Chapter 4 **Components and Circuits**

[9 exam questions – 3 groups] G5, G6, G7

Electrical Terms

Impedance is the **opposition** to the flow of current in an **AC** circuit
Impedance is measured in **Ohms**
Reactance is the **opposition** to AC caused by **capacitance or inductance**
Reactance opposes the flow of **AC** in an **inductor**
Reactance opposes the flow of **AC** in a **capacitor**
Reactance is measured in **Ohms**

Electrical Properties

Inductor reactance **increases with frequency**
Capacitor reactance **decreases with frequency**
When the impedance of **load = source** the **maximum power** is delivered
To **maximize power transfer** use an **impedance matching transformer**
Insert an **LC network to match impedance** between circuits
A **transformer, Pi-network or transmission line** can be used for **impedance matching**

Batteries, Resistors, Capacitors & Inductors

Nickel-Cadmium batteries provide **high discharge current** and low internal resistance
10.5 volts is the **minimum discharge voltage** of a standard **12 volt lead acid** battery
Carbon-zinc battery is not rechargeable **Never Charge**
Resistor resistance increases depending on **temperature coefficient**
A **wire-wound resistor's inductance** could make circuit performance unpredictable
A **thermistor** changes in **resistance** with **temperature** variations
Electrolytic capacitors are used in power supply circuits to filter the rectified AC
Ceramic capacitors are low cost compared to other types
High capacitance for given volume is an advantage of an electrolytic capacitor
Low equivalent series resistance for capacitors used to filter the DC
Lead inductance in a capacitor **reduces** effectiveness at **VHF** and above
Filter choke smoothes DC output from the rectifier in a power supply
Inter-turn capacitance in an inductor may cause **self resonant** at some frequencies
Mutual inductance between inductors causes **unwanted coupling** between circuits
A ferrite core toroidal has; **large inductance, freq optimized properties, magnetic field stay in core**
Place windings solenoid inductors at **right angles** to **minimize mutual inductance**

Diodes & Light Emitting Diode

0.3 volts junction threshold voltage of a **germanium diode**
0.7 volts junction threshold voltage of a **conventional silicon diode**
Diodes in parallel to increase current capacity need **current limiting resistors**
The **peak-inverse-voltage** is max voltage the in the **non-conducting direction**
Peak inverse voltage & average forward current must not be exceeded for **silicon diode** rectifiers
Schottky diodes (RF switching circuit) have **lower capacitance** compared to a silicon diode
An LED is **Forward Biased** when emitting light (conducts)
An **incandescent** indicator has **high power consumption** compared to an LED
A **liquid crystal display requires** ambient or back **lighting**

Transistor & Vacuum Tubes

Saturation and cut-off regions are stable operating points for a bipolar transistor used in a logic circuit
Cases of power transistors are insulated to avoid shorting the collector or drain to ground
A **MOSFET gate is separated from the channel** with a thin insulating layer
A **Field Effect Transistor is like a vacuum** tube in its general operating characteristics
Control grid of a triode tube regulates the flow of electrons between cathode and plate
A **screen grid** in a vacuum tube **reduces grid-to-plate capacitance**

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Transformers

Mutual inductance causes a voltage to appear across the **secondary winding** of a transformer
The **primary** of a transformer is normally connected to the **incoming source**
The transformer output **= Input x (Np/Ns)**
The transformer output **= Input x Square Root of (Pimp/Simp)**

Digital Circuits

Binary "ones" and "zeros" are easy to represent with an **"on" or "off" state**
AND gate output is high only when **both** inputs are high
NOR gate output is low when **either or both** inputs are high
Eight states in a **3-bit binary** counter
A **shift register** is a clocked array that **passes data in steps** along the array
Complex digital circuitry can often be replaced by a **Microcontroller**

Integrated Circuits

Linear voltage regulator is an analog integrated circuit
Integrated circuit **operational amplifier** is an **analog** device
MMIC >> **Monolithic Microwave Integrated Circuit**
ROM >> **Read Only Memory**
"NON-VOLATILE" memory information is maintained even if power is removed
A microprocessor is a **computer on a single integrated circuit**
CMOS integrated circuits have **lower power consumption** compared to TTL

