16th **July, 2020**   **Numerical**

1. In a class B power amplifier, load $R_L = 15\ \Omega$, supply voltage $V_{CC} = 22$ V, $V_{EE} = -22$ V, AC input voltage is 20 V peak and frequency is 1 kHz. Calculate the efficiency of the circuit. Select suitable power transistor having ratings: I_C close to 5A and V_{CEO} close to 30V
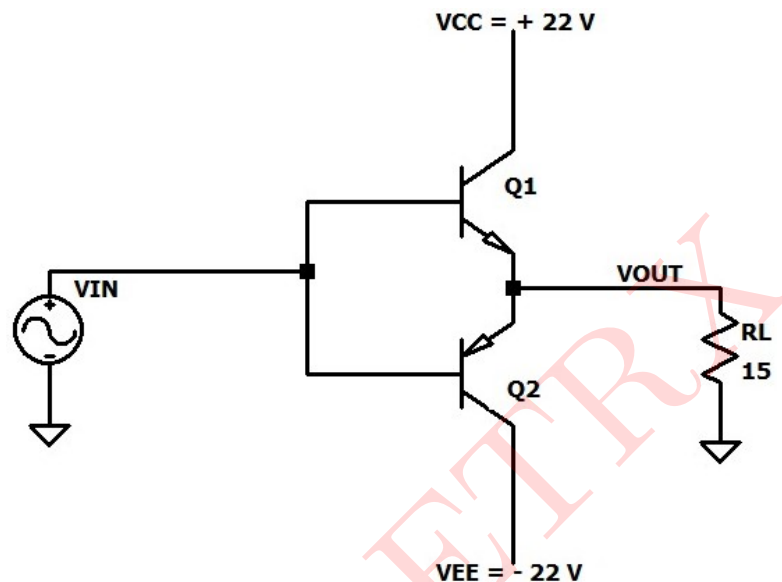

Figure 1: Circuit 1

Solution:

$V_{in} = V_m sin\omega t$

$V_{in} = V_m sin(2\pi ft) = 20 sin(2\pi \times 1000t)$

$V_m = 20$ V

$P_{ac} = \dfrac{V_m^2}{2R_L} = \dfrac{20^2}{2 \times 15} = 13.333$ W

$\therefore P_{ac} = 13.333$ W

$I_m = \dfrac{V_m}{R_L} = \dfrac{20}{15} = 1.333$ A

$P_{dc} = \dfrac{2 \times V_{CC} \times I_m}{\pi} = \dfrac{2 \times 22 \times 1.333}{\pi}$

$\therefore P_{dc} = 18.674$ W

Efficiency $\eta = \dfrac{P_{ac}}{P_{dc}} = \dfrac{13.333}{18.674} = \mathbf{71.39}\%$

SIMULATED RESULTS:

Above circuit is simulated using LTspice and the results are presented below:

Pin(DC) = VCC x ICQ
        = 44 x (Im/pi)
        = 44 x (1.2811/pi)
        = 17.942 W

Pout(AC) = Vorms x Iorms
         = Vom x Iom x 0.5
         = 19.21797 x 1.2811 x 0.5
         = 12.31 W

% Efficiency = 100 x [Pout(AC) / Pin(DC)]
             = 100 x [12.31 / 17.942]
% Efficiency = 68.6%

