ELECTRONICS CIRCUITS II AND SIMULATION LAB

LIST OF EXPERIMENTS

CYCLE I

1. SERIES AND SHUNT FEED BACK AMPLIFIERS
2. DESIGN OF WEIN BRIDGE OSCILLATOR
3. DESIGN OF TRANSISTOR RC PHASE SHIFT OSCILLATOR
4. DESIGN OF LC – HARTLEY AND COLPITTS OSCILLATOR
5. CLASS C TUNED AMPLIFIER
6. INTEGRATORS AND DIFFERENTIATORS
7. CLIPPERS AND CLAMPERS
8. DESIGN OF MONOSTABLE MULTIVIBRATOR
9. DESIGN OF ASTABLE MULTIVIBRATOR
10. DESIGN OF BISTABLE MULTIVIBRATOR

CYCLE II - SIMULATION USING PSPICE

1. DIFFERENTIATE AMPLIFIER
2. ACTIVE FILTER : BUTTERWORTH II ORDER LPF
3. ASTABLE, MONOSTABLE AND BISTABLE MULTIVIBRATOR – TRANSISTOR BIAS
4. D / A and A/D CONVERTER (SUCCESSIVE APPROXIMATION)
5. ANALOG MULTIPLIER
6. CMOS INVERTOR, NAND AND NOR
1. FEED BACK AMPLIFIER

**AIM:**
To design and test the current series and voltage shunt Feedback Amplifier and to calculate the following parameters with and without feedback.
1. Mid band gain.
2. Bandwidth and cutoff frequencies.
3. Input and output impedance.

**APPARATUS REQUIRED:**

<table>
<thead>
<tr>
<th>S.NO</th>
<th>ITEM</th>
<th>RANGE</th>
<th>Q.TY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TRANSISTOR</td>
<td>BC 107</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>RESISTOR</td>
<td></td>
<td>1</td>
</tr>
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<td>3</td>
<td>CAPACITOR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>CRO</td>
<td>(0-30) MHz</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>RPS</td>
<td>(0-30) V</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>FUNCTION GENERATOR</td>
<td>(0 – 1) MHZ</td>
<td>1</td>
</tr>
</tbody>
</table>

**CURRENT SERIES FEEDBACK**

**DESIGN:** (Without Feedback):

Given data: \( V_{cc} = 15V \), \( \beta = 0.9 \), \( f_L = 1kHz \), \( I_c = 1mA \).

Stability factor = \([2-10]\), \( R_s = 680\Omega \),

\( A_v = 50\text{dB} \), \( I_E = 1.2mA \).

Gain formula is given by

\[ A_v = -hfe \frac{R_{\text{eff}}}{Z_i} \]

Assume,

\[ V_{\text{CE}} = \frac{V_{cc}}{2} \]

\[ R_{\text{eff}} = \frac{R_c}{RL} \]

\[ re = 26\text{mV} / I_E \]

\[ hie = \beta re \] where \( re \) is internal resistance of the transistor.

\[ hie = hfe re \]

\[ V_E = \frac{V_{cc}}{10} \]

On applying KVL to output loop,
\[ V_{cc} = I_c R_c + V_{CE} + I_E R_E \]
\[ V_E = I_E R_E \]
\[ R_c = ? \]

Since \( I_B \) is very small when compared with \( I_C \)
\[ I_c \text{ approximately equal to } I_E \]
\[ R_E = V_E / I_E = ? \]
\[ V_B = V_{BE} + V_E \]
\[ V_B = V_{CC} \cdot R_{B2} / R_{B1} + R_{B2} \]
\[ S = 1 + (R_B / R_E) \]
\[ R_B = ? \]
\[ R_B = R_{B1} \text{ or } R_{B2} \]

Find

Input Impedance , \( Z_i = ( R_B \| h_{ie} ) \)

Coupling and bypass capacitors can be thus found out.

Input coupling capacitor is given by , \( X_{ci} = Z_i / 10 \)
\[ X_{ci} = 1 / 2 \pi f C_i \]
\[ C_i = ? \]

output coupling capacitor is given by ,
\[ X_{co} = (R_c \| R_L) / 10 \]
\[ X_{co} = 1 / 2 \pi f C_o \]
\[ C_o = ? \]

By-pass capacitor is given by , \( X_{CE} = 1 / 2 \pi f C_E \)
\[ C_E = ? \]

Design ( With feedback ) :

Remove the emitter capacitance ( \( C_E \) )
\[ \beta = -1 / R_E \]
\[ Gm = - h_{fe} / [(h_{ie} + R_E) \| R_B] \]
\[ D = 1 + \beta G_m \]
\[ G_{mf} = \frac{G_m}{D} \]
\[ Z_f = Z_i D \]
\[ Z_{of} = Z_o D \]

CIRCUIT DIAGRAM: WITHOUT FEEDBACK:

WITH FEEDBACK:
Voltage shunt DESIGN: (Without Feedback):

Given data: \( V_{cc} = 15V \), \( f_L = 1kHz \), \( I_c = 1mA \).

- Stability factor = [2-10], \( R_s = 680\Omega \), \( Av = 40 \text{ dB} \).

Gain formula is given by

\[ Av = -hfe \frac{R_{\text{Leff}}}{Z_i} \]

Assume, \( V_{CE} = \frac{V_{cc}}{2} \)

\[ R_{\text{Leff}} = R_c \parallel R_L \]

- \( re = 26mV / I_E \)
- \( hie = \beta re \) where \( re \) is internal resistance of the transistor.
  \[ hie = hfe \, re \]
- \( V_E = \frac{V_{cc}}{10} \)

On applying KVL to output loop,

\[ V_{cc} = I_c R_c + V_{CE} + I_E R_E \]

\[ V_E = I_E R_E \]

\[ R_c = ? \]

Since \( I_B \) is very small when compared with \( I_c \)

- \( I_c \) approximately equal to \( I_E \)
  \[ R_E = \frac{V_E}{I_E} = ? \]

\[ V_B = V_{BE} + V_E \]

\[ V_B = V_{CC} . \frac{R_{B2}}{R_{B1} + R_{B2}} \]

\[ S = 1+ \frac{R_B}{R_E} \]

\[ R_B = ? \]

\[ R_B = R_{B1} \parallel R_{B2} \]

Find

Input Impedance, \( Z_i = (R_B \parallel hie) \)
Coupling and bypass capacitors can be thus found out.

Input coupling capacitor is given by, \( X_{ci} = \frac{Z_i}{10} \)

\[ X_{ci} = \frac{1}{2\pi f C_i} \]

\[ C_i = ? \]

Output coupling capacitor is given by,

\[ X_{co} = \frac{(Rc \parallel RL)}{10} \]

\[ X_{co} = \frac{1}{2\pi f C_o} \]

\[ C_o = ? \]

By-pass capacitor is given by, \( X_{CE} = \frac{1}{2\pi f C_e} \)

\[ C_e = ? \]

Design (With feedback):

Connect the feedback resistance \( (R_f) \) and feedback capacitor \((C_f)\) as shown in the figure.

\[ X_{cf} = \frac{R_f}{10} \]

\[ C_f = \frac{R_f}{2\pi f} \times 10 \]

Assume, \( R_f = 68 \, K\Omega \)

\[ \beta = -\frac{1}{R_f} \]

Trans – resistance \( R_m = -h_{fe} (RB \parallel R_f) (Rc \parallel R_f) / (RB \parallel R_f) + hie \)

\[ D = 1 + \beta R_m \]

\[ Av_f = \frac{Rmf}{Rs} \]

\[ Rmf = \frac{Rm}{D} \]

\[ Z_{if} = \frac{Z_i}{D} \]

\[ Z_{of} = \frac{Z_o}{D} \]
CIRCUIT DIAGRAM: Voltage shunt feedback

WITHOUT FEEDBACK:

WITH FEEDBACK:

Vin
F = 1 KHz

Vo

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MODEL GRAPH (WITH & WITHOUT FEEDBACK)

Without feedback

With feedback

f2 – f1 = Bandwidth of without feedback circuit
f4 – f3 = Bandwidth of with feedback circuit

THEORY:

An amplifier whose function fraction of output is feedback to the input is called feedback amplifier. Depending upon whether the input is in phase or out of phase with the feedback signal, they are classified into positive feedback and negative feedback. If the feedback signal is in phase with the input, then the wave will have positive gain. Then the amplifier is said to have a positive feedback.

If the feedback signal is out of phase with the input, then the wave will have a negative gain. The amplifier is said to have a negative feedback. The values of voltage gain and bandwidth without feedback.

PROCEDURE:

The connections are made as shown in the circuit. The amplifier is checked for its correct operation. Set the input voltage to a fixed value. Keeping the input voltage Vary the input frequency from 0Hz to 1MHz and note down the corresponding output voltage. plot the graph : gain (dB) vs frequency. Find the input and output impedances. Calculate the bandwidth from the graph. Remove RE and follow the same procedure.
**OBSERVATION:**

**WITH OUT FEEDBACK**

\[ \text{Vin} = \text{--------- Volts} \]

<table>
<thead>
<tr>
<th>S.NO</th>
<th>FREQUENCY</th>
<th>O/P voltage</th>
<th>Gain Av=20 log Vo/Vi</th>
</tr>
</thead>
<tbody>
<tr>
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**WITH FEEDBACK**

<table>
<thead>
<tr>
<th>S.NO</th>
<th>FREQUENCY</th>
<th>O/P voltage</th>
<th>Av=20 log Vo/Vi</th>
</tr>
</thead>
<tbody>
<tr>
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**RESULT:**

<table>
<thead>
<tr>
<th>Theoretical</th>
<th>Practical</th>
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<tbody>
<tr>
<td></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>With F/B</th>
<th>Without F/B</th>
<th>With F/B</th>
<th>Without F/B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Impedance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output impedance</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Bandwidth</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Transconductance (gm)</td>
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</tr>
</tbody>
</table>

2. **WEIN BRIDGE OSCILLATOR**
Aim: To Design and construct a Wein – Bridge Oscillator for a given cut-off frequency.

APPARATUS REQUIRED:

<table>
<thead>
<tr>
<th>S.NO</th>
<th>ITEM</th>
<th>RANGE</th>
<th>Q.TY</th>
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<tbody>
<tr>
<td>1</td>
<td>TRANSISTOR</td>
<td>BC107</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>RESISTOR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CAPACITOR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>CRO</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>RPS</td>
<td>DUAL(0-30) V</td>
<td>1</td>
</tr>
</tbody>
</table>

CIRCUIT DIAGRAM:
Given : \( Vcc = 12V \), \( fo = 2 \text{ KHz} \), \( I_{c1} = I_{c2} = 1mA \); Stability factor = [0-10], 
\( fL = 100\text{Hz} \)

When the bridge is balanced, 
\( fo = \frac{1}{2\pi RC} \)

Assume, \( C = 0.1\mu\text{F} \)

Find, \( fo = ? \)

Given data : \( Vcc = 15V \), \( fL = 50\text{Hz} \), \( I_{c1} = I_{c2} = 1mA \); \( A_{VT} = 3 \); \( Av1 =2; Av2 = 1; \)

Stability factor = [10] 
Gain formula is given by 
\[ Av = \frac{-hfe \cdot R_{Leff}}{Z_i} \]

\[ R_{Leff} = \frac{R_c}{|RL|} \]
\( hfe_2 = 200 \) (from multimeter )
\[ re_2 = 26\text{mV} \cdot I_{E2} = 26 \]
\[ hie_2 = hfe_2 \cdot re_2 = 200 \cdot 26 = 5.2k\Omega \]

From dc bias analysis, on applying KVL to the outer loop, we get 
\[ Vcc = I_{c2}R_{c2} + V_{CE2} + V_{E2} \]
\[ V_{CE2} = V_{cc}/2 \]; \( V_{E2} = Vcc / 10 \); \( I_{c2} = 1mA \)

Since \( I_B \) is very small when compared with \( I_c \)
\( I_c \) approximately equal to \( I_E \)

\[ Av_2 = \frac{-hfe_2 \cdot R_{Leff}}{Z_i} \]

Find \( RL||Rc2 \) from above equation

Since \( Rc2 \) is known, Calculate \( RL \).
\[ V_{E2} = I_{E2}R_{E2} \]

Calculate \( R_{E2} \)

\[ S = 1 + \frac{R_{B2}}{R_{E2}} \]
\[ R_{B2} = ? \]
\[ R_{B2} = R3 \parallel R4 \]
\[ V_{B2} = V_{CC} \cdot R4 / R3 + R4 \]
\[ V_{B2} = V_{BE2} + V_{E2} \]
\[ R3 = ? \]

Find \( R4 \)
\[ Z_{i2} = (R_{B2} \parallel hie2) \]
\[ Z_{i2} = ? \]
\[ R_{\text{left1}} = Z_{i2} \parallel Rc1 \]

Find \( R_{\text{left1}} \) from the gain formula given above
\[ A_{v1} = -hfe1 \frac{R_{\text{left1}}}{Z_{i1}} \]
\[ R_{\text{left1}} = ? \]

On applying KVL to the first stage, we get
\[ V_{cc} = Ic_{1} R_{c1} + V_{CE1} + V_{E1} \]
\[ V_{CE1} = V_{CC} / 2 ; V_{E1} = V_{CC} / 10 \]
\[ R_{c1} = ? \]

Find \( Ic_{1} \) approximately equal to \( I_{E1} \)
\[ R6 = R_{E1} = ? \]
\[ S = 1 + \frac{R_{B1}}{R_{E1}} \]
\[ R_{B1} = ? \]
\[ R_{B1} = R1 \parallel R2 \]
\[ V_{B1} = V_{CC} \cdot R2 / (R1 + R2) \]
\[ V_{B1} = V_{BE2} + V_{E2} \]

Find \( R1 = ? \)
Therefore find \( R2 = ? \)
\[ Z_{i1} = (R_{B1} \parallel hie1) \]
\[ R5 = R_{L} - R6 \]
Coupling and bypass capacitors can be thus found out.

Input coupling capacitor is given by, \( X_{ci} = \frac{Z_i}{10} \)
\[ X_{ci} = \frac{1}{2\pi f C_i} \]
\( C_i = ? \)

output coupling capacitor is given by,
\[ X_{co} = \frac{(Rc_2 \parallel RL_2)}{10} \]
\[ X_{co} = \frac{1}{2\pi f C_o} \]
\( C_o = ? \)

By-pass capacitor is given by, \( X_{CE} = \frac{R_E}{10} \)
\[ X_{CE} = \frac{1}{2\pi f C_{E2}} \]
\( C_E = ? \)

**THEORY:**

In wein bridge oscillator, wein bridge circuit is connected between the amplifier input terminals and output terminals. The bridge has a series \( R \) \( C \) network in one arm and parallel network in the adjoining arm. In the remaining 2 arms of the bridge resistors \( R_1 \) and \( R_f \) are connected. To maintain oscillations total phase shift around the circuit must be zero and loop gain unity. First condition occurs only when the bridge is balanced. Assuming that the resistors and capacitors are equal in value, the resonant frequency of balanced bridge is given by

\[ F_0 = 0.159 RC \]

**PROCEDURE:**
1. The circuit is constructed as per the given circuit diagram.
2. Switch on the power supply and observe the output on the CRO (sine wave)
3. Note down the practical frequency and compare it with the theoretical frequency.

RESULT:

<table>
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<tr>
<th></th>
<th>Theoretical</th>
<th>Practical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>$f = \frac{1}{2 \pi RC}$</td>
<td></td>
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</table>
AIM:
To design and construct the transistor Phase shift oscillator.

