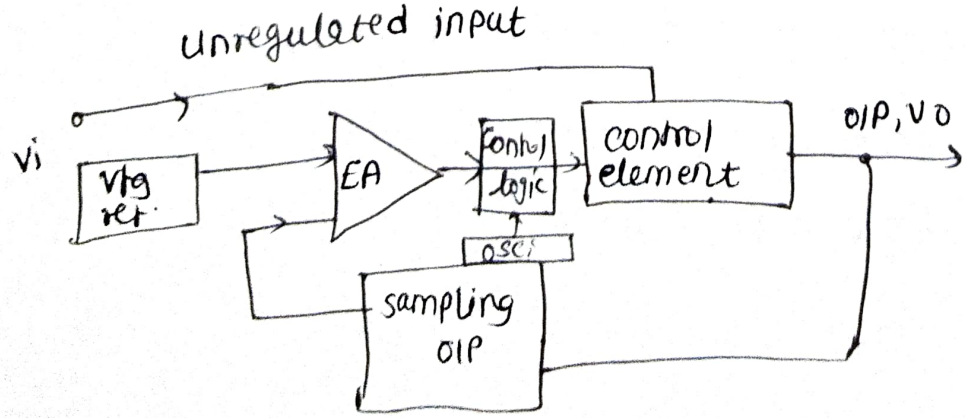


- Unregulated power supply — Vo ↕ - Vi ↕ or RL ↕.
- Regulated Power supply → Vo in not depending on Vi or RL, temp or ripple in Vi

* — Types of Regulators



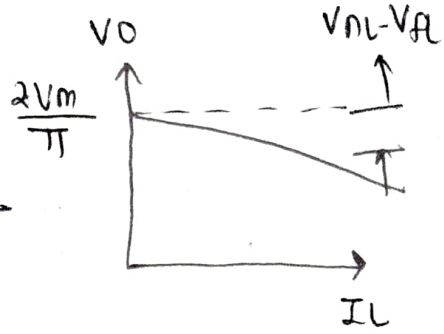
b] switching Regulator :-



Line regulation → change in o/p vtg for a change in line supply vtg. Keeping I_L & temp constant.

$$\text{Line reg.} = \frac{\Delta V_o}{\Delta V_i}\Big|_{I_L = \text{const}}$$

$$\text{Load regulation} = \frac{V_{no\,load} - V_{full\,load}}{V_{full\,load}}$$



* IC Vtg. Regulators:-

1) fixed +ve / -ve o/p vtg regulators.
2) Adjustable o/p vtg reg.

Adv of IC vtg regulators:-

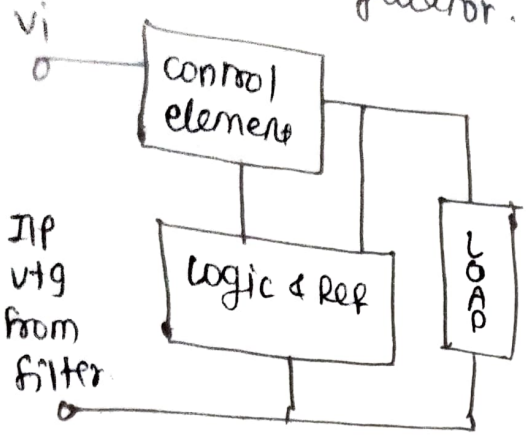
1) Versatile
2) relatively inexpensive
3) programmable o/p
4) current / vtg boosting.
5) floating operation for high vtg.

* Fixed vtg. Regulators:-

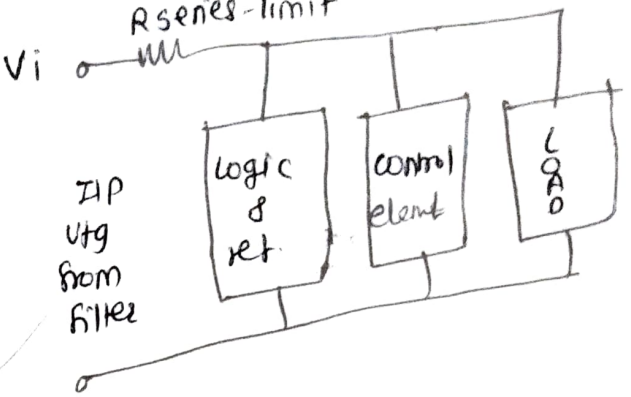
78XX → for 3 terminal +ve fixed vtg. regulators.
7805, 7506, 7808, 7812, 7815, 7818 & 7824.

79XX → for 3 terminal -ve fixed vtg. reg.
above 7 + for -2V & for -5.2V.

* Series vtg. Regulator.



Shunt vtg. regulator:



LMPS :

B.D.