Resistors, Inductors & Capacitors

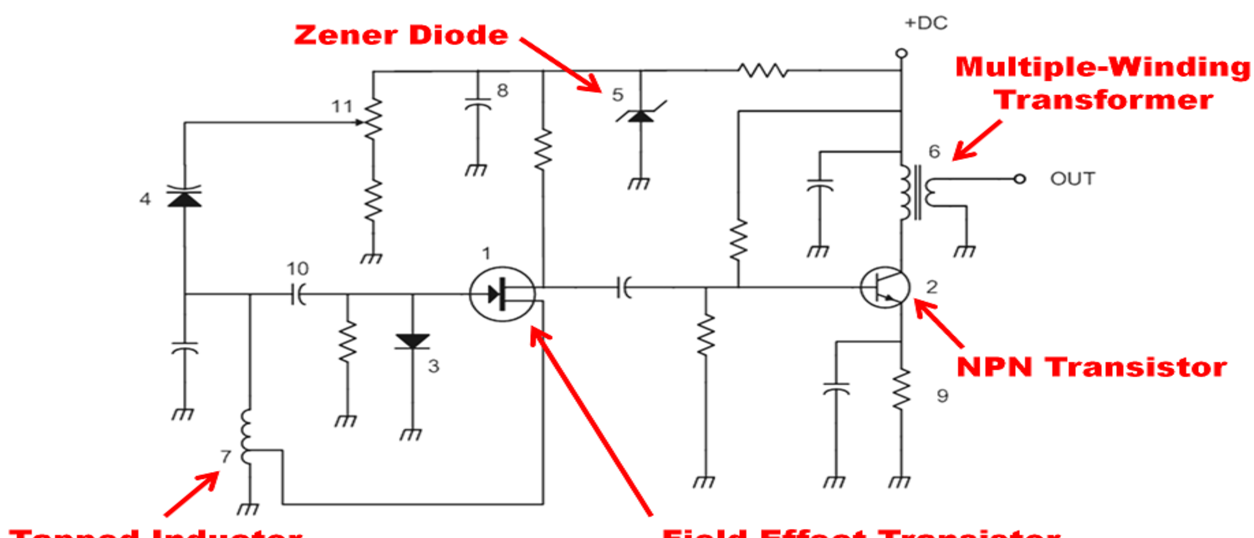

Figure G7-1

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Resistors, Inductors & Capacitors (Con't)

Resistors in series = resistor values added
Equal Resistors in parallel = resistor value / number of resistors
Resistors in parallel = the reciprocal of (the sum of all the reciprocal resistor values)
Equal Inductors in parallel = inductor value / number of inductors
Inductors in parallel = the reciprocal of (the sum of all the reciprocal inductor values)
Inductors in series = inductors values added
Capacitors in parallel = capacitor values added
Equal Capacitors in series = capacitor value / number of capacitors
Capacitors in series = the reciprocal of (the sum of all the reciprocal capacitor values)

Inductors or Resistors in Parallel

$$L = \frac{1}{\frac{1}{L} + \frac{1}{L} + \cdots \frac{1}{L}}$$

Inductors or Resistors in Series

$$L = L + L + \cdots L$$

Capacitors in Series

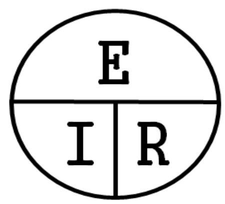
$$C = \frac{1}{\frac{1}{C} + \frac{1}{C} + \cdots \frac{1}{C}}$$

Capacitors in Parallel

$$C = C + C + \cdots C$$

Ohm's Law, Power, Vpp, RMS, PEP

E = I x R
I = E / R
R = E / I
P = E x I
P = I^2 x R
PEP = [(Vpp/2) x 0.707] ² / R
Vpp = Voltage Peak to Peak = 2 (1.41 x RMS)
RMS = Peak x 0.707
I = P / E



Total current in each branch of a **parallel** circuit equals **sum of the branches**
The **RMS value** of an AC signal is the **power dissipation** as a **DC** voltage of the **same value**
The ratio of **peak** envelope power to **average** power for an **unmodulated carrier is 1.00**

Decibel (dB)

+1 dB = 20.5% of X **+3 dB = 2X** +6 dB = 4X +10dB = 10X

Test and Measurement Equipment

An **oscilloscope** contains **horizontal and vertical channel** amplifiers
An oscilloscope can **measure complex waveforms**
An oscilloscope can **check the keying waveform of a CW transmitter**
The attenuated TX RF is connected to **the vertical of an oscilloscope to check RF envelope**

A **high input impedance voltmeter** decreases the **loading on circuits** being measured
A digital voltmeter has better precision than an analog meter

A **field strength meter** can be used for **close-in radio direction-finding**
A **field strength meter** can be used for **relative RF output** on antennas and transmitters
A **field strength meter** can be used to **radiation pattern** of an antenna

An **antenna analyzer** is used for **antenna and feed line SWR measurements**
An **antenna analyzer** is used to **determine the impedance of a coaxial cable**
Strong signals can affect the **accuracy of antenna analyzer** measurements
An **analog** readout may be **preferred** when **adjusting tuned circuits**
Standing wave ratio (SWR) can be determined with a **directional wattmeter**

Transmitter Linearity performance is determined by a **two-tone test**
Two **non-harmonically related audio signals** are used to conduct a **two-tone test**

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Connectors

Computer and transceiver might be connected using a **USB interface**
DE-9 connectors would be a good choice for a **serial data port**
Keyed connectors reduce chance of **incorrect mating**
DIN connector is a multiple circuit connector suitable for audio and control signals
RCA Phono connectors are commonly used for **audio signals**
PL-259 connectors are commonly used for RF service at **frequencies up to 150 MHz**
SMA connector is a small threaded connector suitable for signals up to several GHz
N connector is a moisture-resistant RF connector useful to 10 GHz

Power Supplies

The **peak-inverse-voltage** across the rectifiers in a **full-wave PS = PS output voltage**
The **peak-inverse-voltage** across the rectifiers in a **half-wave PS = 2 X PS output voltage**
360 degrees of the AC cycle is converted to DC by a **full-wave rectifier**
180 degrees of the AC cycle is converted to DC by a **half-wave rectifier**
The OP waveform of a **full-wave rectifier** = DC **pulses 2X freq** of the AC input
Capacitors and inductors are used in a **power-supply filter network**
A power-supply **bleeder resistor** discharges the filter capacitors
A **switch-mode PS high freq operation** allows the use of smaller components