M E 345

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Lecture 35

- Continue to review the pdf module: Mechanical Measurements, and do some examples
- Do a demo stroboscopic tachometer

Example: RPM measurement

Given: A "poor person's" magnetic pickup tachometer is made from a standard hex nut on an automobile turbocharger to measure the rpm of the turbocharger.

(*a*) **To do**: If the observed pulse rate is 5,000 pulses per second, calculate the rpm of the rotating hex nut.

(b) To do: Calculate the multiplaction factor to convert from P to $N_{\rm rpm}$.

Solution:



Example: RPM measurement

Given: A shaft is rotating at 2400 rpm. A single dot is painted on the end of the shaft, and a stroboscope is used to measure the rpm.

To do: For each case, determine how many dots you will see, whether they are moving or "frozen," and if you are fooled (infer the incorrect rpm). The strobe flashes at:

(*a*) 800, (*b*) 1600, (*c*) 3000, and (*d*) 4800 rpm.

Solution:

Some additional comments and notes about measuring rpm with a strobe:

Procedure: How to properly measure the rpm using a strobe:

1. Start at *low* flash rate, and slowly *increase* the flashing rpm until you see one "frozen dot" for the *last* time. This will be the correct rpm.

OR

2. Start at *high* flash rate, and slowly *decrease* the flashing rpm until you see one "frozen dot" for the *first* time. This will be the correct rpm.

THEN

3. For either case, *double* the flash rate at which you see one "frozen dot" and verify that you now see two "frozen dots". If so, then you are confident that half of this rpm is the correct rpm.

[E.g., at 600 rpm see *one* frozen dot, and at 1200 rpm see *two* frozen dots. We are confident that the correct rotation speed is 600 rpm.]

Additional comments:

- 1. *Any strobe flashing rate above the correct rpm cannot fool you*. [You will never see only one "frozen dot" and be fooled at that rpm. You will either see two or more "frozen dots", or you will see the shaft rotating at some (incorrect) rotation speed, either forward or backward, or you will see some other pattern of dots you will not be fooled.]
- 2. Any strobe flashing rate that is an integer fraction below the correct rpm will fool you. [You will see only one "frozen dot" and be fooled at that rpm. In other words, you will think the actual rpm is the strobe flashing rpm, but this will be incorrect.] [E.g., if the true rpm is 600, you will see one "frozen dot" at 600 rpm (correct), but also at 600/2 = 300 rpm, 600/3 = 200 rpm, 600/4 = 150 rpm, ... etc. If you are not careful, you could be fooled into thinking the correct rpm is at one of these lower (incorrect) rotation rates.]
- 3. Things get a little more complicated when there are identical spokes, as in a wagon wheel.

Example: RPM measurement

Given: A wagon wheel has 12 identical spokes, and rotates at 600 rpm. The rpm is measured with a stroboscopic tachometer in a room where it is dark except when the strobe light flashes. There are no painted dots anywhere, and *there is no way to distinguish one spoke from another*.

To do: Calculate the maximum strobe flashing frequency at which you could be fooled. In other words, calculate the maximum strobe flashing frequency at which you would see a wagon wheel that appears to be frozen (not rotating), and therefore you could be fooled into thinking that this is the correct rpm. *Give your answer as in integer in units of rpm*.

Solution: