

Introduction

Rather than try to give you the material so that you can answer the questions from "first principles," I will provide enough information that you can recognize the correct answer to each question.

Chapter 6 Notes

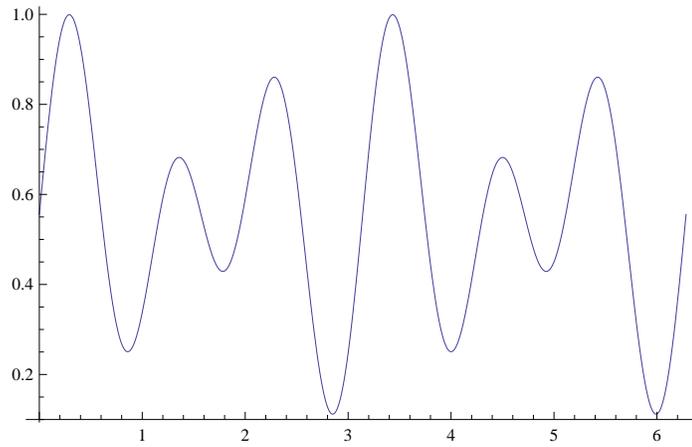
In no particular order, the necessary "nuggets:"

1. Junction transistors are current controlled and therefore have relatively low input impedance. Field effect devices, including vacuum tubes, are voltage controlled and therefore have relatively high input impedance. Vacuum tubes are implicitly diodes as well. Transistor input and output elements can be reversed and the device would operate somewhat.
2. *See attached amplifier circuits sheet.* Another phrase for "common word" amplifier is "grounded word" amplifier. The key is determining which lead is at *signal* ground level. The lead may not be at DC ground for bias reasons. If a lead is connected to the power supply via a capacitor in parallel with a resistor then that lead is at signal ground.
3. *See attached oscillators circuits sheet.* Oscillators can be built using any type of amplifier. All that is required is a gain greater than 1 with positive feedback. The major classes of oscillators are named according to the method of providing that feedback.
If the feedback circuit is a divided capacitor, then the oscillator is a Colpitts oscillator. The memory key is C for capacitance.
If the feedback circuit is a divided inductor, then the oscillator is a Hartley oscillator. The memory key is H for Henries of inductance.
If the feedback circuit is a crystal, then the oscillator is a Pierce oscillator. A crystal is a piezo-electric device. The memory key is P for piezo-electric.
It is difficult to significantly modify the frequency of a Pierce (crystal) oscillator.
Properly doped diodes properly biased into their negative resistance region of operation can be used as the amplifier section of an oscillator. Common such devices are Gunn and tunnel diodes, which can be made to oscillate into the THz range.
4. To stabilize an amplifier, provide negative feedback.
5. Distortion causes unintended (spurious) signals. Unintended signals are a violation of FCC regulations. Spurious signals can be wide bandwidth and result in transmissions outside the permitted amateur radio bands.
6. Common (grounded) control (grid, base or gate) element amplifiers have low output impedance. Linear power regulator circuits tend to use such amplifiers. Another common use is direct drive (transformerless) loudspeaker amplifiers.
7. Parametric amplifiers are very low noise. They are common as the on-the-antenna amplifier of satellite signal receiver systems.
8. The opposite to a digital to analog converter (DAC) is an analog to digital converter. Most ADCs work by *sampling* a voltage (signal) and generating a match using an over-under procedure using a DAC working from the high order (largest value bit) to the low order (smallest value bit) and giving the digital value of a DAC's input.

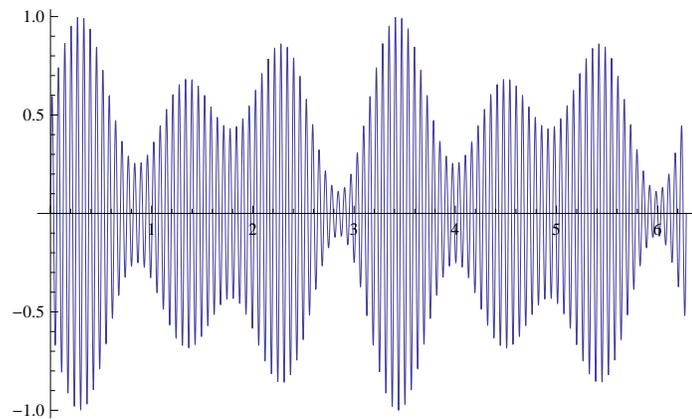
9. AM implies changing the power of the signal. Often AM modulation is done using a “mixer” circuit. A 100Hz carrier modulated with a 6HZ and a 4HZ signal.

$$\sin(100t)(1 + \sin(6t)/2 + \sin(4t)/3)/1.8$$

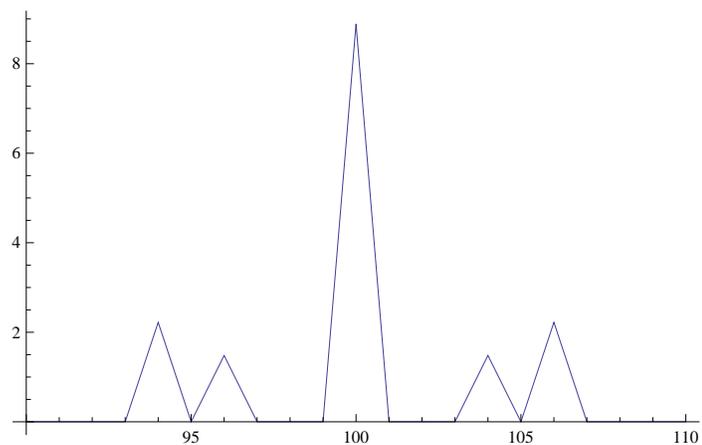
The modulation signal:



The transmitted signal:



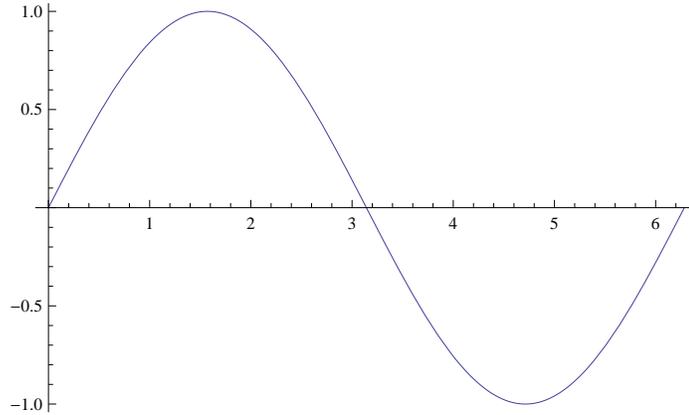
The Discrete Fourier Transform Power Spectrum:



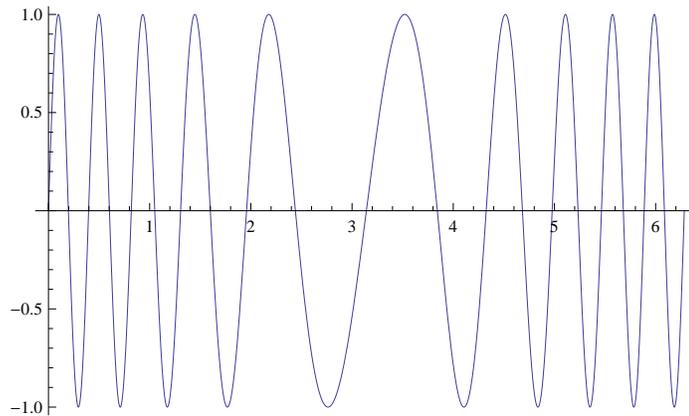
10. FM implies changing frequencies. In a Colpitts or Hartley oscillator, one changes the frequency by modulating the reactance of something in the resonant circuit of the oscillator.

$$\sin(100t + 6 \sin(t))$$

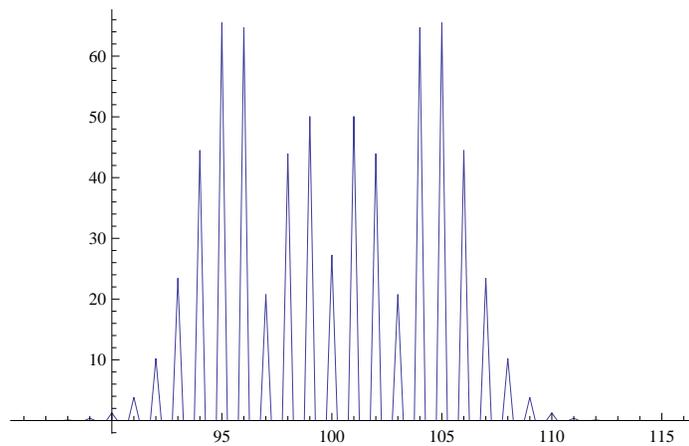
The modulation signal:



The transmitted signal (carrier at 10Hz for illustration):



The Discrete Fourier Transform Power Spectrum:



11. FM implies PM modulation and vis-a-vis. If an amplifier has a resonant circuit in it and that resonant circuit is modulated by a reactance modulator, the phase of the signal is affected.

Question by question explanations:

E6E01 What is a crystal lattice filter?

A filter with narrow bandwidth and steep skirts made using quartz crystals.

It is a signal filter and not a power supply filter nor an audio filter.

E6E02 Which of the following factors has the greatest effect in helping determine the bandwidth and response shape of a crystal ladder filter?

The relative frequencies of the individual crystals.

E6E03 What is one aspect of the piezoelectric effect?

Physical deformation of a crystal by the application of a voltage.

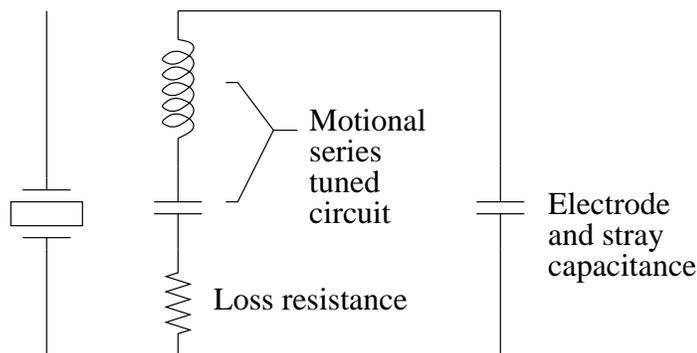
The other principal effect is a voltage generated by the physical deformation of a crystal.

E6E09 Which of the following must be done to insure that a crystal oscillator provides the frequency specified by the crystal manufacturer?

Provide the crystal with a specified parallel capacitance.

E6E10 What is the equivalent circuit of a quartz crystal?