APPARATUS REQUIRED:

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<th>ITEM</th>
<th>RANGE</th>
<th>Q.TY</th>
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<tr>
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<td>BC 107</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>RESISTOR</td>
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<td></td>
</tr>
<tr>
<td>3</td>
<td>CAPACITOR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>CRO</td>
<td>(0 – 30) MHz</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>RPS</td>
<td>(0-30) V</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>FUNCTION GENERATOR</td>
<td>(0-1)MHz</td>
<td>1</td>
</tr>
</tbody>
</table>

CIRCUIT DIAGRAM:

MODEL GRAPH:

DESIGN:
Given : Vcc = 12V, fo = 1 KHz, C = 0.01µF; Ie = 5mA;
Stability factor = 10

\[ f = \frac{1}{2\pi RC} \quad \text{Find } R \]

\[ R1 = (R_i - R) \]

\[ R >> R_c \]

\[ \beta = \frac{-1}{29} \]

Amplifier Design:
Gain formula is given by

\[ Av = -hfe \frac{R_{\text{eff}}}{hie} \] (Av = 29, design given)

Assume,
\[ V_{CE} = \frac{Vcc}{2} \]

\[ R_{\text{eff}} = R_c | | RL \]

\[ re = \frac{26mV}{I_e} \]

\[ hie = \beta re \quad \text{where } re \text{ is internal resistance of the transistor.} \]

\[ hie = hfe re \]

\[ VE = \frac{Vcc}{10} \]

On applying KVL to output loop,
\[ Vcc = I_c R_c + V_{CE} + I_e R_E \]

\[ V_E = I_e R_E \]

\[ R_E = ? \]

Since \( I_B \) is very small when compared with \( I_c \)
\( I_c \) approximately equal to \( I_e \)
\[ R_E = \frac{V_E}{I_e} = ? \]

\[ V_B = V_{BE} + V_E \]

\[ V_B = V_{CC} \cdot \frac{R_{B2}}{R_{B1} + R_{B2}} \]

\[ S = 1 + \frac{R_B}{R_E} \]

\[ R_B = ? \]

\[ R_B = R_{B1} | | R_{B2} \]
Find RB1 & RB2

Input Impedance, \( Z_i = (R_B || h_{ie}) \)

Coupling and bypass capacitors can be thus found out.

Input coupling capacitor is given by, \( X_{ci} = Z_i / 10 \)
\[
X_{ci} = \frac{1}{2\pi f C_i}
\]
\( C_i = ? \)

Output coupling capacitor is given by,
\[
X_{c0} = \frac{1}{2\pi f C_o}
\]
\( C_o = ? \)

By-pass capacitor is given by, \( X_{ce} = \frac{1}{2\pi f C_e} \)
\( C_e = ? \)

**THEORY:**

The Transistor Phase Shift Oscillator produces a sine wave of desired designed frequency. The RC combination will give a 60° phase shift totally three combination will give a 180° phase shift. The BC107 is in the common emitter configuration. Therefore that will give a 180° phase shift totally a 360° phase shift output is produced. The capacitor value is designed in order to get the desired output frequency. Initially the C and R are connected as a feedback with respect to input and output and this will maintain constant sine wave output. CRO is connected at the output.

**PROCEDURE:**

1. The circuit is constructed as per the given circuit diagram.
2. Switch on the power supply and observe the output on the CRO( sinewave)
3. Note down the practical frequency and compare it with the theoretical frequency.

**RESULT:**

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Theoretical</th>
<th>Practical</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f = \frac{1}{2\pi RC \sqrt{6RC}} )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. LC OSCILLATOR – HARTLEY and COLPITT OSCILLATOR
AIM:
To Design and construct the given Oscillator at the given operating frequency.

APPARATUS REQUIRED:

<table>
<thead>
<tr>
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<td></td>
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<td>CRO</td>
<td>(0 – 30)MHZ</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>RPS</td>
<td>(0-30) V</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>FUNCTION GENERATOR</td>
<td>(0- 1 ) MHz</td>
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</tr>
<tr>
<td>7</td>
<td>DIB, DRB</td>
<td></td>
<td>1</td>
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</tbody>
</table>

CIRCUIT DIAGRAM:
MODEL GRAPH:

Design of Feedback Network (Hartely Oscillator):
Given: \( L_1 = 1\text{mH} \); \( f = 800\text{kHz} \); \( V_{cc} = 12V \); \( Av = 50 \); \( f_L = 1\text{Khz} \)

\[
Av = \frac{1}{\beta} = \frac{-L_1}{L_2}
\]

\[
F = \frac{1}{2\pi \sqrt{(L_1 + L_2)C}}; \quad C = ?
\]

Design of Feedback Network (Colpitt Oscillator):

Given: \( C_1 = 0.1\mu\text{F} \); \( f = 800\text{kHz} \); \( V_{cc} = 12V \); \( Av = 50 \); \( S = 10 \)
\[ I_E = 5mA; f_i = 1kHz \]
\[ Av = Av = 1 / \beta = C_2 / C_1 \]
\[ f = \frac{1}{2\pi\sqrt{(C_1 + C_2) / L C_1 C_2}} \]
\[ L = ? \]

Amplifier Design:
Gain formula is given by
\[ Av = -hfe \frac{R_{\text{eff}}}{hie} \quad (Av = 29, \text{design given}) \]
Assume, \[ V_{CE} = \frac{V_{cc}}{2} \]
\[ R_{\text{eff}} = R_c | | RL \]
\[ re = 26mV / I_E \]
\[ hie = \beta re \quad \text{where} \, re \, \text{is internal resistance of the transistor.} \]
\[ hie = hfe re \]
\[ VE = \frac{V_{cc}}{10} \]

