Answer to the Question : 1

Calculate the average and effective value of the load voltages in circuits of Fig 1 and Fig 2 without capacitor. Compare these values with those obtained with the multimeter

Fig 1: Half wave rectifier:

(I) Average value of load voltage

$$V_{dc} = \frac{V_m}{\pi} - \frac{1}{2} V_{D_0}$$

$$= \frac{\cancel{10}5}{\pi} - \frac{1}{2} \times 0.7$$

$$\cancel{= 2.833\,V} = 1.242\,V$$

The value obtained with the multimeter was 1.7 V

(II) Effective value of load voltage :

ripple factor, $r = 1.21$

$$V_{rms} = r \times V_{dc}$$

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$$=(1.21 \times \overset{1.242}{\cancel{2.833}})\ V$$

$$\cancel{= 3.43\ V} = 1.502\ V$$

The value obtained with multimeter was 2.16

Fig 2: Full wave rectifier

(I) Average value of load Voltage

$$V_{DC} = \frac{2V_m}{\pi} - 2V_{D_0}$$

$$= \frac{2 \times \cancel{10}5}{\pi} - 2 \times 0.7$$

$$= \cancel{4.96\ V}\ 1.783V$$

value obtained with multimeter ~~2.9~~ 2.9V

(II) Effective value of load voltage

$$V_{rms} = r \times V_{dc}$$

$$= 0.482 \times \cancel{4.96\ V}\ 1.783V$$

$$= \cancel{2.39V}\ 0.86V$$

value obtained with multimeter 1.54V

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...wer to Question no. : 02

Q. Calculate the ripple factors for the two circuits for each of the three cases and compare with the ideal values.

Ans:

for a half wave rectifier, $r = 1.21$

for a full wave rectifier, $r = 0.482$

The ~~ideal~~ ideal value of ripple factor is zero

Half wave rectifier:

Case 1: No capacitor

ripple factor $r = \frac{V_{rms}}{V_{dc}}$

$= \frac{2.16V}{1.7V}$

$= 1.27$

So from our experiment we obtain the ripple factor as 1.27, which is ~~is~~ unacceptably high. The ideal value is 0.

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Case 2 : capacitor 1 μF

$$\text{ripple factor}, r = \frac{V_{rms}}{V_{dc}}$$

$$= \frac{1.08}{3.08}$$

$$= 0.35$$

we can see that using a filter has reduced the ripple factor to 0.35, which is closer to the ideal value.

Case 3: capacitor : 47 μF

$$\text{ripple factor}, r = \frac{V_{rms}}{V_{dc}}$$

$$= \frac{0.02}{2.36}$$

$$= 8.5 \times 10^{-3}$$

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wave rectifier:

Case 1: No capacitor

ripple factor, $r = \frac{V_{rms}}{V_{dc}}$

$= \frac{1.54}{2.97}$

$= 0.5$

Here $r > 0$, where 0 is the idal value.

Case 2: Capacitor 1µF

ripple factor, $r = \frac{V_{rms}}{V_{dc}}$

$= \frac{0.6}{3.96}$

~~wh~~ $= 0.15$

which is closer to the ideal value (zero)

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Case 3 : capacitor 47 μF

ripple factor, $r = \frac{V_{rms}}{V_{dc}}$

$= \frac{0.02 V}{4.66 V}$

$= 4.3 \times 10^{-3}$

Here the experimented value is almost equal to the ideal value.

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Answer to Question no. 03

Q. Which capacitor acts as a better filter? explain your answer.

~~Fo~~

Ans.

From the experiment, it is obivious that the capacitor of 47uF capacitance acts as a better filter.

When a sinusoidal voltage is converted into dc the output voltage waveform inherently contains ripples. Ripple is an unwanted ac component in dc output. Smaller value of ripple factor is desirable. Ideal value of ripple factor is zero. Zero ripple factor means a perfectly dc quantity. Ripple factor ~~a~~ of a single phase half wave rectifier is 1.21. This value is ~~unex~~ unacceptably high. In the case of a full wave rectifier, the usual value of ripple factor is 0.482.

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To reduce these values a capacitor as a filter. As the ripple current stays constant, the ripple voltage varies inversely with the capacitance. So as the capacitance increases the ripple factor decreases.

Thus, the capacitor with the highest capacitance ($47 \mu F$) acts as a better filter.

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wer to Question no. 04

What are the advantages and distanges of the full wave center tapped and bridge rectifier circuit?

Ans:

① Center tapped full wave rectifier.

Advantages:

① The ripple factor is much less than that of half wave rectifier

(ii) The rectification efficiency is twice than that of a half wave rectifier. For a full wave rectifier, the maximum possible value of rectification efficiency in 81.2% while that half wave rectifier is 40.6%.

(ii) The ~~of~~ DC output voltage and DC load current values are twice than those of a half wave rectifier.