Motional capacitance, motional inductance and loss resistance in series, with a shunt capacitance representing electrode and stray capacitance.



E6E12 What is a "Jones filter" as used as part of a HF receiver IF stage?

A variable bandwidth crystal lattice filter.

<http://www.wikipatents.com/US-Patent-5051711/variable-bandwidth-crystal-filter-with-varactor-diodes>

Patent assigned to Ten-tec.

— Amplifier classes (as compared to amplifier types) are determined by what portion of the input signal is present in the output.

A The entire 360° of the the input is represented in the output. Such amplifiers can be quite linear. They are less than 50% efficient.

AB More than 180° but less than 360° of the input is represented in the output. They are between class A and class B in efficiency.

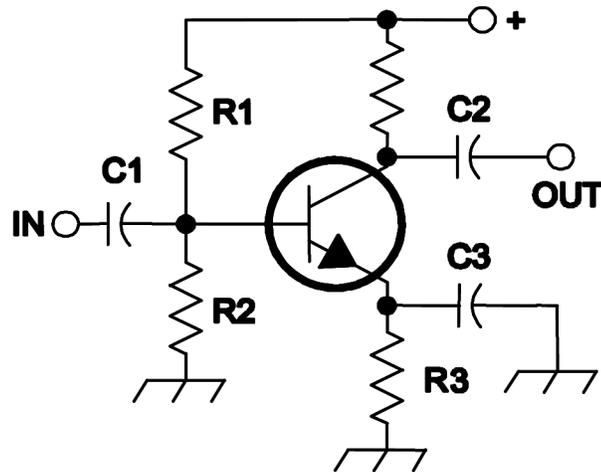
B Exactly 180° of the input is represented in the output. They are about 75% efficient.

C Less than 180° of the input is represented in the output. Such amplifier are quite nonlinear (i.e., cause considerable distortion) and can be quite efficient.

D Basically, a switching power supply whose output voltage is controlled by the signal being amplified. They can be extremely efficient; but, require extreme output filtering.

- E7B01 For what portion of a signal cycle does a Class AB amplifier operate?
More than 180 degrees but less than 360 degrees.
They are between class A and class B in efficiency.
- E7B02 What is a Class D amplifier?
A type of amplifier that uses switching technology to achieve high efficiency.
- E7B03 Which of the following forms the output of a class D amplifier circuit?
A low-pass filter to remove switching signal components.
- E7B04 Where on the load line of a Class A common emitter amplifier would bias normally be set?
Approximately half-way between saturation and cutoff.
This usually is the operating region where the amplifier is most linear.
- E7B05 What can be done to prevent unwanted oscillations in an RF power amplifier?
Install parasitic suppressors and/or neutralize the stage.
- E7B06 Which of the following amplifier types reduces or eliminates even-order harmonics?
Push-pull.
"Push-push" does not exist under that label. It is possible and practical to operate several devices in parallel for greater power handling; that *might* be called "push-push." Classes AB and C have considerable distortion. "Push-pull" amplifiers are coupled class B amplifiers, each of which handle half the signal. Even harmonics are reduced.
- E7B07 Which of the following amplifier types reduces or eliminates even-order harmonics?
Signal distortion and excessive bandwidth.
Class C amplifiers have considerable distortion which causes unintended (spurious) signals. See nuggets above.
- E7B08 How can an RF power amplifier be neutralized?
By feeding a 180-degree out-of-phase portion of the output back to the input.
Negative feedback stabilizes amplifiers. Out-of-phase output feed back to the input provides negative feedback.
- E7B09 Which of the following describes how the loading and tuning capacitors are to be adjusted when tuning a vacuum tube RF power amplifier that employs a pi-network output circuit?
The tuning capacitor is adjusted for minimum plate current, while the loading capacitor is adjusted for maximum permissible plate current
Tune for minimum plate current. Load for maximum plate current. The issues are minimum resting plate current and maximum coupling to the antenna and its feedline.

Figure E7-1



E7B10 In Figure E7-1, what is the purpose of R1 and R2?

Fixed bias.

The load resistor is the resistor from the collector to the power supply. The changing currents through the load resistor creates the varying output voltage. R3 provides self bias, a bias proportional to the current through the transistor which protects the transistor from thermal run-away. It is not feed back as it is feed directly from the power supply.

E7B11 Figure E7-1, what is the purpose of R3?

Self bias.

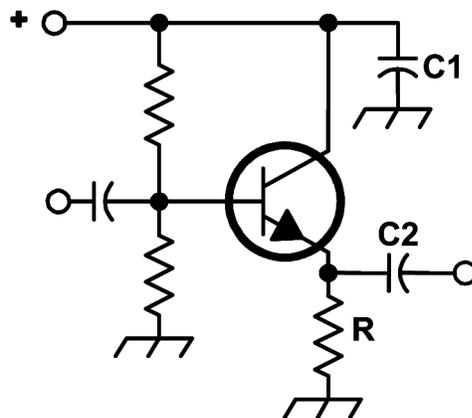
See E7B10's discussion of R3.

E7B12 What type of circuit is shown in Figure E7-1?

Common emitter amplifier.

Common emitter as the emitter is at signal ground because of C3.

Figure E7-2



E7B13 In Figure E7-2, what is the purpose of R?

Emitter load.

This circuit is a common collector amplifier as the collector is at signal ground caused by C1.

E7B14 In Figure E7-2, what is the purpose of C2?

Output coupling.

Note that this is a common (grounded) collector amplifier circuit because of C1.

E7B15 What is one way to prevent thermal runaway in a bipolar transistor amplifier?

Use a resistor in series with the emitter.

You want negative feedback *that is dependent on the current into the emitter*. Even though neutralization is negative feedback, it is not negative feedback that is dependent on the emitter current. That is the purpose of R3 in E7-1. The emitter bias resistor should be signal bypassed by a capacitor to leave the transistor's emitter at signal ground. That is the purpose of C3 in E7-1.

E7B16 What is the effect of intermodulation products in a linear power amplifier?

Transmission of spurious signals.

Whereas all of the answers are technically correct, the *primary* effect is the creation of spurious signals. A linear amplifier is inherently low efficiency. Intermodulation products do not necessarily cause oscillations. This leaves "[t]ransmission of spurious signals" as the best answer.

E7B17 Why are third-order intermodulation distortion products of particular concern in linear power amplifiers?

Because they are relatively close in frequency to the desired signal.

They are likely to become transmitted.

E7B18 Which of the following is a characteristic of a grounded-grid amplifier?

Low input impedance.

E7B19 What is a klystron?

A VHF, UHF, or microwave vacuum tube that uses velocity modulation.

Klystrons and magnetrons are VHF or higher power devices. Think microwave oven.

E7B20 What is a parametric amplifier?

A low-noise VHF or UHF amplifier relying on varying reactance for amplification.

Parameteric amplifiers are very low noise. They are common as the on-the-antenna amplifier of a satellite signal receiver system. A varactor diode is a diode used in a back biased and blocking mode. It can be used in a variable reactance modulator or a parametric amplifier.

E7B20 Which of the following devices is generally best suited for UHF or microwave power amplifier applications?

Field effect transistor.

FETs (field effect transistors) can be built to operate at high power and at UHF and SHF frequencies.

Silicon controlled rectifiers and Triacs are switched devices.

Nuvisitors are UHF and higher *signal* vacuum tubes. Usually, Nuvisitors are triodes although some tetrodes were made. Typical diameter is on the order 1.5cm and height is on the order of 2cm. Since time of flight of electron within the device is a significant limiting factor in their frequency response, the small size helps them operate at high frequencies than conventionally sized vacuum tubes.

E7C01 How are the capacitors and inductors of a low-pass filter Pi-network arranged between the network's input and output?

A capacitor is connected between the input and ground, another capacitor is connected between the output and ground, and an inductor is connected between input and output.

The purpose of a low pass filter is to block passage or to shunt to ground high frequencies.

Therefore, in a pi (Π) low pass filter the "legs" should be capacitors to shunt the high frequencies to ground and the "top" should be an inductor to block the same high frequencies.

The component types would be reversed for a high pass filter.

- E7C02 A T-network with series capacitors and a parallel shunt inductor has which of the following properties?
It is a high-pass filter.
The purpose of a high pass filter is to block passage or to shunt to ground low frequencies. Therefore, in a T high pass filter the "leg" should be an inductor to shunt the low frequencies to ground and the "tops" should be capacitors to block the same low frequencies.
The component types would be reversed for a low pass filter.
- E7C03 What advantage does a Pi-L-network have over a Pi-network for impedance matching between the final amplifier of a vacuum-tube transmitter and an antenna?
Greater harmonic suppression.
The Pi-L filter has two filtering stages which makes it more effective at removing undesired frequencies.
- E7C04 How does an impedance-matching circuit transform a complex impedance to a resistive impedance?
It cancels the reactive part of the impedance and changes the resistive part to a desired value.
A network which transforms a complex impedance does so by supplying corrective complex impedances (capacitors and inductors) and transforms the resistive component to the desired value.
- E7C05 Which filter type is described as having ripple in the passband and a sharp cutoff?
A Chebyshev filter.
- E7C06 What are the distinguishing features of an elliptical filter?
Extremely sharp cutoff with one or more notches in the stop band.
An elliptical filter has ripple in **both** the pass and stop bands. Its sides are sharp.
- E7C07 What kind of filter would you use to attenuate an interfering carrier signal while receiving an SSB transmission?
A notch filter.
You want to notch out the undesired carrier frequency.
- E7C08 What kind of digital signal processing audio filter might be used to remove unwanted noise from a received SSB signal?
An adaptive filter.
You want a filter which discovers constantly present frequencies and removes them: an adaptive filter.
- E7C09 What type of digital signal processing filter might be used to generate an SSB signal?
A Hilbert-transform filter.
It is usually implemented in a Digital Signal Processor (DSP). The other filter types in the answer selection are all easily implemented in analog form. It takes several pages in the ARRL handbook to try to describe how Hilbert transform filter works. A brief explanation is that the audio is converted to a frequency domain description, displaced to the carrier frequency by adding the audio frequencies to form the positive (USB) or by subtracting the audio frequencies to form the negative (LSB) signal description and converting the result back to a time domain signal.
- E7C10 Which of the following filters would be the best choice for use in a 2 meter repeater duplexer?
A cavity filter.
A cavity filter or a circulator is a three or four port device. A signal coming in on one port leaves out the next port around the device. With correct connections, an antenna can be connected to one port, a receiver to another and a transmitter to a third and both the receiver and transmitter can be in operation at the same time without harm to either. Received signals would be routed to the receiver and transmitted signals would be routed to the antenna.

E7C11 Which of the following is the common name for a filter network which is equivalent to two L networks connected back-to-back with the inductors in series and the capacitors in shunt at the input and output?

Pi

E7C12 Which of the following describes a Pi-L network used for matching a vacuum-tube final amplifier to a 50-ohm unbalanced output?

A Pi network with an additional series inductor on the output.

A Pi-L network has four components. A low pass Pi-L network has two inductors in series and two capacitors shunting from the inductors to ground.

E7C13 What is one advantage of a Pi matching network over an L matching network consisting of a single inductor and a single capacitor?

The Q of Pi networks can be varied by changing the component values chosen.

E7C14 Which of these modes is most affected by non-linear phase response in a receiver IF filter?

Digital.

Digital signal modes require that the phase relationships of various signal components remain unchanged.

E7D01 What is one characteristic of a linear electronic voltage regulator?

The conduction of a control element is varied to maintain a constant output voltage

Normally, the control element is active.

E7D02 What is one characteristic of a switching electronic voltage regulator?

The control device's duty cycle is controlled to produce a constant average output voltage.

In a switching power supply, the control element is switched on and off rapidly to supply high frequency pulsed power at the appropriate average power for the load. That pulsed power is then supplied to an appropriate low pass filter to create a constant output voltage.

E7D03 What device is typically used as a stable reference voltage in a linear voltage regulator?

A Zener diode.

1. A Zener diode is a common voltage reference source. It has a stable breakdown voltage when biased in the reverse direction. If the current through the diode is appropriately limited, then the device is not damaged in this mode of operation.
2. A tunnel diode is a negative resistance device used as signal amplifier or oscillator in the UHF and higher frequencies. It can be used in the THz range.
3. A silicon controlled rectifier (SCR) is a power handling device which can be switched into operation by a small control signal. These devices can handle multiple megawatts.
4. A varactor diode is a diode used in a back biased and blocking mode. Depending on the back voltage on the diode, its capacitance varies. It can be used in a variable reactance modulator or a parametric amplifier.

E7D04 Which of the following types of linear voltage regulator usually make the most efficient use of the primary power source?

A series regulator.

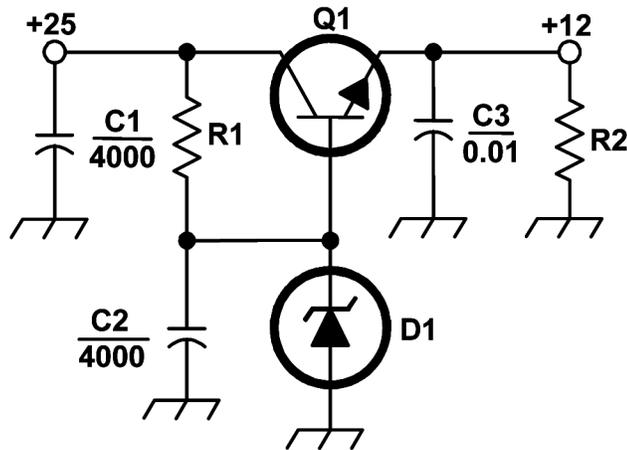
Shunt circuits throw away unneeded power. Constant current sources always supply some current. Only a series regulator "turns on" as needed.

E7D05 Which of the following types of linear voltage regulator places a constant load on the unregulated voltage source?

A shunt regulator.

A shunt regulator throws away the current unneeded by the load. Neither the voltage nor the current change at the power source.

Figure E7- 3

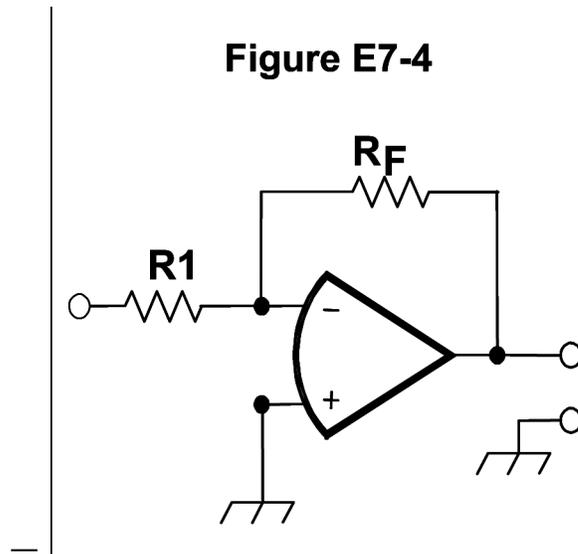


- E7D06 What is the purpose of Q1 in the circuit shown in Figure E7-3?
It increases the current-handling capability of the regulator.
- E7D07 What is the purpose of C2 in the circuit shown in Figure E7-3?
It bypasses hum around D1.
The bypass capacitor provides a high pass filtering function to the Zener voltage reference diode.
- E7D08 What type of circuit is shown in Figure E7-3?
Linear voltage regulator.
This circuit operates constantly and not in pulses. This circuit operates in a common base configuration.
- E7D09 What is the purpose of C1 in the circuit shown in Figure E7-3?
It filters the supply voltage.
- E7D10 What is the purpose of C3 in the circuit shown in Figure E7-3?
It prevents self-oscillation.
C3 is too small to be an output filter. C3 brings the output collector to signal ground.
- E7D11 What is the purpose of R1 in the circuit shown in Figure E7-3?
It supplies current to D1.
R1 supplies a small amount of current to the Zener diode so that it can operate and limits the maximum current that the Zener diode can draw so that the Zener diode does not damage itself.
- E7D12 What is the purpose of R2 in the circuit shown in Figure E7-3?
It provides a constant minimum load for Q1.
It helps the regulator circuit stay in its linear range of operation.
- E7D13 What is the purpose of D1 in the circuit shown in Figure E7-3?
To provide a voltage reference.
- E7D14 What is one purpose of a "bleeder" resistor in a conventional (unregulated) power supply?
To improve output voltage regulation.
- E7D15 What is the purpose of a "step-start" circuit in a high-voltage power supply?
To allow the filter capacitors to charge gradually.
A step circuit reduces the size of the charging currents to the output filtering capacitors when the power supply is turned on. Otherwise, these surge currents could destroy the regulator circuit.

- E7D16 When several electrolytic filter capacitors are connected in series to increase the operating voltage of a power supply filter circuit, why should resistors be connected across each capacitor?
All of these choices are correct.
- E7D17 What is the primary reason that a high-frequency inverter type high-voltage power supply can be both less expensive and lighter in weight than a conventional power supply?
The high frequency inverter design uses much smaller transformers and filter components for an equivalent power output.
- E7E01 Which of the following can be used to generate FM phone emissions?
Reactance modulation of the oscillator.
Modulating amplifiers does not make much sense. A balanced modulator creates a double sideband suppressed carrier signal.
- E7E02 What is the function of a reactance modulator?
To produce PM signals by using an electrically variable inductance or capacitance
A varying reactance creates FM (frequency modulated) or PM (phase modulated) signals. In this case, the main effect is generating FM modulation of the signal oscillator. It does not create an AM (amplitude modulated) signal.
- E7E03 How does an analog phase modulator function?
By varying the tuning of an amplifier tank circuit to produce PM signals.
A varying reactance creates FM (frequency modulated) or PM (phase modulated) signals. In this case, the main effect is generating PM modulation of the signal signal being generated. It does not create an AM (amplitude modulated) signal.
- E7E04 What is one way a single-sideband phone signal can be generated?
By using a balanced modulator followed by a filter.
A balanced modulator creates a double sideband suppressed carrier signal. The desired sideband can then be selected by filtering and amplified as needed. Or, a DSP implementing a Hilbert transform filter can generate the SSB signal directly.
- E7E05 What circuit is added to an FM transmitter to boost the higher audio frequencies?
A pre-emphasis network.
Pre-emphasis on the transmitter side. De-emphasis on the receiver side. This is also done in phonograph and magnetic sound recordings. Pre-emphasis when recording; de-emphasis when playing.
- E7E06 Why is de-emphasis commonly used in FM communications receivers?
For compatibility with transmitters using phase modulation.
See E7E05 for the correct answer. The best available answer is the one given above.
- E7E07 What is meant by the term baseband in radio communications?
The frequency components present in the modulating signal.
Note in the modulating signal.
- E7E08 What are the principal frequencies that appear at the output of a mixer circuit?
The two input frequencies along with their sum and difference frequencies.
In the frequency domain, mixers do not multiply; they only Only one answer has only sums and differences.
- E7E09 What occurs when an excessive amount of signal energy reaches a mixer circuit?
Spurious mixer products are generated.
A excessive input power drives the circuit into saturation and distortion. The distortion causes harmonics. The harmonics create spurious signals.

- E7E10 How does a diode detector function?
By rectification and filtering of RF signals.
- E7E11 Which of the following types of detector is well suited for demodulating SSB signals?
Product detector.
A product detector is a product mixer which reduces the implicit carrier frequency to 0.
- E7E12 What is a frequency discriminator stage in a FM receiver?
A circuit for detecting FM signals.
A frequency discriminator has a output proportional to the input frequency. It can be used to demodulate a FM signal.
- E7E13 Which of the following describes a common means of generating an SSB signal when using digital signal processing?
The quadrature method.
As previously noted, the Hamilton transform filter method might also be sued.
- E7E14 What is meant by direct conversion when referring to a software defined receiver?
Incoming RF is mixed to "baseband" for analog-to-digital conversion and subsequent processing.
Direct conversion in any case is the conversion of a RF signal directly to "baseband." In this question, the mention of software-defined radio is a "spurious signal" (a red herring). The other answers are nonsense.
- E7G01 What primarily determines the gain and frequency characteristics of an op-amp RC active filter?
The values of capacitors and resistors external to the op-amp.
The external components around the operational amplifier form a potentially complex feedback circuit.
- E7G02 What is the effect of ringing in a filter?
Undesired oscillations added to the desired signal.
Ringing in an active filter occurs when there is positive feedback almost sufficient to cause oscillation at some frequencies. The filter effectively has a high Q. Ringing in a passive filter occurs when the components have sufficiently high Q at some frequencies so that the signal decays slowly at those frequencies.
- E7G03 Which of the following is an advantage of using an op-amp instead of LC elements in an audio filter?
Op-amps exhibit gain rather than insertion loss.
- E7G04 Which of the following is a type of capacitor best suited for use in high-stability op-amp RC active filter circuits?
Polystyrene.
- E7G05 How can unwanted ringing and audio instability be prevented in a multi-section op-amp RC audio filter circuit?
Restrict both gain and Q.
See E7G02.
- E7G06 Which of the following is the most appropriate use of an op-amp active filter?
As an audio filter in a receiver.
Generally, operational amplifiers are not power devices. Radio frequency interference (RFI) is generally done with passive components. Therefore, of the answer selections given, the audio receiving filter is the proper choice.

