Class C BJT amplifiers

Resources and methods for learning about these subjects (list a few here, in preparation for your research):

Questions

Question 1

A common class of operation used in radio-frequency (RF) amplifier circuits is *class-C*. Explain what this means, contrasting it against the class-A and class-B operations common in audio-frequency amplifier circuits.

file 02504

Question 2

Contrast *class-A*, *class-B*, and *class-C* amplifier operations, explaining what defines each class. Then, rank these three classes in order of least power efficiency to greatest power efficiency.

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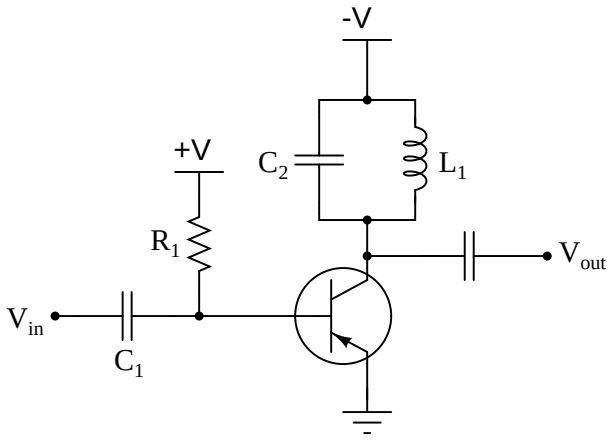
Question 3

Shown here is a schematic diagram for a class-C RF (radio frequency) amplifier circuit:



This circuit will look very strange if you are accustomed to analyzing audio-frequency and DC amplifier circuits. Note some of the distinct differences between this amplifier and an amplifier used to boost audio signals. Also, explain what "class-C" operation means, and how this amplifier is able to output a continuous sine wave despite the transistor's behavior in class-C mode.

Finally, write an equation that predicts this amplifier's operating frequency, based on certain component values which you identify.

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Answers

Answer 1

Class-C amplification is where the active device (transistor, usually) is conducting substantially less than 50% of the waveform period.

Answer 2

I'll let you research what the definition of each "class" of amplifier operation is! These definitions are fairly easy to find, so you should not experience much difficulty.

Class-A is least efficient, followed by class-B, and then class-C which is most power efficient.

Answer 3

Operating in class-C mode, the transistor only turns on for a very brief moment in time during the waveform cycle. The "flywheel" action of the tank circuit maintains a sinusoidal output waveform during the time the transistor is off.

$$f = \frac{1}{2\pi\sqrt{L_1 C_2}}$$

Follow-up question: why is this mode of amplifier operation – where the transistor is off most of the time and a tank circuit sustains sinusoidal oscillations – desirable for an amplifier circuit? Could this technique be applied to audio-frequency amplifier circuits? Why or why not?

Notes

Notes 1

A natural question that arises when students first hear of class-C operation is, "How does a class-C amplifier circuit reproduce the entire waveform, if the transistor is completely off most of the time?" The answer to this lies in *resonance*, usually supplied in the form of a tank circuit, to maintain oscillations while the transistor is cut off.

Notes 2

Students are liable to wonder why class-C operation is not the most popular in electronic circuits, since it is the most power-efficient of the three classes. Discuss the limitations of class-C operation, specifically in terms of waveform distortion.

Notes 3

Perhaps the most noteworthy detail of this circuit is the positive biasing voltage, despite the transistor being PNP and V_CC being negative. Ask your students to explain why this is necessary to get the transistor operating in class-C mode.