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*" amplifer is "grounded *word*" amplifer. 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. 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.

   AB More than 180° but less than 360° of the input represented in the output.

   B Exactly 180° of the input is represented in the output.

   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.

4. Push-pull amplifiers use two matched class B amplifiers. One for each half of the input signal driving the common output. They tend to cancel even order harmonic distortions.

5. *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 feed back. 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 os 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.

6. To stabilize an amplifier, provide negative feedback.

7. E7B14: 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. The emitter bias resistor should be signal bypassed by a capacitor to leave the transistor's emitter at signal ground.

8. 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.

9. Third order distortion in linear amplifers tends to be close to the signal frequencies.

10. 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.

11. Klystrons and magnetrons are VHF or higher devices.

12. Parameteric amplifiers are very low noise. They are common as the on-the-antenna amplifier of satellite signal receiver systems.

13. Nuvistors are UHF and higher *signal* vacuum tubes. FET (field effect transistor) can be built to operate at high power and at UHF and SHF frequencies. E7B20 asks for an UHF power device.

14. E7C09: the answer is the Hilbert transform filter, which is usually implemented digitally. 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 in frequency by adding the carrier frequency to the positive (USB) or negative (LSB) of the audio signal description and converting the sum back to a time domain signal. This is most easily done in a Digital Signal Processor (DSP).

15. 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.

16. 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.

17. A balanced modulator provides a double sideband, suppressed carrier signal. A sharp filter can pass the desired sideband.

18. Pre-emphasis on the transmitter side. De-emphasis on the receiver side.

19. Phase locked loop (PLL) frequency synthesizer: look for phase, loop and loop in both the question and the answer.

    A PLL has a very limited range over which it can achieve a lock. It works by modulating an oscillator to change its frequency to lock it into a fixed harmonic relationship with a very stable reference oscillator.

    The modulation signal in a PLL locked to a FM signal gives the original signal modulated on the FM signal.

    PLLs have broadband noise.

20. Direct digital synthesizer: look for table and digital to analog in the question, the answer is direct digital synthesizer.

    The lookup table contains a sine table in digital form. The digital to analog converter (DAC) converts those digital values to analog values. Because the generated signal has “stair steps,” it needs to go through a low-pass filter to remove the high frequency spurious components generated. The spurious signals are mainly at harmonics of the table sampling frequency. The spurious signals resemble a “comb” on a spectrum analyzer.

21. A direct digital synthesizer has a phase accumulator and may be associated with a phase locked loop to give a wider frequency range.

22. 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 a 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.

E6E01 Single side band (SSB) audio signals, in amateur radio, usually has a bandwidth of 2.4 KHz.

E6E02 Double side band (DSB) audio signals, in amateur radio, usually has a bandwidth of 6 KHZ.

E6E03 A crystal lattice filter typically has a narrow bandwidth and sharp side.

E6E04 A crystal ladder filter requires multiple crystals which are moderately matched within the desired bandwidth of the filter.

E6E05 See the answer to E6E04 above.

E7B08 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.

E7C01 The purpose of a low pass filter is to block passage or to shunt to ground high frequencies. Therefore, in a pi (II) 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. See the answer to E7C02 below.

E7C02 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 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 high pass filter. See the answer to E7C01 above.

E7C03 The Pi-L filter has two filtering stages which makes it more effective at removing undesired frequencies.

E7C04 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 A Chebyshev filter has ripple in the pass band and no ripple in stop bands. Its sides are sharp.

E7C06 An elliptical filter has ripple in **both** the pass and stop bands. Its sides are sharp.

E7C07 You want to notch out the undesired carrier frequency.

E7C08 You want a filter which discovers constantly present frequencies and removes them: an adaptive filter.

E7C10 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 reciever 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 Depending on how the L filters are connected “back to back,” this could be either a Pi or a L filter. Only a Pi filter is mentioned among the answer selections.

E7C12 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 The Q of Pi networks can be varied by changing the component values used.

E7C14 Digital signal modes require that the phase relationships of various signal components remain unchanged.

