Back Emf

Thursday, June 06, 2013
9:19 AM

When an electric motor is operating it acts as a partial generator, putting voltage & current back into the circuit. This is called Back Emf

$$V_{back} = \mathcal{E} - Ir$$

$\mathcal{E}$: input voltage

r: resistance in the motor (armature)

When connected to 220V a motor draws 8 amps of current thru its 1Ω armature. What is the Back Emf

$$V_{back} = \mathcal{E} - Ir$$
$$= 220V - (8A)(1\Omega)$$
$$= 212V$$

Find current if motor stalls

$V_{back} = 0$

$$V_{back} = \mathcal{E} - Ir$$
$$0 = 220V - I(1\Omega)$$
$$I = 220A$$

Back EMF

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NAME: _____

Back EMF

1. A motor operating at full speed draws a current of 4.0 A when connected to a 110 V source. The motor has an armature resistance of 3.5 Ω. What is the back emf at full speed?
   A. 14 V
   B. 96 V
   C. 110 V
   D. 124 V

$V_{back} = \mathcal{E} - Ir$

$= 110V - (4A)(3.5\Omega) = 96V$

2. A dc motor has a resistance of 2.0 Ω. When connected to a 12 V source, with the motor rotating at its operational speed, a back emf of 5.5 V is generated. What is the current in the motor at operational speed?
   A. 2.8 A
   B. 3.3 A
   C. 6.0 A
   D. 8.8 A

3. An electric motor rotates at various speeds and the current through the armature changes accordingly. Which pair of conditions occurs when the motor generates the greatest back emf?

	SPEED	CURRENT THROUGH THE ARMATURE
A.	Fastest ✓	Largest
B.	Fastest ✓	Smallest ✓
C.	Slowest	Largest
D.	Slowest	Smallest

4. An electric motor is connected to a 12.0 V power supply. When the armature is prevented from rotating, the current is 8.0 A. When the motor is running at normal speed, the current is 2.0 A. What is the back emf in each case?

	BACK EMF WHEN STATIONARY	BACK EMF WHEN RUNNING
A.	0 V ✓	9.0 V
B.	0 V ✓	3.0 V
C.	12 V	9.0 V
D.	12 V	3.0 V

5. As a carpenter drills into a beam, friction on the drill bit causes the armature of the drill to slow down. How will the back emf and the current through the armature change as the drill slows down?

	BACK EMF	CURRENT
A.	Increase	Increase
B.	Increase	Decrease
C.	Decrease	Increase
D.	Decrease	Decrease

6. An automobile starter motor, connected to a 12.0 V battery, produces a back emf of 9.7 V when operating at normal speed. A malfunction prevents the starter motor from turning and the current increases to 180 A. What current does the starter motor draw when operating normally?

stall: $V_{back} = \mathcal{E} - Ir$ $\quad \frac{12}{180} = r$ $\quad 0 = 12V - 180A\,r$ $\quad r = \frac{1}{15}\Omega$

spins: $V_{back} = \mathcal{E} - Ir$ $\quad 9.7V = 12V - I\left(\frac{1}{15}\right)$ $\quad 34.5A$

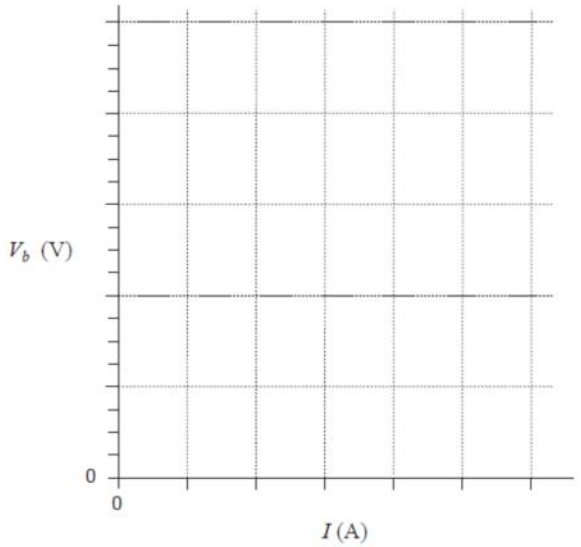
7. An electric motor is connected to a 9.0 V power supply. The data table below shows how the back emf of the motor, V_{back}, varies with the current through the armature, I, as the mechanical load changes.

Back emf V_{back} (V)	7.5	6.0	4.5	3.0	1.5	0
Current I (A)	1.0	2.0	3.0	4.0	5.0	6.0

Plot this data on the graph below.

Determine the slope of this graph.

What property of the motor does the slope of this graph represent?



8. An electric motor is operated from a 6.0 V supply. When the armature is held still, the current in it is 4.0 A. When the armature turns freely, the current is 2.4 A.
   a) What is the resistance of the armature? **1.5 Ω**
   b) What is the back EMF of the motor at this frequency of rotation?
   c) If the load on the motor is increased so that its frequency is reduced to three-quarters of what it was, what will the back EMF be then?

9. A motor has an armature resistance of 1.8 ohms. Running at full speed, it draws 0.50 A when connected to a 12.0 V source. What is the back EMF?

10. The back EMF of a motor is 4.2 V when operated from a 6.0 V source. When held stationary, the current in the armature is 5.0 A.
    a) What is the resistance of the armature?
    b) What current exists in the armature when it rotates at normal speed?

11. A motor has an armature resistance of 3.15 Ohms. If it draws 9.20 A when running at full speed and connected to a 120 V line, how large is the counter EMF?

12. The DC motor is connected to a 120 V source. The motor's coils have a resistance of 4.6 Ω. At full speed the current through the motor is 1.5 A. Determine the back emf when the motor is operating normally.

Answers:

1. B
2. B
3. B
4. A
5. C
6. 34.5 A
7. -1.5 V/A OR -1.5Ω, resistance
8. 1.5 Ω, 2.4 V, 1.8 V
9. 11.1 V
10. 1.2 Ω, 1.5 A
11. 91.0 V
12. 113 V