Figure E7-4



E7G07 What magnitude of voltage gain can be expected from the circuit in Figure E7-4 when R1 is 10 ohms and RF is 470 ohms?

47.

$$\frac{470}{10} = 47$$

Gain is defined as being an absolute number and therefore is not negative.

E7G08 How does the gain of an ideal operational amplifier vary with frequency?

It does not vary with frequency.

A theoretically ideal operational is just that: ideal. It has no frequency dependent characteristics.

E7G09 $-\frac{R_F}{R_1} \times 0.23 = -\frac{10K}{1K} \times 0.23 = -2.3$. Signals are signed. See E7E07.

E7G11 What absolute voltage gain can be expected from the circuit in Figure E7-4 when R1 is 3300 ohms and RF is 47 kilohms?

14.

$$\frac{R_F}{R_1} = \frac{47000}{3300} \approx 14.24$$

E7G12 What is an integrated circuit operational amplifier?

A high-gain, direct-coupled differential amplifier with very high input and very low output impedance

“A high-gain, direct coupled differential amplifier whose characteristics are determined by components external to the amplifier. The Wikipedia article on “Operational amplifiers” provides a good description.

E7G13 What is meant by the term op-amp input-offset voltage?

The input voltage needed to bring the open-loop output voltage to zero.

The Wikipedia answer is: the voltage difference between the differential inputs which causes the output to be at ground in a single output operational amplifier

E7G14 What is the typical input impedance of an integrated circuit op-amp?

Very high.

E7G17 What is the typical output impedance of an integrated circuit op-amp?

Very low.

- E7H01 What are three oscillator circuits used in Amateur Radio equipment?
Colpitts, Hartley and Pierce.
See oscillator nugget above. Example schematics follow.
- E7H02 What condition must exist for a circuit to oscillate?
It must have positive feedback with a gain greater than 1.
See oscillator nugget above. Example schematic follows.
- E7H03 How is positive feedback supplied in a Hartley oscillator?
Through a tapped coil.
See oscillator nugget above. Example schematic follows.
- E7H04 How is positive feedback supplied in a Colpitts oscillator?
Through a capacitive divider.
See oscillator nugget above. Example schematic follows.
- E7H05 How is positive feedback supplied in a Pierce oscillator?
Through a quartz crystal.
See oscillator nugget above. Example schematic follows.
- E7H06 Which of the following oscillator circuits are commonly used in VFOs? Colpitts and Hartley.
See varactor diode nugget above.
- E7H07 What is a magnetron oscillator?
A UHF or microwave oscillator consisting of a diode vacuum tube with a specially shaped anode, surrounded by an external magnet.
Usually used at frequencies of 100s of MHz to 10s of GHz.
- E7H08 What is a Gunn diode oscillator?
An oscillator based on the negative resistance properties of properly-doped semiconductors.
- E7H09 What type of frequency synthesizer circuit uses a phase accumulator, lookup table, digital to analog converter and a low-pass anti-alias filter?
A phase locked loop synthesizer.
- E7H10 What information is contained in the lookup table of a direct digital frequency synthesizer?
The amplitude values that represent a sine-wave output.
- E7H11 What are the major spectral impurity components of direct digital synthesizers?
Spurious signals at discrete frequencies.
The spurious signals are usually at harmonics of the table step frequency.
- E7H12 Which of the following is a principal component of a direct digital synthesizer (DDS)?
Phase accumulator.
- E7H13 What is the capture range of a phase-locked loop circuit?
The frequency range over which the circuit can lock.
- E7H14 What is a phase-locked loop circuit?
An electronic servo loop consisting of a phase detector, a low-pass filter, a voltage-controlled oscillator, and a stable reference oscillator.
Note that a DDS could be used instead of the voltage-controlled oscillator.
- E7H15 Which of these functions can be performed by a phase-locked loop?
Frequency synthesis, FM demodulation.

E7H16 Why is the short-term stability of the reference oscillator important in the design of a phase locked loop (PLL) frequency synthesizer?

Any phase variations in the reference oscillator signal will produce phase noise in the synthesizer output.

E7H17 Why is a phase-locked loop often used as part of a variable frequency synthesizer for receivers and transmitters?

It makes it possible for a VFO to have the same degree of frequency stability as a crystal oscillator. the stability of a crystal oscillator.

E7H18 What are the major spectral impurity components of phase-locked loop synthesizers?

Phase noise.

E8A14 Which of these methods is commonly used to convert analog signals to digital signals?

Sequential sampling.

This is followed analog to digital voltage conversion at the sampling frequency.

Legalese

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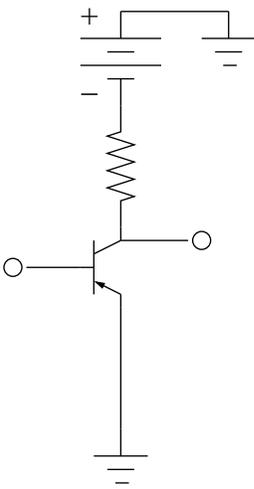
<http://www.ncvec.org/downloads/REVISED%202012-2016%20Extra%20Class%20Pool.txt>

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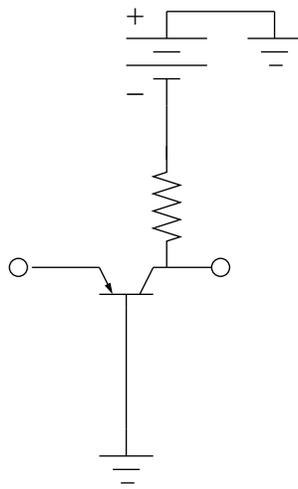
Wolfram Mathematica 8 used to create some of the illustrations.