On applying KVL to output loop,
\[ V_{cc} = I_c R_c + V_{CE} + I_E R_E \]
\[ V_E = I_E R_E \]
\[ R_c = ?; R_E = ? \]

Since \( I_B \) is very small when compared with \( I_c \)
\[ I_c \approx \frac{V_E}{I_E} = ? \]
\[ V_B = V_{BE} + V_E \]
\[ V_B = V_{CC} \cdot \frac{R_{B2}}{R_{B1} + R_{B2}} \]
\[ S = 1 + \frac{R_B}{R_E} \]
\[ R_B = ? \]
\[ R_B = R_{B1} | | R_{B2} \]

Find \( RB1 \) & \( RB2 \)

Input Impedance, \[ Zi = (R_B | | hie) \]
Coupling and bypass capacitors can be thus found out.

Input coupling capacitor is given by, \( X_{ci} = Z_i / 10 \)

\[ X_{ci} = 1/2 \pi f C_i \]

\( C_i = ? \)

Output coupling capacitor is given by,

\( X_{c0} = (R_c || RL) / 10 \)

\[ X_{c0} = 1/2 \pi f C_o \]

\( C_o = ? \)

By-pass capacitor is given by, \( X_{ce} = R_e / 10 \)

\[ X_{ce} = 1/2 \pi f C_e \]

\( C_e = ? \)

**THEORY:**

LC oscillator consisting of a tank circuit for generating sine wave of required frequency. Rectifying Barkhausen criteria \( A_\beta \) for a circuit containing reactance \( A_\beta \) must be positive and greater than or equal to unity.

**PROCEDURE:**

1. The circuit connection is made as per the circuit diagram.
2. Switch on the power supply and observe the output on the CRO(sine wave).
3. Note down the practical frequency and compare it with the theoretical frequency.

**THEORETICAL FREQUENCY FOR HARTLEY OSCILLATOR:**

\[ f_c = 1/2 \pi \sqrt{\frac{(L1+L2)\cdot C}{(L1+L2)\cdot C}} \]

**THEORETICAL FREQUENCY FOR COLPITT OSCILLATOR:**

\[ f_c = 1/2 \pi \sqrt{(C1 + C2) / LC1C2} \]

**PRACTICAL:**

Observed Values:

Time Period =
RESULT:
Thus the LC oscillator is designed for the given frequency and the output response is verified.

<table>
<thead>
<tr>
<th>Theoretical</th>
<th>Practical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>Hartley</td>
</tr>
<tr>
<td></td>
<td>Colpitt</td>
</tr>
<tr>
<td>Hartley</td>
<td>Colpitt</td>
</tr>
</tbody>
</table>

5. CLASS C SINGLE TUNED AMPLIFIER

AIM:
To study the operation of class c tuned amplifier.

APPARATUS REQUIRED:
<table>
<thead>
<tr>
<th>S.NO</th>
<th>ITEM</th>
<th>RANGE</th>
<th>Q.TY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TRANSISTOR</td>
<td>BC 107</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>RESISTOR</td>
<td>4.2KΩ, 500Ω, 197KΩ, 2.2KΩ</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>CAPACITOR</td>
<td>0.1µf, 0.001µf, 100µf</td>
<td>2, 1</td>
</tr>
<tr>
<td>4</td>
<td>CRO</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>RPS</td>
<td>(0-30) V</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>FUNCTION GENERATOR</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

**CIRCUIT DIAGRAM:**

[Diagram of the circuit with components labeled as follows: +Vcc = 10 V, Vin = 1 V, F = 1 KHz, 47KΩ, 47µF, 100KΩ, BC107, 120KΩ, 2.2kΩ, 100µF, CRO.]

**MODEL GRAPH:**

[Model graph showing the circuit components and their connections.]
THEORY:
The amplifier is said to be class c amplifier if the Q Point and the input signal are selected such that the output signal is obtained for less than a half cycle, for a full input cycle. Due to such a selection of the Q point, transistor remains active for less than a half cycle. Hence only that much part is reproduced at the output for remaining cycle of the input cycle the transistor remains cut off and no signal is produced at the output. The total Angle during which current flows is less than 180°. This angle is called the conduction angle, Qc.

PROCEDURE:
1. The connections are given as per the circuit diagram.
2. Connect the CRO in the output and trace the waveform.
3. Calculate the practical frequency and compare with the theoretical Frequency.
4. Plot the waveform obtained and calculate the bandwidth.

RESULT:
Thus a class c single tuned amplifier was designed and its bandwidth is calculated.

6. INTEGRATOR USING OP-AMP
AIM:
To study the output waveform of integrator using op-amp.

APPARATUS REQUIRED:

<table>
<thead>
<tr>
<th>APPARATUS NAME</th>
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<tr>
<td>CRO</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>RESISTORS</td>
<td>1K,10K</td>
<td>1</td>
</tr>
<tr>
<td>CAPACITOR</td>
<td>0.1μ F</td>
<td>1</td>
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<tr>
<td>OP-AMP</td>
<td>IC741</td>
<td>1</td>
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<tr>
<td>BREADBOARD</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>RPS</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

THEORY:
A simple low pass RC circuit can also work as an integrator when time constant is very large. This requires very large values of R and C. The components R and C cannot be made infinitely large because of practical limitations. However in the op-amp integrator by MILLER’s theorem, the effective input capacitance becomes $C_f (1-A_v)$, where $A_v$ is the gain of the op-amp. The gain $A_v$ is the infinite for an ideal op-amp, so the effective time constant of the op-amp integrator becomes very large which results perfect integration.

