Module 3 Electric Brainstorm File

Internal study material for the EASA part 66 Licence for **www.EASA66.com**

Atom Nucleus consists of Protons (+) and Neutrons (neutral). Electrons (−) are orbiting Nucleus

Max number of electrons in a given shell: $2(N^2)$ where N is the shell number. K-shell=2, L-shell=8, M-shell=18, N-shell=32 electrons

Free electrons: Large Amount = Low Resistance; Low Amount = Hi Resistance 1 AMP = 1 Coloumb per second Potential for current flow existist even though there is no current. One Volt will move one Coloumb of charge from one point to another. 1 Ohm allows 1 Amp at 1 Volt also a 60ft wire number 22. Resistance depends on Temperature, Length and Cross-Section of Wire. It is inversely proportional to its cross-section. Most materials have positive temperature coefficient. Few substance as Carbon have negative temperature coefficient. A Thermistor is a special type of resistor that charges much Resistance with a small amount of temperature change. Ni-Chrome mixed metals are used for Resistors and do nut rust. Carbon type resistors are also used for electronics. First 2 Color-Rings indicate resistance-number, 3rd ring is multiplier, 4th ring is tolerance and 5th ring is failure rate. Variable resistor have two connectors and a Potentiometer has 3 connectors.

Ohms - Law: I = E/R Power Law: P = ExI . One Watt is one joule per second. Power in Watt 1 HP(horsepower) = 746 Watts.

Voltage in Series: Vt = V1+V2+V... Resistor in Series: Rt = R1+R2+R... Current in Series: It = I1 = I2 = I..

Voltage in Parallel: Same for all circuits Current in Parallel: It = I1+I2+I... Resistance in Parallel: 1/Rt = 1/R1+1/R2+1/R... Rt is always less than the smallest resistor.

Voltage Drops on loads equals voltage rises provided by battery . The polarity of the voltage depends upon the connection to the ground. Energy in joules = emf in volts and electrons in coloumbs.

High Pass Filter: Low frequencies are filtered off or attenuated

High Pass Filter:allow frequencies above a certain value to pass

Impedance (Z) can be R and X_L. It can be R and X_C, or it can be R and X_C and X_L. Any of the three is Impedance

Impedance for a resistor of 6Ω and a coil of X_L = 8Ω is calculated Z = $\sqrt{{X_L}^2 + R^2} = \sqrt{8^2 + 6^2} = \sqrt{64 + 36} = \sqrt{100} = 10\Omega$

AC-Power Factor: is the relationship of true power and apparent power. Apparent Power is Volt x Ampere = VA , In an AC circuit with a coil or capacitor the Power depends on the ratio of Impedance (R/Z) expressed in the trigonometric angle Θ .

P = E x I x cos equals **Real Power**in Watt , P = E x I x sin equals **Reactive Power**

Apparent Power in VAR = Real Power + Reactive Power

Voltage and current relationship in an AC circuit containing resistance and and inductance - current lags voltage

Voltage and current relationship in an AC circuit containing resistance and and capacitance - current leads voltage

The wave form of AC is a `sine wave`. There is a positive and a negative peak. Peak value x 0.707 = effective value or peak value = 1.414 x effective value, average value = 0.636 x peak value

AC Root Mean Square RMS is the equivalent of DC heating effect

The voltage rating of a capacitor is the max voltage that can be constantly applied

The relative permittivity of of a capacitor is the relative permittivity of the dielectric in relation to a vacuum

Magnetic inclination (same as dip)is the least at the equator and greatest at the poles

Ferromagnetic materials can be magnetized below a certain temperature

Faradays Law states that the magnitude of the EMF is directly proportional to the rate of change of flux

To reduce eddy currents in a transformer you would reduce the thickness of the electrically insulated laminations in the magnetic core

Transformer turns ratio is $\frac{N_{secondary}}{N_{primary}}$ Transformer turns to voltage ratio is $\frac{V_{secondary}}{V_{primary}} = \frac{N_{secondary}}{N_{primary}}$

A transformer has an input of 400V and a ratio of 2:1. If the transformer is DeltaStar wound, the output voltage is 346V (line V = 1.73 x phase V)

The phase difference in a circuit 100V, drawing 0.5A, consuming 50W is 0^o

100V x 0.5A = 50VA = 50W

In an AC circuit,when frequency is reduced inductive elements may be damaged as lower frequency will reduce inductive reactance and current increases

Transformer: voltage stepped down = current stepped up

Two inductive coils in close proximity at 90 dgr to each other the number of flux lines is zero!

Oscilloscope inputs have rectangular waveform and their input pulse and time base are unequal

In a delta-connected generator line volts = phase volts , line current = $\sqrt{3}$ x phase current

In a 3 phase motor if one pase is lost, the motor remains at the same speed - sped depends on frequency and number of pairs of poles

A three phase motor has the windings 120 dgr apart

In a generator when line and phase voltage are equal it is a delta wound generator

To change the direction in a 3 phase induction motor, swap two of the stator connections presented by **www.EASA66.com**

Decreasing field current in a shunt motor will increase speed and increase torque

To calculate generator output you need to know armature speed and field strength

In a shunt motor, if you reverse both field current and armature current, the motor continues to turn in the same direction

The permanent magnet in an AC generator induces AC in the excitor generator

Brushless AC generator: The output of a permanent magnet generator is rectified and supplied as the main exciter field. The output of the main exciter is used to provide the main field for the AC generator. The field is usually provided by a separate small DC generator which is mounted on the same shaft as the field coils, and is called `EXCITER`

Ohms Law: I = $\frac{E}{R}$ R = $\frac{E}{I}$ E = I x R **Power Law:** P = I x E P = $\frac{E^2}{R}$ P = I^2 x R

Batteries: A 10V battery supplies a resistive load of 10Ω for one minute. What work is done? 600J P=$\frac{E^2}{R}$ Energy = P x Time(in seconds)

Battery charging is either by constant current , or constant voltage

In the **constant current** method, current remains almost constant during the entire **charging** process. It requires a longer time to charge the battery fully and, towards the end of the charging process, presents the danger of being over charged.

In **constant**, regulated **voltage**, the current at the start of **charging** is automatically high, but gradually decreases. Once it reaches a value of 1 amp it should be fully charged. Constant voltage method requires less time and supervision than the constant current method.

Trickle charging is simple charging the battery at a rate equal to the rate of discharge while a pack sits idle. This will keep your battery pack in a fully charged condition, ready to go flying when ever you are.

Chemical (Battery), Dry Cell: 1,5 Volt, 2 years Self Life and cannot be recharged is called a primary cell.

Lead Acid Batteries and NiCad batteries are `Secondary Cells = Rechargeable`. A grid made of Lead and Antimony is filled with the active materials. Positive plates are made of LEAD PEROXIDE (Pb O_2). The Negative plates are made of SPONGY LEAD. One positive plate between two negative plates. Which stipulates that end plates in each cell are negative. Each cell has 2.2V, in reality only 2.0V. Six cells in series make a 12V battery

Fully charged Specific Gravity is between 1.300-1.275 Medium state of charge is between 1.275-1.240 Low state of charge is between 1.240-1.200. Electrolyte consists of sulphuric acid (30% by volume) and water.

Overcharging or excessive discharging and too rapid charging or discharging, which results in overheating affects battery life.

Aircraft batteries must achieve a minimum rate of efficiency of 80% on a discharge check. Serviceability checks are due every 3 months.

Nickel Cadmium (NiCad) batteries exist in 'A' to 'D' sizes or blocks and have 1.25 Volts per cell. Cadmium-Oxide is an negative plate. The electrolyte used is potassium hydroxide. Output Voltage constant for 90% of discharge (Flat Rate). You cannot measure specific gravity on NiCads - measure the voltage under load. Temperature range from -65 to 180^oF.

NiCad thermal runaway is caused by overcharging or too rapid charging which results in overheating and explosion. Internal resistance decreases with heat, which allows a greater charge rate and hence more heat developed.... presented by **www.EASA66.com**

Battery capacity is in Ampere/Hours. A hundred ampere/hour capacity battery will supply 50 Amps for 2 hours.