Common Emitter

High voltage gain

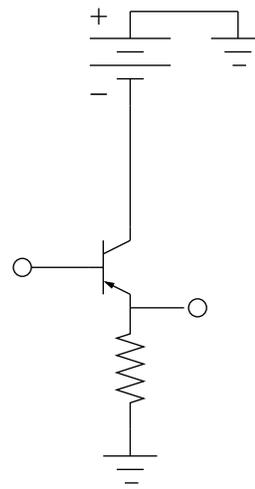
Inverted output



Common Base

Low input impedance

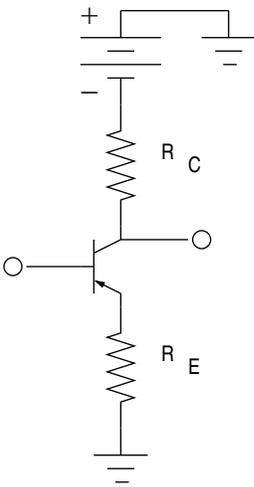
Unity current gain



Common Collector

Low output impedance

Unity Voltage gain



Voltage is about R_C/R_E because of the degenerative or negative of R_E

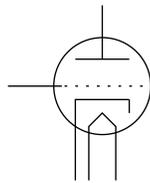


For NPN bipolar transistors, reverse the power supply voltage. From top to bottom bottom, collector, base and emitter.

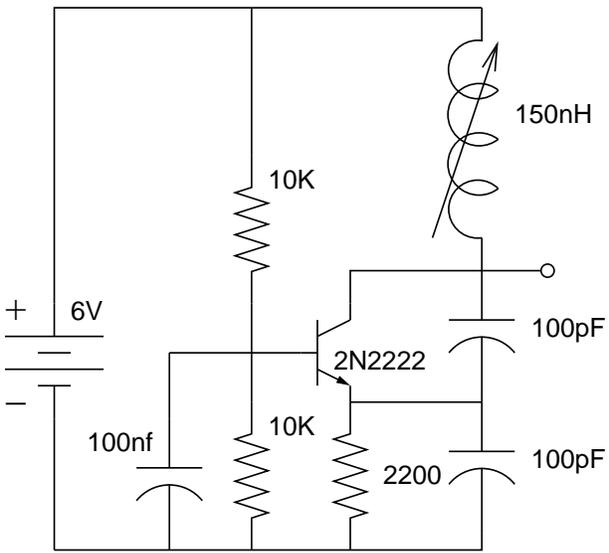


This is the symbol for a N-channel JFET. For a P-channel, the arrow points away from the device.

From top to bottom, the connections are drain, gate and source.

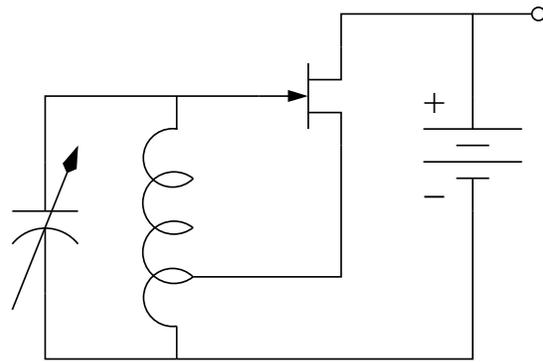


This is a vacuum tube triode, which behaves much like a N-channel JFET. The connections from top to bottom are plate or anode, grid, cathode and heater (which is not part of signal processing; but is necessary for operation).



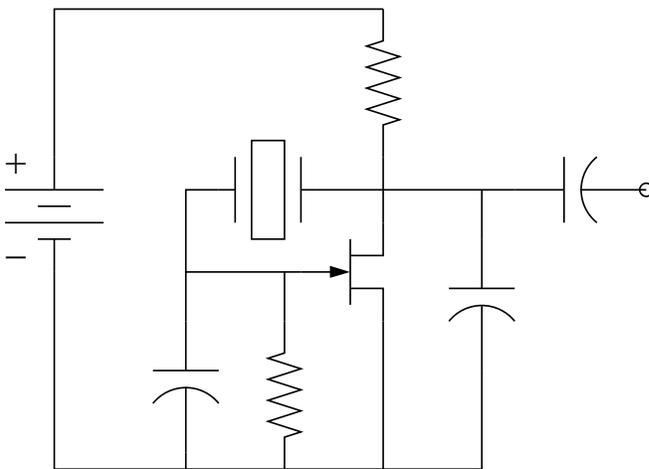
approximately 50MHz common base Colpitts oscillator with a series resonant circuit.

Mnemonic: Capacitor feedback is Colpitts.



Hartley common gate oscillator with at parallel resonant circuit.

Mnemonic: Inductive feedback in Henrys is Hartley.



common source Peirce oscillator with the crystal provides phase reverse at resonant frequency.

Mnemonic: Piezoelectric feedback is Peirce

In general, oscillators are amplifiers with some form positive feedback at the desired frequency. The amplifiers can be of any type and the feedback can be done with series or parallel resonant circuits. The collary is to stablize an amplifier provide negative feedback (degenerative feedback).