E7G01 The external components around the operational amplifier form a pontentially complex feedback circuit.

E7G02 Ring in an active filter occurs when there is positive feedback almost sufficient to cause oscillation at some frequencies. Ringing is a passive filter occurs when the components have sufficiently high Q at some frequencies so that the signal decays slowly at those frequencies.

E7G03 Operational amplifiers have gain. Inductors and capacitors are passive.

E7G04 For temperature stability and high Q, polystrene capacitors are recommended.

E7G05 Both high gain and high Q can cause ringing. Avoid both in filter networks.

E7G06 Resistors have a finer selection of standard values. Select the capacitor values first. Then, calculate and use the closest standard resistor values.

E7G07 Generally, operational amplifiers are not power devices. Radio frequency interference (RFI) is generally done with passive components. Therefore, of the answer selections given, the audion receiving filter is the proper choice.

E7G08 The answer is Sallen-Key. A Gilbert Cell is a four-quadrant multiplier analog computer circuit (signed magnitudes for both multiplier and multiplicand). They are used as mixer circuits. Resonators are not generally used as filters.

E7D01 A *control element’s* conductance varies to provide a *constant* output voltage. Normally, the control element is active.

E7D02 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 The answer is a Zener diode.

1. A Zener diode is a common voltage reference source by having 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 un 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 handles 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 Shunt circuits throw away unneeded power. Constant current sources always supply some current. Only a series regulator “turns on” as needed.

E7D06 The control element increases the amount of power the regulator can manage.

E7D07 The bypass capacitor provides a low pass filtering function to the Zener voltage reference diode.

E7D08 This circuit operates constantly and not in pulses. This circuit operates in a common base configuration. This circuit is a linear voltage regulator circuit.

E7D09 it filters the supply voltage. It is a low pass filter.

E7D10 C3 is too small to be an output filter. C3 brings the output collector to signal ground. Its purpose is to prevent oscillation in the regulator circuit.

E7D11 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 It supplies a minimum load to the regulator circuit, which the regulator circuit stay in its linear range of operation.

E7D13 The Zener voltage reference diode supplies a stable reference voltage to the rest of the regulator circuit.

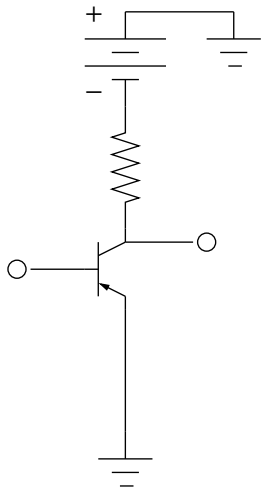
E7D14 It improves the performance and sability of the regulator circuit by supplying a minimum constant load.

E7D15 A step circuit reduces the size of the charging currents to the output filtering capacitors. Otherwise, these surge currents could destroy the regulator circuit.

E7D16 All answers are correct.

E7D17 By converting the incoming and possibly quite “dirty” power to high frequencies, possibly even tens of MHz, the required filter components are much smaller and lighter.