PROCEDURE:
1. Connections are given as per the circuit diagram.
2. The resistance $R_{comp}$ is also connected to the (+) input terminal to minimize the effect of the input bias circuit.
3. It is noted that the gain of the integrator decreases with increasing frequency.
4. Thus the integrator circuit does not have any high frequency problem.
RESULT:- Thus the integrator using op-amp is studied.

7. CLIPPER & CLAMPER CIRCUITS
AIM: To observe the clipping waveform in different clipping configurations.

APPARATUS REQUIRED:

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<tr>
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<th>ITEM</th>
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<td>1</td>
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<tr>
<td>2</td>
<td>RESISTOR</td>
<td>1KΩ, 10KΩ</td>
<td>1, 1</td>
</tr>
<tr>
<td>3</td>
<td>CAPACITOR</td>
<td>0.1µF</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>FUNCTION GENERATOR</td>
<td>(0-1) MHz</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>CRO</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

CLIPPER CIRCUIT DIAGRAM:

[Diagram URL: www.eeeexclusive.blogspot.com]
Procedure:
1. Connections are given as per the circuit.
2. Set input signal voltage (5v, 1kHz) using function generator.
3. Observe the output waveform using CRO.
4. Sketch the observed waveform on the graph sheet.

CLAMPING CIRCUITS

Aim:
To study the clamping circuits
(a). Positive clamper circuit (b) Negative clamper circuit
APPARATUS REQUIRED:

<table>
<thead>
<tr>
<th>S.NO</th>
<th>ITEM</th>
<th>RANGE</th>
<th>Q.TY</th>
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<tbody>
<tr>
<td>1</td>
<td>DIODE</td>
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<tr>
<td>2</td>
<td>RESISTOR</td>
<td>1KΩ, 10KΩ</td>
<td>1, 1</td>
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<td>3</td>
<td>CAPACITOR</td>
<td>0.1µF</td>
<td>1</td>
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<td>FUNCTION GENERATOR</td>
<td>(0-1) MHz</td>
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</tr>
<tr>
<td>5</td>
<td>CRO</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

DESIGN:

Given \( f = 1\text{kHz} \)
\[ T = \frac{1}{f} = 1 \times 10^{-3} \text{Sec} \]
Assuming, \( C = 0.1\mu\text{F} \)
\( R = 10\text{KΩ} \)

Circuit Diagram: Positive clamper

\[ C = 0.1\mu\text{F} \]

\[ \text{I/P} \quad \text{IN4001} \quad 10\text{KΩ} \quad \text{o/p Vo} \]
Negative clamper

![Circuit Diagram](image)

C = 0.1µF

Procedure:
1. Connections are given as per the circuit.
2. Set input signal voltage (5v, 1kHz) using function generator.
3. Observe the output waveform using CRO.
4. Sketch the observed waveform on the graph sheet.

Result:
Thus the waveforms are observed and traced for clipper and clamper circuits.
8. MONOSTABLE MULTI VIBRATOR

AIM:
To Design the monostable multivibrator and plot the waveform.

APPARATUS REQUIRED:

<table>
<thead>
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<th>ITEM</th>
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</thead>
<tbody>
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<td>1</td>
<td>IC</td>
<td>NE555</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>RESISTOR</td>
<td>9KΩ</td>
<td>1</td>
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<tr>
<td>3</td>
<td>CAPACITOR</td>
<td>0.01µ F</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.1µ F</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>RPS</td>
<td>(0-30) V</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>CRO</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

THEORY:
A monostable multivibrator has one stable state and a quasistable state. When it is triggered by an external agency it switches from the stable state to quasistable state and returns back to stable state. The time during which it stays in quasistable state is determined from the time constant $RC$. When it is triggered by a continuous pulse it generates a square wave. Monostable multi vibrator can be realized by a pair of regeneratively coupled active devices, resistance devices and op-amps.
**DESIGN:**

Given $V_{cc} = 12V$; $V_{bb} = -2V$; $I_c = 2mA$; $V_{ce(sat)} = 0.2V$; $h_{fe} = 200$;

$f = 1kHz$.

$R_c = \frac{V_{cc} - V_{ce(sat)}}{I_c} = \frac{12 - 0.2}{2 \times 10^{-3}} = 5.9K\Omega$

$I_{B2(min)} = \frac{I_c}{h_{fe}} = \frac{2mA}{200} = 10 \mu A$

Select $I_{B2} > I_{B1(min)}$ (say $25 \mu A$)

Then $R = \frac{V_{cc} - V_{be(sat)}}{I_{B2}} = \frac{12 - 0.7}{25 \times 10^{-6}} = 452K\Omega$

$T = 0.69 RC$

$1 \times 10^{-3} = 0.69 \times 452 \times 10^3 C$

$C = 3.2 \text{nF}$

$V_{B1} = \frac{V_{bb} \ R_1}{R_1 + R_2} + \frac{V_{be(sat)} \ R_2}{R_1 + R_2}$

Since Q1 is off state, $V_{B1}$ less than equal to 0.

