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Internal Assessment Test - II

Sub:	Operational Amplifiers and Linear IC's							Code:	18EE46
Date:	4/08/22	Duration:	90 mins	Max Marks:	50	Sem:	4th	Branch:	EEE

Answer Any FIVE FULL Questions

		Marks	OBE	
			CO	RBT
1	Define the following terms 1)Load regulation 2) Line regulation 3) Ripple rejection with formula.	10	CO2	L2
2	Design an adjustable positive voltage regulator using LM317 for output voltage varying from 3 to 11V and output current of 0.5A and Explain the need of Voltage Regulator.	10	CO2	L2
3	Explain with the neat circuit diagram & waveform the operation of Inverting and non-inverting Zero crossing detector	10	CO3	L2
4	Design an Non-Inverting Schmitt trigger with V_{UTP}=+1V and V_{LTP}= -3V.Consider supply voltage as ±15V.	10	CO2	L3
5	With neat circuit diagram, explain the working RC phase shift oscillator and design an RC phase shift oscillator of frequency 1kHz.	10	CO3	L2
6	Explain in detail, the working of triangular waveform generation circuit, with suitable waveform.	10	CO3	L3

CI **CCI** **HOD**

1.

- The Line regulation defines the variation in output voltage (ΔV_o) that occurs when the supply voltage (V_s) increases or decreases by a specified amount, usually 10 %. The output voltage change is expressed as a percentage of the normal dc output voltage (V_o). Thus, **Line Regulation** can be mathematically expressed as:

$$\text{Line regulation} = \frac{(\Delta V_o \text{ for a } 10\% \text{ change in } V_S) \times 100\%}{V_o}$$

- The Load regulation defines the regulator performance in relation to load current variation. When the load current changes from zero to full load, then the output voltage also changes by an amount of (ΔV_o). It is expressed as a percentage of the normal dc output voltage (V_o). The **Load Regulation** can be mathematically expressed as:

$$\text{Load regulation} = \frac{(\Delta V_o \text{ for } \Delta I_{L(max)}) \times 100\%}{V_o}$$

- The Ripple rejection is a factor which indicates how effectively the regulator circuit rejects the ripple and attenuates it from input to output. If VR is the ripple voltage, then Ripple rejection is defined as:

$$RR = \frac{\text{Ripple content in output}}{\text{Ripple content in input}} = \frac{V_{R(out)}}{V_{R(in)}}$$

In a datasheet of a regulator, this factor is expressed in units decibels (dB) as,

$$RR' = 20\,\text{Log}_{10}RR\ \text{dB}$$

2.