.tran 5ms
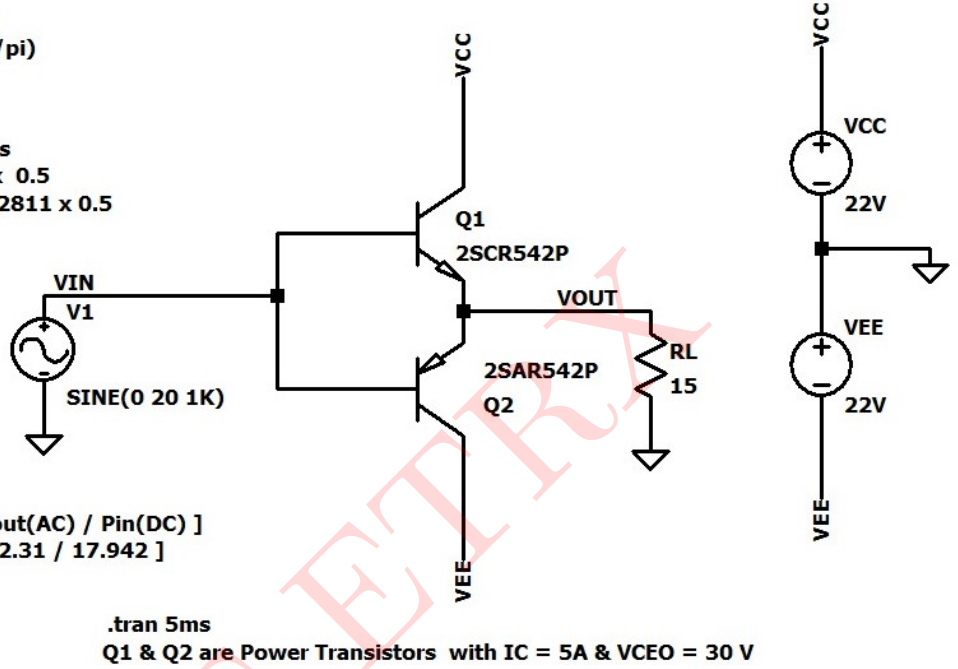Q1 & Q2 are Power Transistors with IC = 5A & VCEO = 30 V

Figure 2: Circuit schematic

The waveforms for output voltage V_{out} and current through R_L are shown in Figure 3
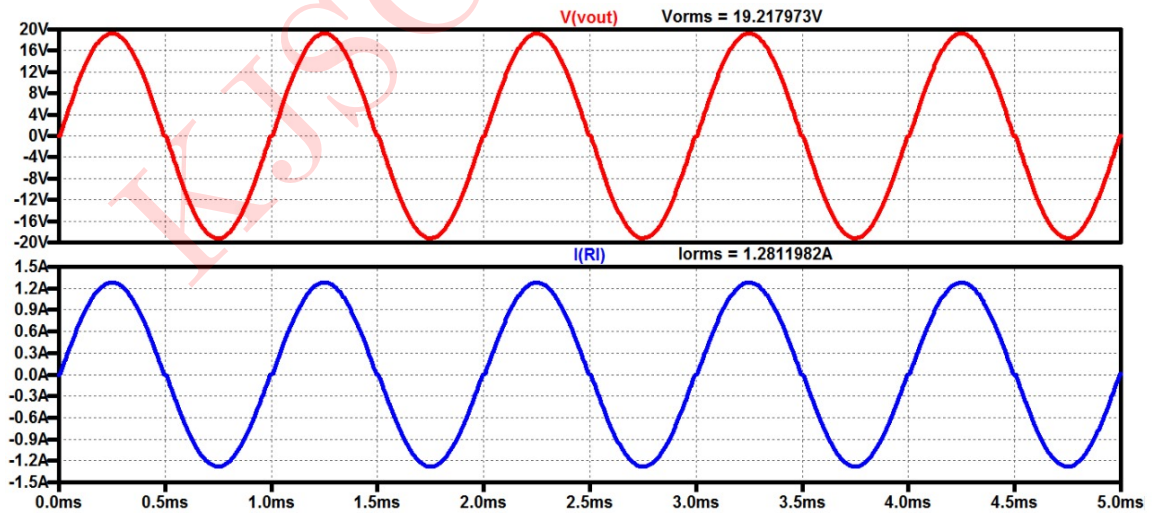

Figure 3: Output load voltage and load current waveforms

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Comparison of theoretical and simulated values:

Parameters	Theoretical	Simulated
Input DC power	18.674 W	17.942 W
Output DC power	13.333 W	12.31 W
Efficiency	71.39 %	68.6 %

Table 1: Numerical 1