Then $V_{bb} R_1 / R_1 + R_2 = V_{ce(sat)} R_2 / R_1 + R_2$

$V_{bb} R_1 = V_{ce(sat)} R_2$

$2R_1 = 0.2R_2$

Assume $R_1 = 10K\Omega$. Then $R_2 = 100K\Omega$

$C_1 = 25pF$ (Commutative capacitor)

**procedure:**

1. Connect the circuit as per circuit diagram.
2. Switch on the regulated power supply and observe the output waveform at the collector of Q1 and Q2 and plot it.
3. Trigger the monostable multivibrator with a pulse and observe the change in waveform.
4. Plot the waveform and observe the changes before and after triggering the input to the circuit.

CIRCUIT DIAGRAM:

![Circuit Diagram]

PROCEDURE:

The connections are made as per the diagram. The value of R is chosen as 9kΩ. The DCB is set to the designed value. The power supply is switched on and set to +5V. The output of the pulse generator is set to the desired frequency. Here the frequency of triggering should be greater than width of ON period (i.e.) T > W. The output is observed using CRO and the result is compared with the theoretical value. The experiment can be repeated for different values of C and the results are tabulated.
**OBSERVATION**

<table>
<thead>
<tr>
<th>C (uf)</th>
<th>Theoretical (T=1.095 RC(ms))</th>
<th>Practical T(ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**RESULT:** Thus the monostable multivibrator using IC555 is designed and its output waveform is traced.
9. ASTABLE MULTIVIBRATOR

AIM:
To design a astable multivibrator and study the waveform.

APPARATUS REQUIRED:

<table>
<thead>
<tr>
<th>S.NO</th>
<th>ITEM</th>
<th>RANGE</th>
<th>Q.TY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TRANSISTOR</td>
<td>BC107</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>RESISTOR</td>
<td>980KΩ</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.9KΩ</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>CAPACITOR</td>
<td>0.74nF</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>RPS</td>
<td>(0-30) V</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>CRO</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

THEORY:

Astable multivibrator has no stable state, but has two quasi – stable states. The circuit oscillates between the states (Q1 ON, Q2 OFF) and (Q2 ON, Q! OFF). The output at the collector of each transistor is a square wave. Therefore this circuit is applied as a square wave generator. Refer to the fig each transistor has a bias resistance RB and each base is capacitor coupled to the collector of other transistor. When Q1 is ON and Q2 is OFF, C1 is charged to \( V_{cc} - V_{BE1} \) positive on the right side. For Q2 ON and Q! OFF, C2 is charged to \( V_{cc} - V_{BE2} \) positive on the left side.
Design

Given $V_{cc} = 10V$; $I_c = 2 \text{mA}$; $h_{FE} = 200$; $f = 1 \text{kHz}$

$R \leq h_{FE} R_c$

$R_c = V_{CC} - V_{C2(sat)}$, $I_c = 10 - 0.2 / 2 \times 10^{-3} = 4.9 \text{K} \Omega$

$R \leq 200 \times 4.9 \times 10^3 = 980 \text{K} \Omega$

$T = 1.38 R$

$1 \times 10^{-3} \leq 1.38 \times 980 \times 10^3 \times C$

$C = 0.74 \text{ nF}$
**Waveforms:**

![Waveform Diagram]

**PROCEDURE:**
1. The connections are given as per the circuit diagram.
2. Switch on the power supply.
3. Observe the waveform both at bases and collectors of Q1 and Q2.
4. Connect the CRO in the output of Q1 and Q2 and trace the square waveform.

**RESULT:**

Thus the square wave forms are generated using astable multivibrator.
10. BISTABLE MULTIVIBRATOR

AIM:
To design a bistable multivibrator and study the output waveform.

Apparatus Required:

<table>
<thead>
<tr>
<th>S.NO</th>
<th>ITEM</th>
<th>RANGE</th>
<th>Q.TY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TRANSISTOR</td>
<td>BC 107</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>RESISTOR</td>
<td>4.7KΩ, 22KΩ</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>CAPACITOR</td>
<td>0.022µf, 10µf, 100Pf</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>CRO</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>RPS (0-30) V</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>FUNCTION GENERATOR</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