3V to 11V
0.5A

For LM317, $I_{ADJ} = 100\mu A$

select $R_1 = 240\Omega$

for $V_0 = 1.25\left[1 + \frac{R_2}{R_1}\right] + I_{ADJ} R_2$

$$3 = 1.25\left[1 + \frac{R_2}{240}\right] + 100 \times 10^{-6} R_2$$

$$3 = 1.25\left[\frac{240 + R_2}{240}\right] + 100 \times 10^{-6} R_2$$

$$= \frac{300 + 1.25 R_2}{240} + 100 \times 10^{-6} \times R_2$$

$$300 + 1.25 R_2 + 0.024 R_2 = 720$$

$$1.274 R_2 = 420 \quad R_2 = \underline{\underline{329\Omega}}$$

$$11 = 1.25\left[1 + \frac{R_2}{240}\right] + I_{ADJ} R_2$$

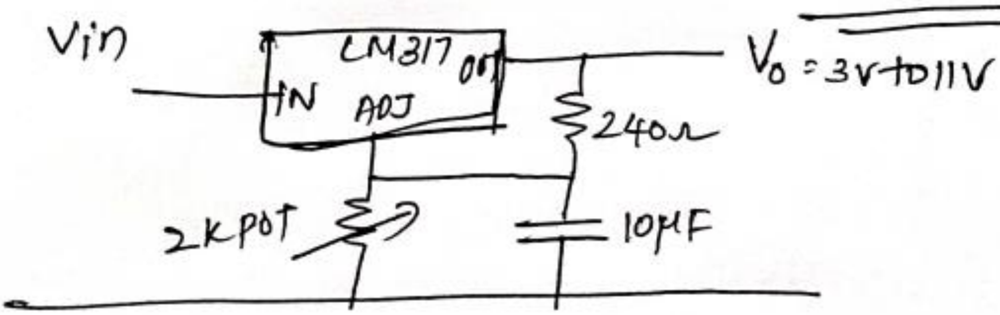
$$11 = 300 + 1.25 R_2 + 0.024 R_2$$

$$1.274 R_2 = 2340$$

$$R_2 = 1836\Omega$$

R_2 to be varied from 329Ω to 1826Ω

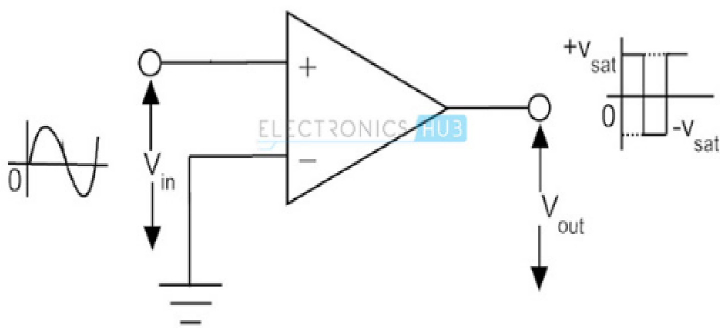
So $2k\Omega$ pot



3.

Non-Inverting Zero Crossing Detector

If the input signal source is connected to the non-inverting input terminal of the op-amp and the inverting input terminal is grounded, the circuit is called a Non-inverting zero crossing detector. The circuit diagram is shown in the figure below.

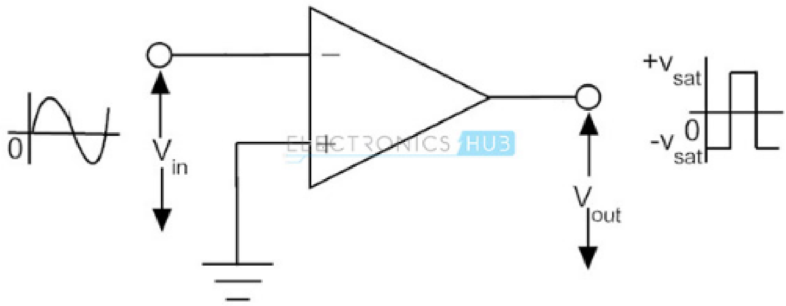


Non-Inverting Zero Crossing Detector

When the input signal is above ground level, the output of the circuit is saturated at its positive extreme. When the input goes below ground level, the output voltage of the circuit immediately switches to its negative saturation level. Every time when the input signal crosses the zero voltage level, the output switches between one saturation level and the other. Since the output of the above circuit goes into positive saturation when the applied input voltage is positive, the circuit is categorized as a non-inverting zero crossing detector. The input and output waveforms of a typical non-inverting zero crossing detector is shown in the above figure. Regardless of the shape of the input wave, the output is always a rectangular wave.

Inverting Zero Crossing Detector

If the input signal is applied to the inverting input terminal of the op-amp, and the non-inverting input terminal is connected to ground, the circuit is called an inverting zero crossing detector. The circuit is shown in the figure below.



Inverting Zero Crossing Detector

When the input is above ground level, the output is saturated at the negative extreme voltage. When the input voltage goes below ground level, the output immediately switches to positive saturation voltage. Since the output is saturated at negative voltage when the input is positive, this circuit is called as an inverting zero crossing detector. The input and output waveforms of an inverting zero crossing detector is shown in the figure above.

4.