Capacitance is the property of a circuit of a device which enables it to store electrical energy by means of an electrostatic field. The act of storing the energy is called charging a capacitor. One Farad is the amount of Capacitance that will store the charge of one coloumb when an EMF of one Volt is applied. **Capacitance depends of: The area of the metal plates (directly proportional), spacing between the plates (indirectly proportional) and the nature of the dielectric.** Variable Capacitor uses air as dielectric and plates are on a rotary shaft. Electrolytic Capacitor uses: Foil - Oxide-layer

Electrolyte on paper - Foil In capacitance current leads Voltage ICE

Capacitors in Series: $1/C_t = 1/C_1 + 1/C_2 + 1/C_{...}$ **Capacitors in Parallel:** $C_t = C_1 + C_2 + C_{...}$

Inductors in Parallel: $1/L_t = 1/L_1 + 1/L_2 + 1/L_{...}$ **Inductors in Series:** $L_t = L_1 + L_2 + L_{...}$

Resistors in Parallel: $1/R_t = 1/R_1 + 1/R_2 + 1/R_{...}$ **Resistors in Series:** $R_t = R_1 + R_2 + R_{...}$

Inductive Reactance X_l measured in Ohms opposes current and is directly proportional to Frequency + Inductance and tends to block higher Frequencies.

Region of influence = Electrical field that surrounds a magnet Flux lines don't cross, they try to make small loops, they travel from North to South an concentrate the Poles. Ferromagnetic materials are strongly attracted by magnetic field. Most substance are classified as paramagnetic - they are only slightly attracted. Air is considered as standard permeability. Cobalt: 170 Nickel: 100 Reluctance magnetic resistance Standby Compass Magnetic Dip = Cause the largest compass error (corr-18 dgr tilt) Float is balanced on a pivot which allows free rotation. It is also called free to tilt at an angle up to 18^o

Magnetic Compass = Filled with acid free white Kerosine. Compass Errors: Variation - Angular difference between Magnetic & Geographic North Deviation - Deflection of needle from magnetic north due local disturbances Three ways to increase strength of electromagnets: Increase of number of turns in a coil - increase of current flow - add an iron core. Residual magnetism - Magnetism that remains after removing magnet. Electromagnetic induction - Action that cause current flow when a conductor moves across a field. Same poles repel and unlike poles attract. Do not use multi meter on flux valve - voltage will fry wiring in flux valve. When current flows through a wire, a magnetic field is developed around the wire. Looking in direction of current flow field turns

Induction is the effect of a body on another without any physical contact. The amount of EMF induced depends on: Strength of field - Speed - length and angle (RT angle is max) of conductor field. Inductivity transfers energy from one circuit to another. Mutual inductance is a process by which a coil induces a voltage into another coil. Coefficient coupling 98% is best , Cores: Iron - 98% and Air - 65%. Air core is used for high frequencies. Secondary coil has higher current . Primary coil has higher counter EMF. Turns ratio equals voltage ratio. Iron core is laminated to prevent eddy currents. Transformer have Hysteresis energy loss (AC magnetic field change in iron core), Eddy currents iron core and cooper loss in long copper wire. Dots on transformer indicate if Transformers are in phase or not. Dots on same side means in phase. Autotransformer use one winding for primary and secondary . Advantages: smaller, cheaper, less weight. Disadvantage: No isolation

LVDT and RVDT have 3 secondary connectors to signal 'IN' 'Transit' and 'Out'. presented by **www.EASA66.com**

Motors have following losses: Friction, Hysteresis, Cooper and Heat. `There are 3 types of DC-Motors:` **Series wound:** has Hi torque and heavy load - bad speed control. Greatest flow of current when started. **Shunt wound:** has good speed control, low starting torque. When motor gains speed armature current decreases due to Counter-EMF and field current increases. Field controls speed of armature current up. **Compound wound:** has advantage of both series- and shunt wound motors. Reversing of polarity will not change direction of rotation! Field or armature must be reserved or a second coil installed. AC motors are classified according to horsepower, phase, frequency and type of construction. Motor must be designed to operate efficiently on NET-EMF due large counter EMF. Resistance of the armature coils must be relatively low.

