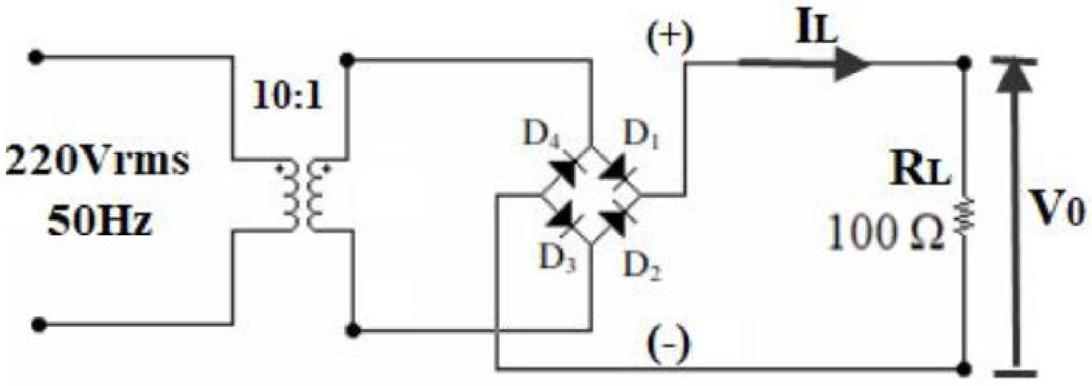
SOLUTION FOR END-OF-TERM EXAM IN TERM 2 OF SCHOOL YEAR 2018 - 2019

SENTENCE 1 (2 M)

Full wave rectifier circuit

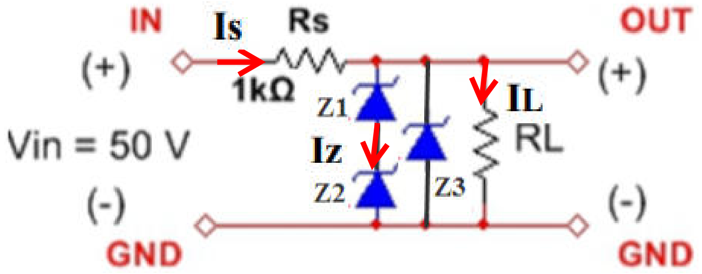


Average output voltage is calculated by:

$$V_{0(dc)} = \frac{2\,(22\sqrt{2} - 1.4)}{\pi} = 18.91\text{ V}$$

From Ohm 's law, load current has average value as: $I_L = 18.91\text{ V} / 0.1\text{ K} = \underline{189.1\text{ mA}}$

SENTENCE 2 (2 M)



Clearly, Z3 OFF and Z1, Z2 ON at the same time.
In addition, permissible maximum current flowing through Z1 and Z2 in series is calculated as:
I_{Zmax} = 120 mW / 5 = 24 mA for ensuring reliability in service.
It can be noticed that output voltage has constant amount such as: V_0 = 10V
As It's known, current through resistor Rs keeps constant regardless of load resistance
In other words, it's represented as: $I_s = (50 - 10) / 1\text{K} = 40\text{ mA} = \text{const}$
Further more, according to Kirchhoff 's current law, it can be written as:

$$I_s = I_z + I_L = \text{const}$$

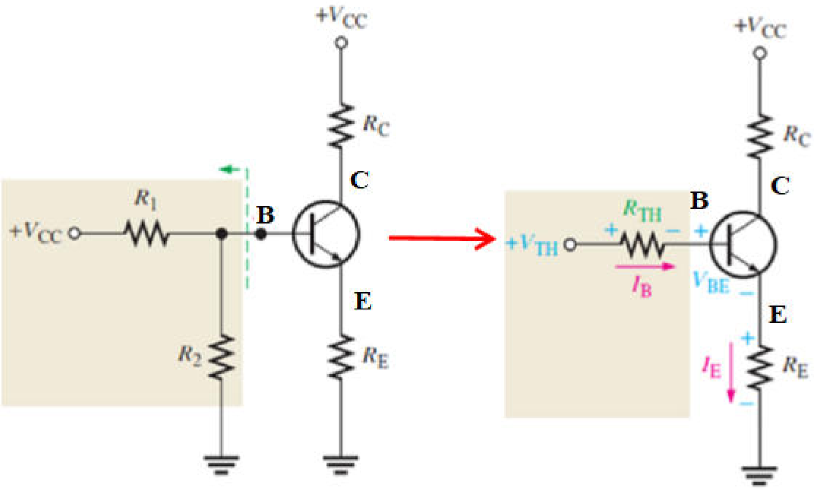
Where, Iz is current through the branch including Z1 and Z2 connected in series.
And I_L is current through load R_L.
It's easy to see that, due to Is = const, we get the following expressions:

$$I_s = I_{zmin} + I_{Lmax} = \text{const}$$

$$I_s = I_{zmax} + I_{Lmin} = \text{const}$$

As a result, maximum load current I_{Lmax} = 40 mA.
And minimum load current I_{Lmin} = 40 - 24 = 16 mA
Briefly, the range of load current can be depicted such as: $\underline{16\text{ mA} < I_L < 40\text{ mA}}$

SENTENCE 3 (2M)



$$V_{TH} = \left(\frac{R_2}{R_1 + R_2}\right)V_{CC} = 5.4V$$

$$R_{TH} = \frac{R_1 R_2}{R_1 + R_2} = 6K$$

IB = (5.4 - 0.7) / (6K + 10K) = 0.29mA

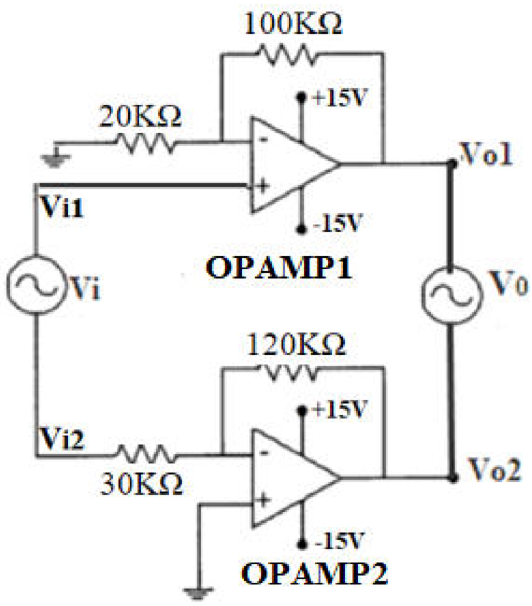
Hence, IC = IE = 29mA

From KVL, it results in:

VCE = VCC - (RC + RE)IC = - 0.4V

It can be concluded that BJT is in saturation mode.

SENTENCE 4 (2M)



As it's given, Vi and Vo include ac and dc components.
In details, Vi = 0.2exp(j30) + 0.5
with Vi(ac)= 0.2exp(j30) [V] and Vi(dc)= 0.5V
Vo = 4exp(j210) + 10
where Vo(ac) = 4exp(j210) = - 4exp(j30) [V]
and Vo(dc) = 10V

By superposition,

OPAMP 1 operating as noninverting amplifier and OPAMP 2 as inverting amplifier.

As a result,Vo1 = 6Vi1 and Vo2 = - 4Vi2

Hence, we get equation systems as following

Vi1 - Vi2 = 0.5
6Vi1 + 4Vi2 = 10 (dc quantities)

Vi1 - Vi2 = 0.2exp(j30)
6Vi1 + 4Vi2 = - 4exp(j30) (ac quantities)

Solve with matrix of determinant, it can be described as:

Vo1 = - 1.92exp(j30) + 7.2 [V] and Vo2 = 2.08exp(j30) - 2.8 [V]

SENTENCE 5 (2M)

Output Boolean expression is determined by: $Y = AB + \bar{B}C$

3 variable K map is represented as following: