Review for Quiz 14

Part 14d of
"Communications"
A Fairfield University E-Course
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Section 14 Schedule

Session 14a	11/19	Intro to Applied Technical Mathematics	Notes: Binary/Octal/Hex, Powers of 10, Basic Algebra
Session 14b	11/24	DC & AC Motors	Elect1-7: pp. 7-39: 7-69, pp. 7-89: 7-117
Session 14c	11/26	Levers/gears, Torque/HP/RPM	Notes
Quiz 14 Review (Quiz 14 due 12/07)	**12/01**		**Notes**
Quiz 14 Results	12/08		
MT8 (Sat,Cheshire)	**12/13**		
MT8 Results	12/15		

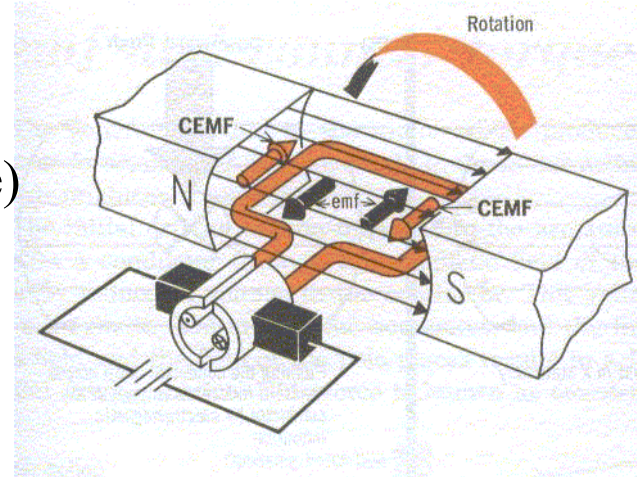
Section 14:
Applied Technical Mathematics

- Math review
  - Binary numbers (Hex and Octal)
  - Powers of ten
  - Working with equations
- DC & AC Motors and Generators
  - Simple relationships and vocabulary
- Levers and Gears
  - Relating linear force and motion to rotational torque and motion
  - F=M*A vs T=J*α
- Torque, RPM and Horsepower
  - Simple relationships and vocabulary

Math Review

- Number Systems
  - Binary (powers of 2 - **011011010011**)
  - Octal (3 bits at a time, powers of 8 - **3323**)
  - Decimal (powers of 10 - **1747**)
  - Hexadecimal (4 bits at a time, Powers of 16 – **6D3**)
- Scientific Notation ($1.5*10^{3}$, $15*10^{-6}$)
- Solving Equations (Maintain equality)
  - Add (or subtract) the same number to both sides
  - Multiply (or divide) both sides by the same number (except zero)
  - Square (or take the square root of) both sides
  - Use the same function on both side (sine, arccos, log …)
- Multiple Equations (N equations, N unknowns)
- Polynomials
  - Foiling (First, Outer, Inner, Last) $(x-3)*(x+3) = x^2+3x-3x-9 = x^2-9$
  - UnFoiling (Factoring)

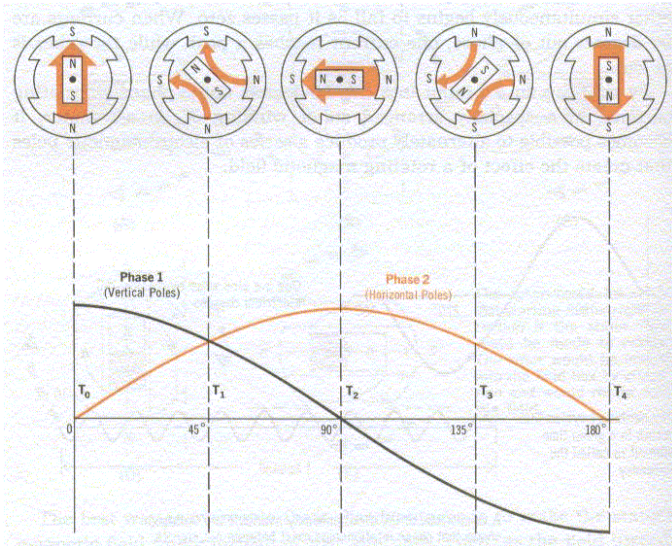
DC Motor/Generator Review



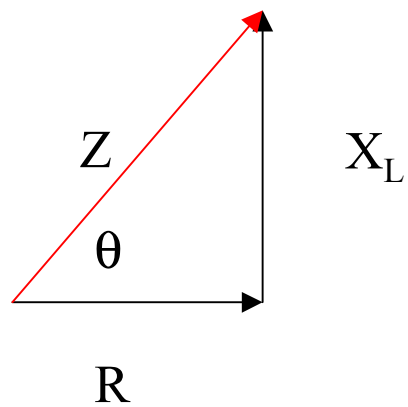
- Electro Motive Force (Voltage)
  - Applied EMF (armature battery voltage)
  - Counter EMF (Generated armature voltage)
- DC Motor / Generator
  (Which one depends on power flow direction)
  - Operation
    - Armature spins in a magnetic field
    - Armature current causes rotational force
      (Motor action due to Applied EMF)
    - Rotation creates Counter EMF (CEMF – Generator Action)
  - DC Motor Facts
    - Steady-State Speed is approximately proportional to Applied EMF
    - Steady-State Armature current is whatever is required to provide the Power (736 Watts = one Horsepower) needed to turn the load at the Steady-State speed
    - There is a high starting current (locked rotor $\Rightarrow$ overload
    - If the magnetic field strength is increased, the CEMF increases and the motor slows down

AC Motor Review

- Rotating Field
  - Armature tries to stay aligned with the field
  - Armature aligns with field
- Characteristics
  - Guarantees rotational direction
  - Speed determined by frequency and the number of poles



- Coils (Armature and Field)
  - Resistance (R)
  - Inductance ($X_L=2\pi fL$)
- Impedance ($Z = \vec{R} + \vec{X}_L$)
  - Length: $|Z| = SQRT(R^2 + X_L^2)$
  - Angle: $\theta = ARCTAN(X_L/R)$

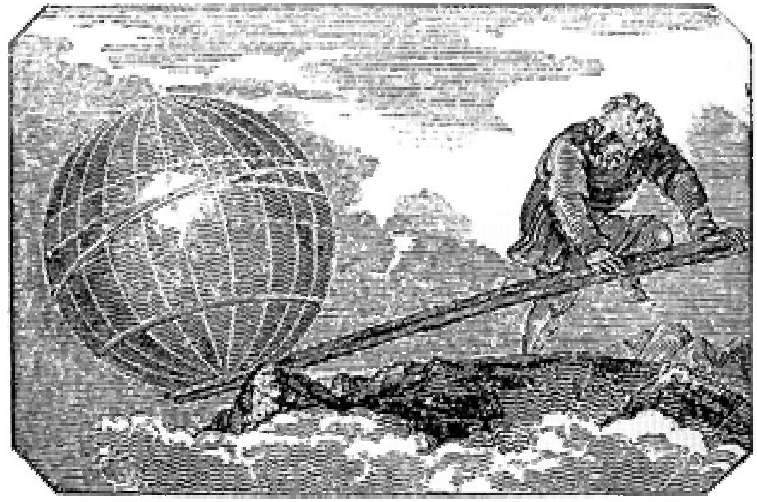


Motor/Generator Equations Review

- EMF = I * R (Ohms Law)
- $X_L = 2*\pi*L$ (Inductive reactance, remember vectors)
- Power = I * V (in Watts, I & V are RMS values)
  (1 HP = 736 Watts)
- $cemf=V_{total}-(Ia*Ra)-(I_{field}*R_{field})$
  (just Kirchoff, armature winding & field winding in series,
  same current in both windings)
- T=(hp)(5252)/Na (Na=rev/min, T in ft-lbs)
- Nm=(T)*1Nm/0.73756 lb-ft (Nm =Newton-meter)
- Kemf=cemf/(Ifield*Na) - the generator constant
- Hp=(lb-ft)*(rev/min)/5252
- Synchronous speed=120*frequency/no. of poles

Levers/Torque Review

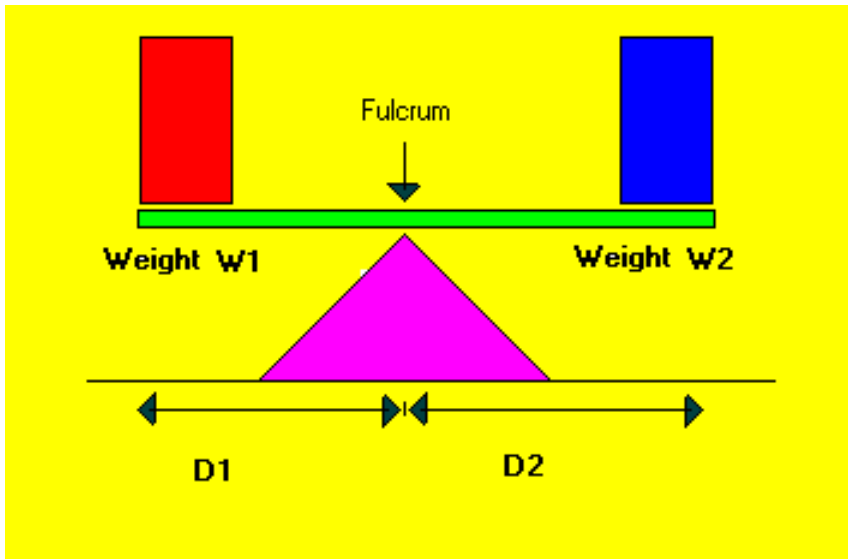
- $F^1 * D^1 = F^2 * D^2 = \text{Torque}$
- Torque units
  - Foot-Lbs
  - Newton-Meters
- Rotational acceleration
  - $T = J * \alpha$
  - J is “moment of inertia”
  - α is “angular acceleration”



ΔΟΣ ΜΟΙ ΠΟΥ ΣΤΩ ΚΑΙ ΚΙΝΩ ΤΗΝ ΓΗΝ

Give me where [to] stand and [I will] move the earth

Archimedes 340 AD



Gear/Pulley Review

- Operation
  - Gears are mechanical transformers
  - $RPM_1 * R_1 = RPM_2 * R_2$
  - $T_1/R_1 = T_2/R_2$
  - You can use the number of teeth instead of the radius
- Belts and Pulleys work the same way as gears

Motor/Generator Equations Again

- EMF = I * R (Ohms Law)
- $X_L = 2*\pi*L$ (Inductive reactance, remember vectors)
- Power = I * V (in Watts, I & V are RMS values)
  (1 HP = 736 Watts)
- $cemf=V_{total}-(Ia*Ra)-(I_{field}*R_{field})$
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- T=(hp)(5252)/Na (Na=rev/min, T in ft-lbs)
- Nm=(T)*1Nm/0.73756 lb-ft (Nm =Newton-meter)
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- Hp=(lb-ft)*(rev/min)/5252
- Synchronous speed=120*frequency/no. of poles

Another Practice problem

A 24 volt, ½ HP, Permanent Magnet, 1800 RPM, DC motor uses 20 amps at its rated output.
(This is all stated on the motor "Nameplate")

- What is the CEMF if Ra=0.1(Ifield = 0)

  cemf=Vtotal-(Ia*Ra)-(Ifield*Rfield)
  cemf=24 – (20*0.1)
  cemf=24 – 2 = **22 volts**

- What is the Kemf for this motor?

  Kemf=cemf/(Ifield*Na)
  Kemf=22/(20*1800) = 11/18000 = 0.00061 = **$0.61*10^{-3}$**

- Find the Motor Efficiency and Torque
  - Power in = V * I = 24 * 20 = 480
  - Power out = 0.5 HP = 0.5 * 736 (W/HP) = 368 Watts
  - Efficiency = 368/480 = **0.77 or 77%**
  - Torque = HP*5252/Na = 0.5*5252/1800 = **1.46 ft-lbs**
  - Torque = 1.46/0.73756 = **1.98 newton-meters**

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Holiday break till	**1/5/04**		