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Disadvantages

(I) It is expensive to manufacture a center tapped transformer which produces equal voltage on each half for the secondary windings.

(II) The PIV (peak inverse voltage) of a diode used twice that of the diode used in the ~~diode~~ half wave rectifier, so the diodes used must have high PIV.

(III) The output voltage is half of the secondary voltage, as each diode utilizes only one half of the transformer secondary voltage.

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Bridge rectifier circuit

Advantages

(I) The PIV is one half that of center tapped rectifier. Hence bridge rectifier is highly suited for high voltage applications.

(II) Transformer utilization factor in case of a bridge rectifier, is higher than that of a center tapped rectifier

(III) It can be used in application allowing floating ~~oup~~ output terminals. i.e. no output terminal is grounded.

(IV) The need for center tapped transformer is eliminated

(V) The transformer is less costly as it is required to provide only half the voltage of an equivalent center tapped transformer used in a full wave rectifier.

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Disadvantages

(i) It requires ~~fore~~ four semiconducting diodes which is comparatively more expensive than center tapped full wave rectifier.

(ii) Two diodes in series conduct at a time on alternate half cycles. This creates a problem when low DC voltages are required. This leads to poor voltage regulation.

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Answer to Question no. 01.

Compare the circuits of Fig 1(a) and 1(b) with respect to stability against variation in β and justify your answer

Ans:

The amplifier's bias voltage can be ~~stabill~~ stabilised by placing a single resistor in the transistors emitter circuit. The addition of this emitter resistor means that the transistors emitter terminal is no longer grounded but sits at a small potential above it given by the ohms law equation.

The addition of this emitter resistance helps control the transistors base bias using negative feedback which negates any attemted change in collector current with an opposing change in the base bias voltage and so the circuit tends to be stabilised at a fixed level.

C 828 and C829 was used in the experiment.

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For Fig 1(a)

	β	I_B (A)	I_C (A)	V_{CE} (V)
C828	104.81	1.50×10^{-4}	0.0157	7.56
C8298	224	7.05×10^{-5}	0.0154	7.60

Here, The increase in β is 113%. So ~~53% decreases~~ in ~~base current~~. 2% increases in collector current and 0.52% decreases in collector-emitter voltage.

For Fig 1(b)

	β	I_B(A)	I_C(A)	V_{CE}(V)
C829	106	2.377×10^{-4}	0.0155	7.55
C828	225	1.91×10^{-5}	0.0156	7.56

So The increase in β is 112%. Due to increase in β, 0.64% increase in I_C and 0.13% decrease in V_{CE}

The circuit which has less change in I_C and V_{CE} is has more stability.

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Here Fig 1(b) circuit is more stable. As there is low change in I_C and V_{CE} in the 1(b) circuit. it is more stable than 1(a) circuit.

Answer to Question no. 02

Compare the circuits of figure 2(a) and 2(b) with respect to stability against β and justify your answer.

Ans:

For circuit 2(a)

	β	$I_B(\mu A)$	$I_C(mA)$	V_{CE} (V)
C828	205	57.28	15.4	7.25
C829	114	135.8	~~16.7~~ 14.7	7.62

Here, 5% increase in collector ~~coll~~ current

5% decrease in collector - emitter voltage

For circuit 2(b)

	β	$I_B (\mu A)$	$I_C (mA)$	$V_{CE} (V)$
C828	205	130	16.8	7.15
C829	114	119.4	16.7	7.24

Here,
1·25% decrease in collector-emitter voltage and 0·6% increase in collector current

Here we can see, the change in collector current and collector emitter voltage (V_{CE}) is less ~~thant~~ in the circuit 2(b) than the circuit 2(a).

So, the amplifiers' bias voltage can be stabilised by placing a single resistor in the transistors emitter circuit. Here Fig 2(b) is is more stable.

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Answer to Ques. no. 03

Compare the stability of fixed bias circuits with that of self bias circuits.

Ans

Fixed bias is when the biasing circuit is independent of changes in transistor parameters and is solely dependent on supply and biasing circuit made up of passive components.

Self bias is when some parameter of transistor circuit is connected to the biasing circuit, such that the changes in transistor parameter effect it's own biasing circuit.

Stability means less change of operating point $Q(I_C, V_{CE})$ with the change of various parameter like β or temperature.

Here, from the experiment we can see that

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the change in collector current (I_C) and collector-emitter voltage is less in the self bias circuits than the fixed bias circuits. In the circuit 2(b), ~~we~~ the change is quite smaller. It is a self bias circuit.

The self bias amplifier circuit will be stable for a greater range of input signal amplitude than will the fixed biased amplifier circuit. An amplifier circuit with fixed bias tries to maintain the same gain for all values of input signal. This may cause the amplifier to go into spurious oscillations if the input signal voltage becomes higher in amplitude. Where as an amplifier circuit with self bias uses negative feedback to lower it's gain during the time the input signal is higher in amplitude.