Copper losses in a DC motor are caused by high resistance field windings

Armature torque is proportional to armature current and field strength

Rotational speed of a DC motor is proportional armature current and field strength Increasing the voltage applied to the armature causes rotational speed to increase
Reversing the supply to a permanent magnet field motor causes to reverse its rotation presented by **www.EASA66.com**
Voltage induced into a conductor depends on strength of the magnetic field, the speed of the conductor, the angle at which the field is cut and the length of the conductor in the field
3-phase AC motors will turn at one-third of rated power when one phase is missing and has tendency to overheat. 3-phase AC motor speed is (60x fp) 60 times frequency divided by pair of poles.
3-phase motors have about 4% slip. Single phase AC motors must have a starting resistor or capacitor with a centrifugal switch. **Synchroneous** motors rotate at synchronized speed with the AC. 1 hp equals 746 watts Power = Force x Distance/ Time
Motor is LH rule: Index = N to S , middle = current + to − , thumb is direction of motion
Generator is RH rule: Index = N to S , middle = current + to − , thumb is direction of motion
RH rule for coils + to − thumb indicates 'N'
To reverse a dc motor rotate field or armature - Synchroneous motor has permanent magnets
If one phase is missing of a 3 phase motor it runs at the same speed but won't restart
Single phase motors use capacitors or shaded poles to create an opposite small magnetic field or hysteresis motor with a cobalt steel rotor or a split winding with a control resistor 90° lead or lag.

Static inverter: Filter for glitches, oscillator to form a sine wave. Pulse with modulator = sine wave ¿ square wave. Driver amplifier amplifies square vaves. Power amplifier converts square waves to sine waves. Output filter reduces distortion. Voltage regulator controls modulator.
Paramagnetic material = alu ; diamagnetic material = copper
CR circuits - resistor slows capacitor down RMS = 0.707 of peak
Coils in series Lt = L1 + L2 + L3 ... In parallel: 1/Lt = 1/L1 + 1/L2 + 1/L3 ...
Capacitors in parallel Ct = C1 + C2 + C3 ... In series: 1/Ct = 1/C1 + 1/C2 + 1/C3 ...
XL = 2 pi f L ; Xc = 1 / 2 pi f C C I V I L ; C = epsilon x Area / distance
Max bonding on A/C is 0.05 Ohm ; leads on bonding tester have critical length
A transformer works on the principle of induction.
If the rate at which a conductor passing through a magnetic field and cutting the lines of force is increased, the induced e.m.f. in the conductor will Increase.
Electro-magnetism principle is used to operate a solenoid.
The formula to calculate the frequency is R.P.M. x pair of poles / 60 = Hz
Frequency output is depends on the speed of rotation and number of pairs of poles.
The unit of frequency measurement is called Herz (Hz).
Root mean square value (V r.m.s.) of an a.c. voltage depends on the amplitude and the pattern of waveform.
Pure inductive current lags voltage.
Pure capacitive current leads voltage.
Pure resistive circuit is in phase.
A 3 phase a.c. generator can be constructed by: 3 single-phase a.c. generators.
The power ratings of a.c. generator are generally given in KVA.
The power ratings of d.c. generator are generally given in KW.
The power factor of a generator usually of a value from 0.7 - 0.85
115 a.c. connected to the load and grounded line to line voltage, voltage remains constant.
115 a.c. connected to other phase terminal and grounded phase to phase voltage, voltage increases.
Power factor is expressed as cos = effective power / apparent power
The function of a rotating rectifier is to convert from a.c. to d.c. for the PMG.
When one of the generator failed, its load would spread evenly to other generator due to load sharing.
Load shedding of a a.c. generator is voltage remains the same, current reduced.
Delta winding gives better current output.
Transformer rectifier unit (TRU) step down first and rectifier later.
Single phase rectifier has 4 diodes and a 3 phase rectifier has 6 diodes
D.C. motor to drive A.C. generator = Rotatory invertor.
Check for open circuit : continuity test by low range ohm-meter
Functional test after repair of circuit: Detect isolation.
Circuit breaker protection :- protect A.C. and D.C. from overload current
Testing the high current a.c. generator, use a 250 millivolt drop tester.
How to check for open circuit: By continuity test.
Insulation test on circuit: Reading is affected by moisture, is infinite when cable is properly insulated.
Low insulation resistance of battery. 250 V insulation tester (for lead acid), R greater 1 megohms Indicates battery case or cell leakage.
The electrolyte used in Nickel-cadmium battery is: 30% Potassium hydroxide and 70% distilled water.
Nickel-cadmium battery storage condition : full fill and discharge (potassium hydroxide electrolyte)
Normal acid cell battery storage condition : full fill and recharge
When two batteries of 12V connected in parallel: 12 volts and increase in amper-hour.
Emergency light battery is fitted with the bus bar.
Potential difference of electricity is called: Volt Power is in Watt.

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