$V_{UTP} = +1V \qquad V_{LTP} = -3V$.

$$R_2 = \frac{V_{UTP}}{I_2} = \frac{1}{500\mu A} = 2k\Omega \qquad \boxed{R_2 = 2k\Omega}$$

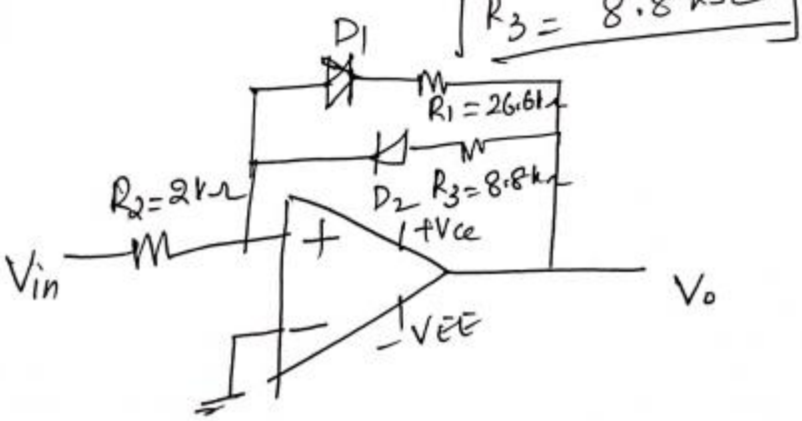
for $V_{cc} = +15V \qquad V_o = \pm 14$

$$UTP = \frac{(V_o - V_F) R_2}{R_1} \qquad 1 = \frac{(14-0.7)\times 2k\Omega}{R_1}$$

$$\boxed{R_1 = 26.6\, k\Omega}$$

$$|LTP| = \frac{(V_o - V_F) R_2}{R_3} \qquad R_3 = \frac{(14-0.7)\times 2k\Omega}{3}$$

$$\boxed{R_3 = 8.8\, k\Omega}$$



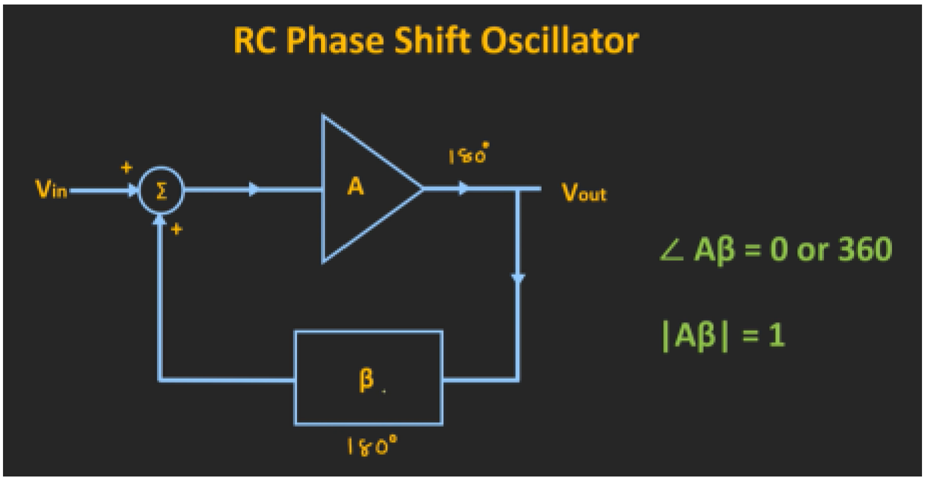
5.

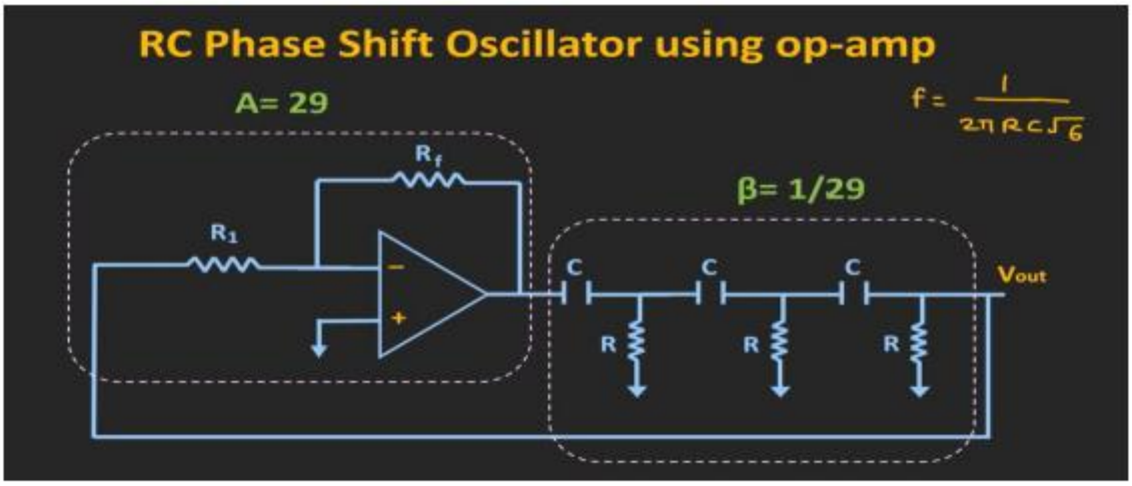
Design Criteria for Oscillators

1. The magnitude of the loop gain must be unity or slightly larger

$$|A\beta| = 1$$ – Barkhaussen criterion

2. Total phase shift, ϕ of the loop gain mus t be o ° or 360°





❖For the loop gain βA to be greater than unity, the gain of the amplifier stage must be greater than 29.

❖If we measure the phase-shift per RC section, each section would not provide the same phase shift (although the overall phase shift is 180°).

❖In order to obtain exactly 60° phase shift for each of three stages, emitter follower stages would be needed for each RC section

For $f =$ 1Khz Hz

$$f = \frac{1}{2\pi\sqrt{6}RC}$$

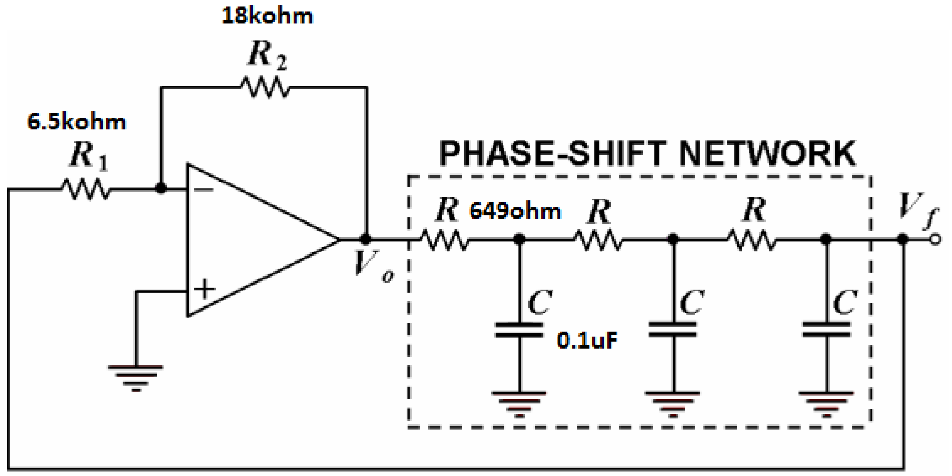
Let $C = 0.1\mu F$

$$R = \frac{1}{2\pi\sqrt{6} f C} = 650 \text{ ohm}$$

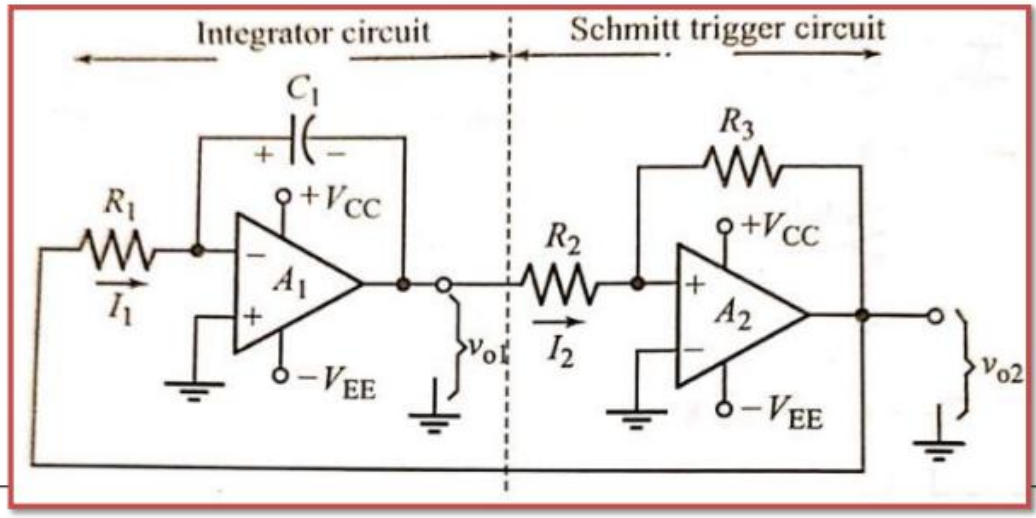
For Amplifier

$R_1 = 10R =$ 6.5 kohm

$R_F = 29 R_1 =$ 18kohm $=$



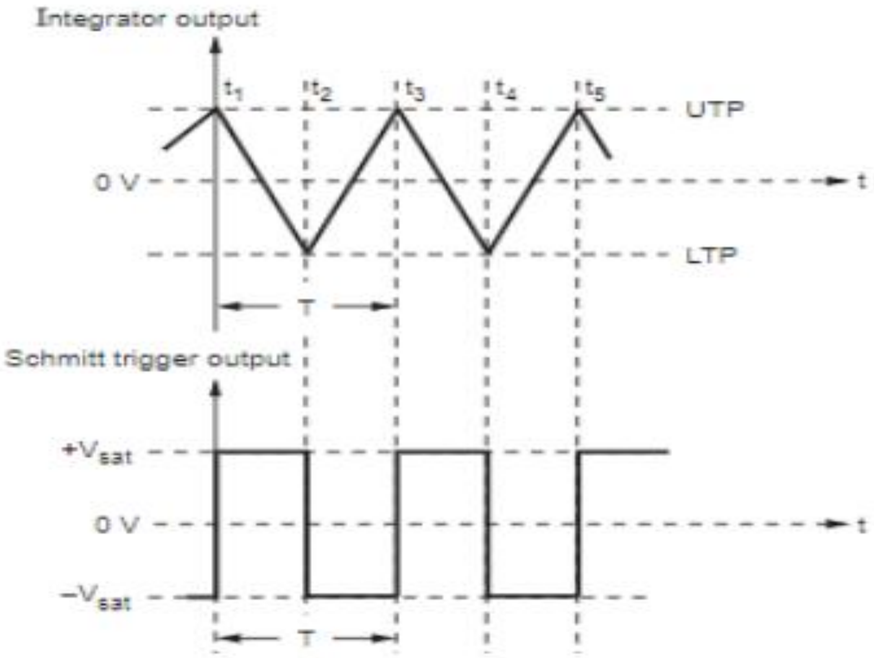
6.



The output of an integrator is triangular if its input is square wave input. While output of a Schmitt trigger is square wave for any input. Thus if output of Schmitt trigger is applied to input of integrator and output of integrator as input to Schmitt trigger then the circuit works as a triangular/rectangular wave generator.

Let the output of the Schmitt trigger is $+V_{sat}$. This forces current $+V_{sat}/R_1$ through C_1, charging C_1 with polarity positive to left and negative to right. This produces negative going ramp at its output, for the time interval t_1 to t_2. At t_2 when ramp voltage attains a value equal to LTP of Schmitt trigger, the output of Schmitt trigger changes its stage from $+V_{sat}$ to $-V_{sat}$.

Now direction of current through C_1 reverses. It discharges and recharges in opposite direction with polarity positive to right and negative to left. This produces positive going ramp at its output, for the time interval t_2 to t_3. At t_3 when ramp voltage attains a value equal to UTP of Schmitt trigger, the output of Schmitt trigger changes its state from $-V_{sat}$ to $+V_{sat}$ and cycle continues.



Integrator output
t_1
t_2
t_3
t_4
t_5
UTP
0 V
t
LTP
T
Schmitt trigger output
$+V_{sat}$
0 V
t
$-V_{sat}$
T