AES731 Electrical Technology I

Final Exam AY2016-2017 Semester 1

Formulas, Data, and Conversions

General

$e = -1.6 \times 10^{-19}\ C$

$1\ hp = 746\ W$

$1\ \text{rpm} = \frac{2\pi}{60} rad/s$

Electric Fields

$F = k\frac{q_1 q_2}{d^2}; k = 9.1 \times 10^9\ Nm^2/C^2$

$E = \frac{F}{q} = \frac{V}{d}$

$V = \frac{E}{Q}$

$I = \frac{Q}{t}$

Kirchhoff's Laws

$\sum I_{node} = 0$

$\sum V_{loop} = 0$

Y-Δ conversions

$R_a = \frac{R_1 R_3}{R_1 + R_2 + R_3}$

$R_b = \frac{R_1 R_2}{R_1 + R_2 + R_3}$

$R_c = \frac{R_2 R_3}{R_1 + R_2 + R_3}$

$R_1 = \frac{R_a R_b + R_b R_c + R_c R_a}{R_c}$

$R_2 = \frac{R_a R_b + R_b R_c + R_c R_a}{R_a}$

$R_3 = \frac{R_a R_b + R_b R_c + R_c R_a}{R_b}$

Inductors and Capacitors

$CEMF = -L\frac{\Delta I}{\Delta t}$

$T_L = \frac{L}{R}$

$V = L\frac{\Delta I}{\Delta t}$

$C = \frac{Q}{V}$

$C = k\frac{A}{d}; k = 8.85 \times 10^{-12} F/m$

DC Generators

$E_g = k\varphi N$

DC Motors

$T = k\varphi I_a$

$E_{CEMF} = k\varphi N$

Batteries

$Battery\ Rating = \frac{SG_{FC} - SG_{DR}}{Normal\ Gravity\ Drop \times 0.001} \times 100\%$

Uniformly Accelerated Rotational Motion

$\omega = \omega_0 + \alpha t$

$\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$

$\Delta\theta = \omega_0 t + \frac{1}{2}\alpha t^2$

1 Find the Thévenin equivalent of the circuit in **Figure 1**. [5]

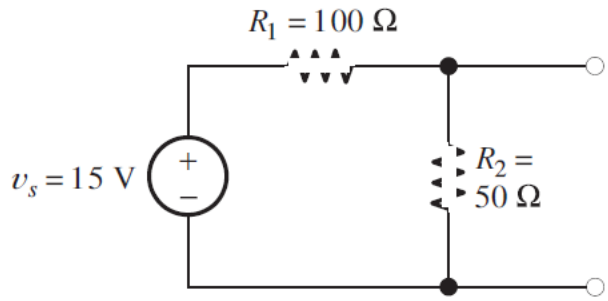

Figure 1

2 The specific gravity of a 12-V lead-acid battery has an average full-charge of 1.250 and has a normal gravity drop of 160 points at a 12-hour discharge rate. Currently the battery has a specific gravity 1.180. The battery is rated at 1,000 amp hours.

(a) Name an instrument that can be used to measure the battery's specific gravity. [1]

………

(b) Calculate the charge on the battery [3]

(c) Calculate the amp-hours remaining in the battery [3]

(d) The battery is connected to a charger that supplies an average of 50 amps. Calculate the total amp-hours in the battery after 10 hours of charging. [3]

3 **(a)** State the three requirements for electromagnetic induction. [3]

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………

………

(b) A conductor AB is placed between two magnetic poles as shown in **Figure 3a**.

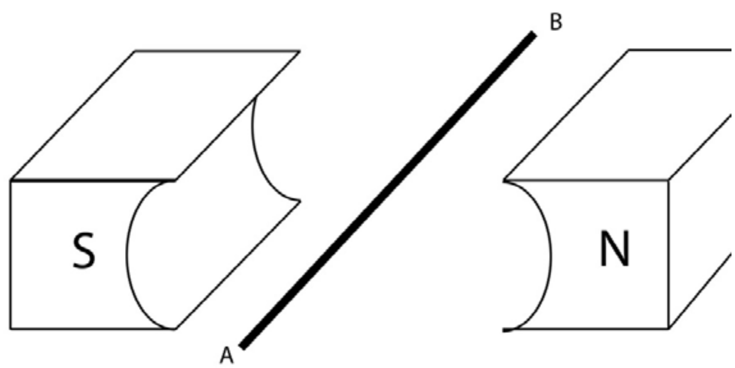

Figure 3a

(i) Draw the magnetic field lines in the space between the poles. [1]

(ii) Mark the polarity of the induced emf when the conductor moves upwards. [1]

(iii) Determine the direction of the conventional current in conductor AB when it moves downwards. [3]

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(c) Another conductor is formed in the shape of a flat coil and placed between the same magnetic poles as shown in **Figure 3b.** [2]

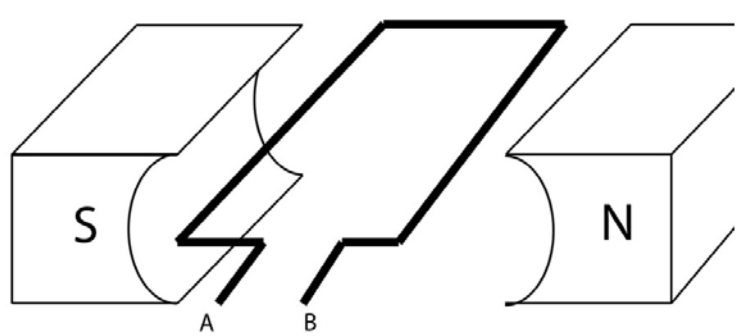

Figure 3b

As the coil starts to rotate clockwise predict the polarity of terminals A and B.

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4 On the axes in **Figure 4**, sketch the output of an electric generator

(a) Without a commutator, and [1]

(b) With a commutator [1]

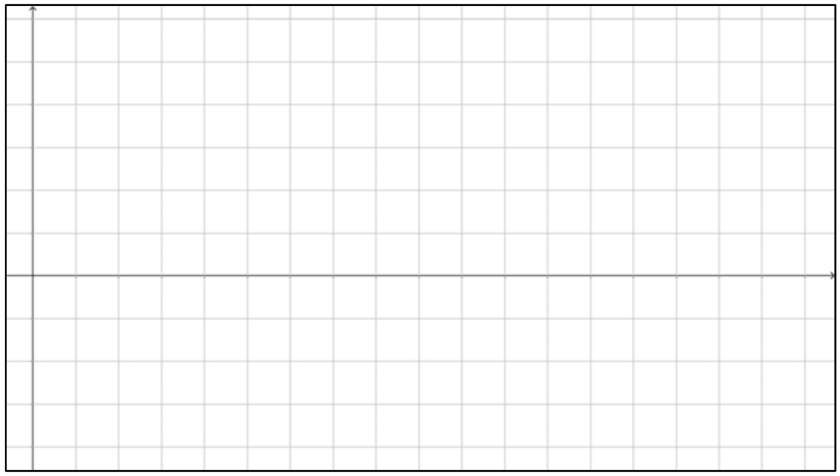

Figure 4

(c) A dc generator has an armature current of 65 A, a field current of 12 A, and armature resistance of 3 Ω and a field resistance of 2 Ω. Calculate the total copper loss in the generator. [2]

(d) Provide the meanings or functions of the following terms or components: [13]

(A) Terminal voltage
(B) Armature
(C) Stator
(D) Field
(E) Voltage rating
(F) Current rating
(G) Shut-wound generator
(H) Series-wound generator
(I) Flat-compounded generator
(J) Hysteresis losses
(K) Mechanical losses
(L) Rotor
(M) Voltage regulator

5 **Figure 5a** shows the end view of a theoretical dc motor.

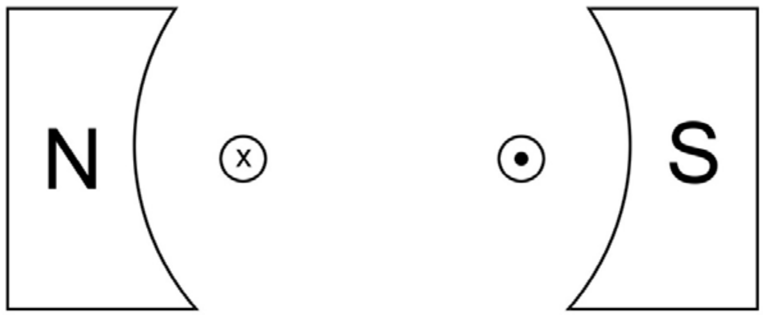

Figure 5a

(a) On **Figure 5a**, show the direction of the force on each of the conductors due to its presence in the magnetic field. [4]

(b) Based on the directions of the forces you determined in **(a)**, determine the sense of rotation of the rotor. [1]

(c) As the motor runs, a counter electromotive force is developed in the armature, as shown in the armature equivalent circuit in **Figure 5b.**

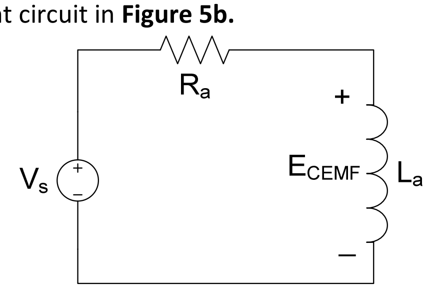

Figure 5b

Given that $V_s = 250\ V$, $R_a = 2.5\ \Omega$ and $E_{CEMF} = 70\ V$, calculate the armature current. [4]