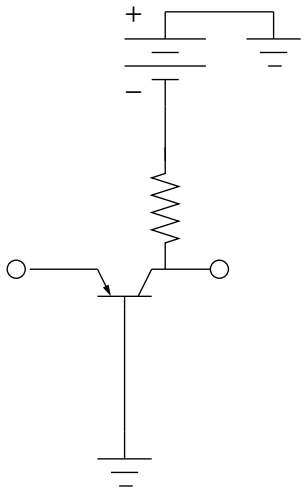
Legalese



Common Emitter

High voltage gain

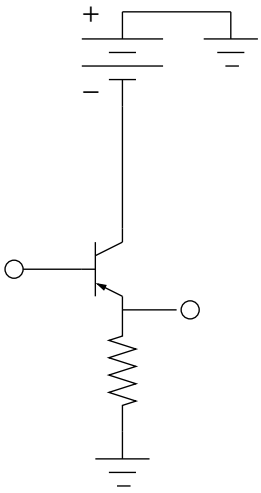
Inverted output



Common Base

Low input impedance

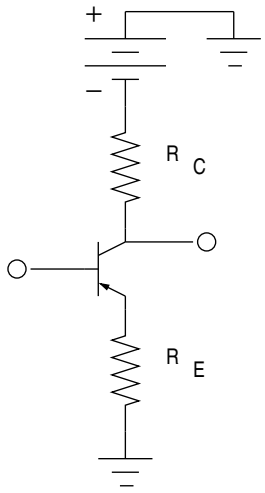
Unity current gain



Common Collector

Low output impedance

Unity Voltage gain

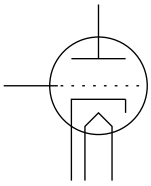


Voltage is about RC/RE because of the degenerative or negative of RE

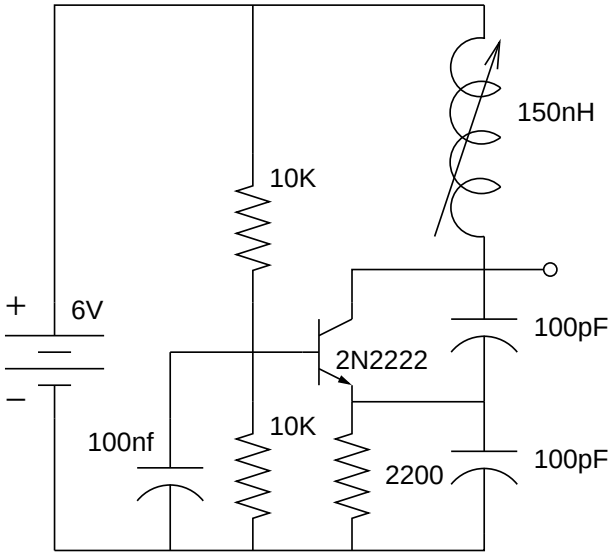
For NPN bipolar transistors, reverse the power supply voltage. From top to bottom bottom, collector, base and emitter.

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.

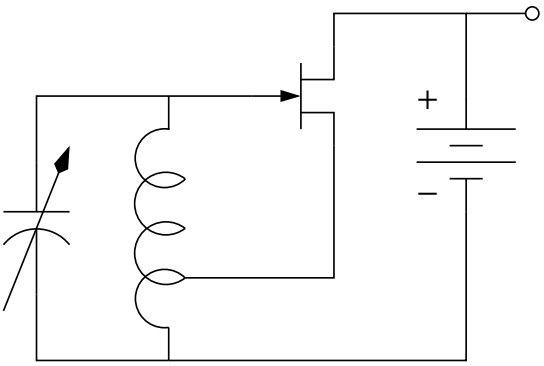


This is a vacuum tube triode, which behaves much like a N–channel JFET. The connections from top to bottom are plate or anode, grid, cathode and heater (which is not part of signal processing; but is necessary for operation.



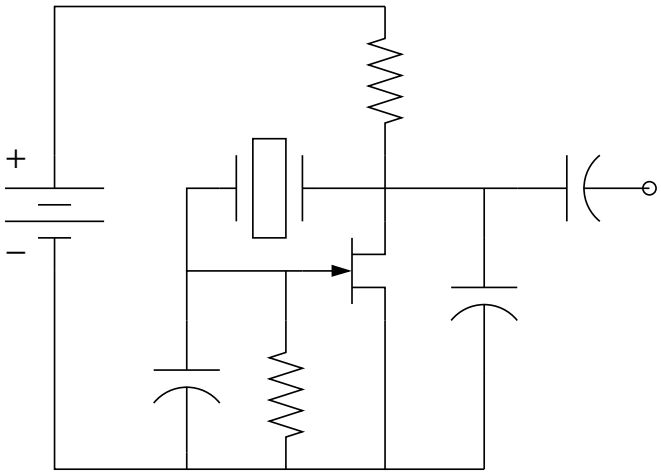
approximately 50MHz common base Colpitts oscillator with a series resonant circuit.

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 ctystal provides phase reverse at resonant frequencey.

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).