THEORY:
The bistable multivibrator is a switching circuit with a two stable state either Q1 is on and Q2 is off (or) Q2 is on and Q1 is off. The circuit is completely symmetrical. Load resistors $RC_1$ and $RC_2$ all equal and potential Divider ($R1$, $R2$) and ($R_1'$ and $R_2'$ ) from identical bias Network at the transistor bases. Each transistor is biased from the collector of the other Device when either transistor is ON and the other transistor is biased OFF. $C1$ and $C2$ operate as speed up capacitors or memory capacitors.
Design :
Given \( V_{cc} = 12\text{V} \); \( V_{BB} = -12\text{V} \); \( I_c = 2\text{mA} \); \( V_{C(sat)} = 0.2\text{ V} \)
\( V_{BE(sat)} = 0.7\text{V} \)
Assume \( Q1 \) is cut-off \( V_{c1} = V_{CC}(+12\text{V}) \)
\( Q2 \) is in saturation (ON) \( V_{c2} = V_{c(sat)} (0.2 \text{ V}) \)
Using superposition principle,
\[
V_{B1} = V_{BB} \left[ \frac{R_1}{R_1 + R_2} \right] + V_{c2} \left[ \frac{R_2}{R_1+R_2} \right] << 0.7
\]
Let us consider \( V_{B1} = -1\text{V} \)
Then
\[-1 = \left[ \frac{-12R_1}{R_1+R_2} \right] + \left[ \frac{0.2R_2}{R_1+R_2} \right]
\]
Assume \( R_1 = 10\text{K}\Omega \) such that it ensures a loop gain in excess of unity during the transition between states. The inequality
\[
R_1 < h_{fe} R_c
\]
\[
R_2 = 91.67\text{ K}\Omega
\]
Test for conditions : \( Q1 \) = cut-off \( (V_{c1} = 12\text{V}) \)
\( Q2 \) = Saturation / (ON) \( (VC_2 = 0.2\text{V}) \)
Minimum base current, \( I_B \text{(min)} \) must be less than the base current (\( I_B \))
i.e.,
\[
I_{B \text{(min)}} < I_B
\]
Calculate \( h_{fe} \) from multimeter (say = 200)
\[
I_{B_2(\text{min})} = \frac{I_{c2}}{h_{fe}}
\]
\[
I_{c2} = I_c - I_3
\]
\[
I_{c2} = (2 - 0.12 )\text{mA} = 1.88\text{ mA}
\]
\[
I_{B_2(\text{min})} = 1.88\text{mA} / 200 = 9.4 \mu\text{A}
\]
\[
I_{B_2} = I_1 - I_2
\]
\[
I_{B_2} = (0.71 - 0.14 )\text{mA} = 0.57\text{ mA}
\]
Since \( I_{B_2} > I_{B_2(\text{min})} \), \( Q2 \) is ON
\[
C_1 = 25\text{ pF (Commutative capacitor)}
\]
\[ I_C = V_{CC} - V_c / R_C \]
\[ R_C = V_{CC} - V_c / I_C = 12 - 0.2 / 2 \times 10^{-3} = 5.9 \, \Omega \]
\[ I_3 = V_c - V_{BB} / R1 + R2 = 0.2 + 12 / (10 + 91.6) \, K = 0.12 \, mA \]
\[ I_1 = V_{C1} - V_{BE} / R_C + R1 = 12 - 0.7 / (5.9 + 10) \, K = 0.71 \, mA \]
\[ I_2 = V_{BE} - V_{BB} / R_2 = 0.7 + 12 / 91.6 \, K = 0.14 \, mA \]

Procedure:
1. Connect the circuit as per circuit diagram.
2. Switch on the regulated power supply and observe the output waveform at the collector of Q1 and Q2.
3. Sketch the waveform.
4. Apply a threshold voltage and observe the change of states of Q1 and Q2.
5. Sketch the waveform.
RESULT:

Thus the bistable multivibrator is designed and the square waveforms are generated at the output.

CYCLE II
SIMULATION LAB

1. Differential Amplifier

Aim: Calculate the dc voltage gain, the input resistance and the output resistance of a differential amplifier with a transistor current source.
Specifications: The input voltage is 0.1v. The model parameters of the bipolar transistors are BF = 50, RB = 70, RC = 40.
Circuit Diagram:

Program:

<p>| | | | | | | | | | |</p>
<table>
<thead>
<tr>
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<td>VEE</td>
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<td>Pin 1</td>
<td>Pin 2</td>
<td>Pin 3</td>
<td>Value</td>
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<td></td>
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<td>1.5k</td>
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<td>2</td>
<td>4</td>
<td>QN</td>
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<tr>
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<td>6</td>
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<tr>
<td>Q5</td>
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<td>QN</td>
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</tr>
</tbody>
</table>

```
.TF V (3,5) VIN
END
```

The results of the transfer – function analysis by the .TF commands are given below.

**ACTIVE LOW BUTTER FILTER**
PROGRAM:

LOW PASS FILTER
VCC 6 0 DC 12V
VEE 0 7 DC 12V
VIN 1 0 AC 1V
R1 4 0 1K
R2 1 2 1K
R3 2 3 1K
RF 4 5 0.586K
C2 2 5 0.079 UF
C3 3 0 0.079UF
X1 4 3 6 7 5 UA 741
.LIB NOB .LIB
.AC DEC 10HZ 100HZ 1MEGHZ
.PROBE
.END

PROGRAM FOR FREE RUNNING MULTIVIBRATOR
A CMOS INVERTER
VDD 2 0 5V
VIN 1 0 DC 5V PULSE (0 5V 0 1NS 1NS 20US 40US)
RL 3 0 100k
M1 3 1 2 2 PMOD L=1U W= 20U
M2 3 1 0 0 NMOD L=1U W= 5U
.TRAN 1US 80US
.TF V(3) VIN
.OP
.PLOT TRAN V(3) V(1)
.PROBE
.END

2 VDD = 5

PMOS M1

3

NMOS M2

RL 100K

0

1

ANALOG MULTIPLIER

V1 1 0 1V
V2 4 0 1V
R1  1  2  1K
R2  4  5  1K
R3  3  7  1K
R4  6  7 1K
R5  7  8  1K
R6 10  0  1K
D1  2  3  DA
D2  5  6  DA
D3  8  9  DA
.MODEL DA D
X1 2  0  3 IOP
X2  5  0  6 IOP
X3  7  0  8 IOP
X4  9  0  10 IOP
.SUBCKT IOP M P V0
RI M P 1G
E V0 0 P M 2E5
. ENDS
.DC V1  -1  1  0.1
.PROBE
.END

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