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Even if both amplifiers are stable generally a self biased amplifier is able to maintain a constant output amplitude over a relative wide range of input signals whereas the output of the amplifier with a fixed bias will vary with the amplitude of the input signal.

The main key to self bias circuit is the resistance added to the emitter. This resistor causes a a negative feedback to stable the I_c and V_{CE}.

So self bias circuit is more stable.

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Answer to ~~Qe~~ Question no. 04

Discuss the stability of fixed bias and self bias circuits against variation in temperature.

Ans.

The small values of stability factor indicates good bias stability whereas large value of stability factor indicates poor bias stability.

The ideal value of stability factor is zero (0).

As temperature changes, V_{BE}, β and Reverse saturation current (I_{CO}) change. Any of this can change the operating point of a transistor.

Stability factor, $S = \frac{dI_C}{dI_{CO}} = \frac{\Delta I_C}{\Delta I_{CO}}$

The collector current for a CE amplifier is given by,

$$I_C = \beta I_B + (1+\beta) I_{CO}$$

Differentiating the equation w.r.t I_C, we get,

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$$1 = \frac{\beta(dI_B)}{dI_C} + (1+\beta)\frac{d(I_{CO})}{dI_C}$$

Therefore, $\frac{1-\beta(dI_B)}{dI_C} = \frac{(1+\beta)}{S}$

$$\Rightarrow S = \frac{(1+\beta)}{1 - \frac{\beta(dI_B)}{(dI_C)}}$$

From this equation it is clear that S should be as small as possible to have better thermal stability.

<u>For fixed bias</u> stability factor reduces to

$$S = 1+\beta$$

Since β is large quantity, this a very poor bias stable circuit.

<u>For self bias</u>

$$S = \frac{(1+\beta)\left(1+\frac{R_B}{R_E}\right)}{\left((1+\beta)+\frac{R_B}{R_E}\right)}$$

As can be seen, the value of S is equal to one if the ratio R_B/R_E is very small. So self bias circuit is more stable.

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Answer to Question no. 05

For Fig 1(a)

C828

Experimental values:

$V_{CE} = 7.60V$

$I_C = 15.8mA$

$\beta = 224$

Calculated values

$\therefore \quad I_C = \beta \cdot \frac{V_{CC} - V_{BE}}{R_B}$

$= 224 \times \frac{15 - 0.68}{203 \times 10^3} \ A$

$= 15.8 \ mA$

$V_{CE} = V_{CC} - I_C R_C$

$= 15 - 15.8 \times 10^{-3} \times 470 \ V$

$= 7.57 V$

Here, calculated values and experimental values is quite same.

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C829

Experimental values.

$$\beta = 106$$

$$I_C = 15.7\,mA$$

$$V_{CE} = 7.56\,V$$

Calculated values

$$I_C = \beta \cdot \frac{V_{CC} - V_{BE}}{R_B}$$

$$= 106 \times \frac{15 - 0.73}{95 \times 10^{3}}\ A$$

$$= 15.9\,mA$$

$$V_{CE} = V_{CC} - I_C R_C$$

$$= 15 - (15.9 \times 10^{-3} \times 470)$$

$$= 7.51\,V$$

Here, also we can see that experimental values and calculated values are quite same.

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For Fig 2(a)

C828

Experimental values

$\beta = 205$

$I_C = 15.4\,mA$

$V_{CE} = 7.70\,V$

Calculated values

$$I_C = \beta \cdot \frac{V_{CC} - V_{BE}}{R_B + (\beta+1) R_E}$$

$$= 205 \times \frac{15 - 0.68}{250 \times 10^3 + (205+1) \times 560}$$

$$\Rightarrow I_C = \cancel{11.7\,mA}\ 8.035\,mA$$

$$V_{CE} = V_{CC} - I_C(R_C + R_E)$$

$$\cancel{= 9.48\,V}$$

$$\Rightarrow V_{CE} = 6.72\,V$$

In this circuit we can see a small difference between calculated values and experimental values

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C829

Experimental values

$\beta = 114$

$V_{CE} = 7.62V$

$I_C = 15.7mA$

Calculated values

$$I_C = \beta \cdot \frac{V_{CC} - V_{BE}}{R_B + (\beta+1)R_E} \qquad R_E = 560$$

$$= 114 \times \frac{15 - 0.74}{105 \times 10^3 + (114+1) \times 560}$$

$\cancel{= 15.4mA}$

$= 9.596mA$

$$V_{CE} = V_{CC} - I_C(R_C + R_E)$$

$\cancel{= 9.88V}$

$= 5.12V$

Here, we can see a quite large difference between calculated values and experimental values.

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