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Week 7 Studio 2

Group 4b

2nd Octorber 2019

**Activity #1: Observing the relationship of (i) rotational speed vs. motor voltage, and (ii) rotational speed vs. generator voltage, for constant load**

3.

|  |  |  |
| --- | --- | --- |
| Motor Voltage Vm(V) | Rotational Speed(RPM) | Generator Voltage Vgen(V) |
| 7 | 1674 | 5.45 |
| 8 | 1984 | 6.33 |
| 9 | 2210 | 7.09 |
| 10 | 2579 | 8.24 |
| 11 | 2851 | 9.11 |
| 12 | 3138 | 10.02 |

The generator voltage measured is negative and the Vgen taken down into the table is the absolute value of the measured voltage Vgen = |Vgen measured|

6(a).

6(b).

The graph of 6(a) Rotational Speed vs. Motor Voltage does not pass through the origin as initial voltage is required to overcome the initial frictional force while the graph of 6(b) Rotational Speed vs. Generator Voltage passes through the origin as Vgen is directly proportional to shaft speed, when there is no Vgen, there is no shaft speed.

7.

For 6(a), ω = 2π(RPM) =

RPM =

So the gradient of the graph = and the y intercept of the graph = -

When motor voltage Vm increases, RPM increases, shaft speed ω increases

For 6(b), ω = 2π(RPM) =

RPM =

So the gradient of the graph = and the y intercept of the graph = 0

When generator voltage Vgen increases, RPM increases, shaft speed ω increases

**Activity #2: Characterizing a DC motor**

1.

Vm = 12V

|  |  |  |  |
| --- | --- | --- | --- |
| Resistive Load Connected to Generator | Motor Current Im(A) | Rotational Speed(RPM) | Angular Speed ω(rad/s) |
| No resistor load | 0.15 | 3182 | 333.22 |
| 100 | 0.23 | 2869 | 300.44 |
| 50 | 0.28 | 2656 | 278.14 |
| 33.3 | 0.31 | 2514 | 263.27 |

Vm = 10V

|  |  |  |  |
| --- | --- | --- | --- |
| Resistive Load Connected to Generator | Motor Current Im(A) | Rotational Speed(RPM) | Angular Speed ω(rad/s) |
| No resistor load | 0.14 | 2616 | 273.95 |
| 100 | 0.20 | 2365 | 247.66 |
| 50 | 0.24 | 2191 | 229.44 |
| 33.3 | 0.27 | 2066 | 216.35 |

3. y-intercept = stall current

For Vm = 10V, stall current = 0.75715A

For Vm = 12V, stall current = 0.91750A

4. x-intercpt = no load speed

For Vm = 10V, x-intercept = (0-0.75714)/-0.00225 = 336.5

No-load speed in RPM = 336.5\*60/2π = 3213 RPM

For Vm = 12V, x-intercept = (0-0.91750)/-0.00230 = 398.9

No-load speed in RPM = 398.9\*60/2π = 3809 RPM

For Vm = 12V, no-load speed from datasheet in RPM = 3840 RPM

Percentage difference = (3840-3809)/3840 \*100% = 0.807%

The no-load speed calculated has a percentage difference of 0.807% from the no-load speed stated in the datasheet. The no-load speed calculated is similar to the value in datasheet. The difference is because there is an increase friction from general usage of the generator.

5. Im=Vm/Rm – Ke\*ω/Rm

For Vm=10V

So the gradient is -Ke/Rm and the y-intercept is Vm/Rm

1. Rm = Vm/y-intercept = 10/0.75175 = 13.2Ω
2. Since it is a PMPC motor,

Ke = Kt = -(Rm\*gradient) = -(13.2\*-0.00225) = 0.0297 = 29.7mNm/A

For Vm=12V

So the gradient is -Ke/Rm and the y-intercept is Vm/Rm

1. Rm = Vm/y-intercept = 12/0.91750 = 13.1Ω
2. Since it is a PMPC motor,

Ke = Kt = -(Rm\*gradient) = -(13.1\*-0.00230) = 0.0301= 30.1mNm/A

Rm and Ke values should remain the same for different operating voltage Vm

From datasheet, for Vm = 12V, Rm = 12.5Ω, Ke = 28.9mNm/A

Percentage difference of Rm = (13.1-12.5)/13.1 \* 100% = 4.58%

Percentage difference of Ke= (30.1-28.9)/30.1 \* 100% = 3.99%

Rm calculated and Ke calculated are similar to the values in datasheet

There is a percentage difference of 4.58% for Rm calculated and Rm in datasheet and a percentage difference of 3.99% for Ke calculated and Ke in datasheet. The percentage difference is small and it may be due to human error when measuring RPM value using tachometer.