Safety Hazards
Instrumentation Laboratory Room 214

HAZARD: Rotating Equipment / Machine Tools

Personal Protective Equipment: Safety Goggles; Standing Shields, Sturdy Shoes
No: Loose clothing; Neck Ties/Scarves; Jewelry (remove); Long Hair (tie back)

HAZARD: Heating - Burns

Personal Protective Equipment: High temperature gloves; High temperature apron

HAZARD: Electrical - Burns / Shock

Care with electrical connections, particularly with grounding; Do not use frayed electrical cords.

HAZARD: Water / Slip Hazard

Clean any spills immediately.

HAZARD: Noise

Personal Protective Equipment: Ear Plugs

Rotation Speed Measurement and Signal Filtration

Major Equipment

D.C. Motor with Magnetic Pickup Output and D.C. Generator; Electronic Frequency Counter; Digital Multimeter; Electronic Tachometer; Stroboscope; Oscilloscope; Frequency Generator; Hi/Lo RC Filter

Procedures

Part I Rotation Speed Measurement

1. D.C. Generator Tachometer Calibration

   The gear on the motor shaft has 60 teeth. One rotation produces 60 counts. Connect magnetic pickup to electronic frequency counter. The counter yields rotation speed in revolution per minute (rpm).

   Connect DC generator to digital voltmeter. Set motor speed to 1500 rpm on the electronic frequency counter with the motor speed control knob. Turn the D.C. amplifier knob to 15.0 Volts on digital voltmeter. Lock the knob.

   Adjust the speed from 1500 to 0 rpm in 300-rpm intervals. At each point, record the electronic frequency counter reading and voltage.

2. Digital Tachometer

   Caution: Use minimum pressure needed to register the actual shaft speed, in order to minimize the loading error and to avoid damage to the equipment.

   Set the motor speed to 1000 ± 10 rpm (as read on the electronic frequency counter). **Maintain this speed setting throughout the entire experiment.**

   Each member of the team should record at least 10 readings from the digital tachometer. At least 50 data should be taken per group.

3. Stroboscope

   Set motor speed to 1000 rpm and record the electronic frequency counter reading

   Set the stroboscope frequency to approximately the electronic frequency counter reading. Fine-adjust the stroboscope frequency until the timing mark appears stationary; record this stroboscope reading, and sketch the mark on the gear face.

   Without changing the motor speed, increase the stroboscope frequency until it is doubled. Record the stroboscope frequency. Sketch the timing mark pattern.

Repeat above measurements for a stroboscope frequency of 3 times true shaft speed.

Repeat above measurement for a stroboscope frequency of ½ times true shaft speed.

4. Oscilloscope Direct Measurement

Connect the output of magnetic pickup to CH 1 of the oscilloscope, and also the electronic frequency counter. Set motor speed to 1000 rpm

Set the fine tuning knob of Time/Div in Cali position. Adjust the oscillator amplitude setting to produce a suitable display (say 3.0 cm peak-to-valley) on the oscilloscope screen. Adjust the oscilloscope time sweep so that a train of about 5 cycles will be displayed on the screen. If curve is unstable, adjust the knob of TRIG/LEVEL.

Record:

(a) Number of pulses (e.g. from the peak farthest on the left to the peak farthest on the right)
(b) Horizontal distance in cm which these pulses occupy to the nearest 0.1 cm
(c) Time sweep setting including the units.

5. Lissajou Figures

Set the motor speed to 1000 rpm (read the output of the electronic frequency counter).

Adjust the frequency generator to have approximately the rotation frequency. Split the output of frequency generator (select sine wave) using a tee-connector to CH 1 and CH 2 of the oscilloscope. Turn the trigger control to the x-y position.

Adjust either the amplitude setting of the oscillator or the gain setting of the horizontal amplifier of the oscilloscope, or both, until the resulting display on the oscilloscope screen will be a "line" of approximately 5 cm length.

Disconnect the frequency generator signal from CH 2. Connect the magnetic pickup output to CH 2 of the oscilloscope. Turn off the trigger control. Select the Vertical Mode for CH 2. Adjust the vertical amplifier gain until a 4 or 5 cm peak-to-valley sine wave appears on the screen.

Turn the trigger control to the x-y position. Fine-tune the frequency generator until the resulting Lissajou figure becomes essentially stationary, although it will be subject to some fluctuation. Sketch the Lissajou figure and record both oscillator frequency and motor speed from the electronic frequency counter.

Increase the oscillator frequency until a double loop figure appears (leaving the motor speed unchanged!). Sketch the Lissajou figure and record both oscillator frequency and motor speed from the electronic frequency counter.

Decrease the oscillator frequency until another double loop figure appears. Sketch the Lissajou figure and record both oscillator frequency and motor speed from the electronic frequency counter.

Part II Signal Filtration

6. RC Filter Gain and Phase Measurements

Set oscillator (frequency generator) to 1000 Hz. Connect the output to the electronic counter and to the input terminals A & B of the low pass RC filter and also to CH 1 of the oscilloscope. Adjust the vertical gain to produce a suitable (say 4.0 com peak-to-valley) display.

Connect the output of the low-pass filter to CH 2 vertical input of the oscilloscope. Record:

(a) Vertical peak-to-valley CH 1 display (cm) and gain setting (volts/cm).
(b) Vertical peak-to-valley CH 2 display (cm) and gain setting (volts/cm).
(c) Phase lag of the filter output signal with respect to the filter input signal, i.e. record "M" and "N" (see Fig.4).

Note: $\phi = (N)(360)/M$, where ϕ = phase angle in degrees.

(In Fig.4, there is a phase lag ϕ is negative)

Note: Gain Controls must be in "detent position!!

Repeat the above for the following oscillator frequency settings: (making sure that the input signal amplitude remains unchanged).

200; 500; 1,000; 2,000; 4,000; 8,000; 20,000; 40,000 Hz

Repeat the above measurements for the high pass filter. Clearly note what lags (or leads) what.

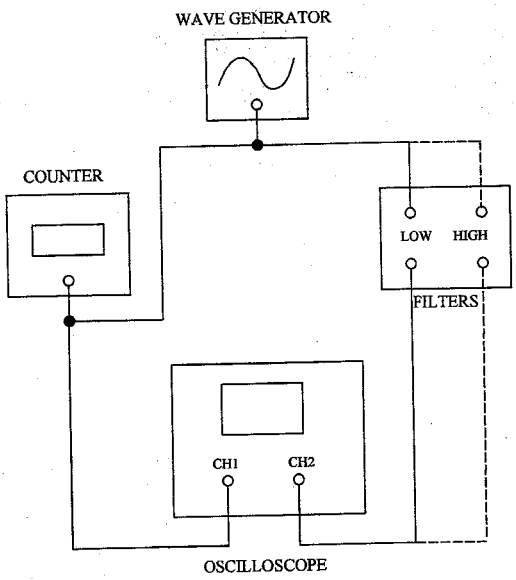

FIGURE 1 LAYOUT OF TEST APPARATUS

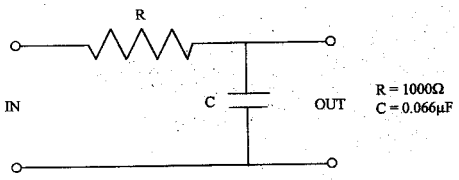

FIGURE 2 LOW PASS FILTER (Ref 1 Fig7.27a)

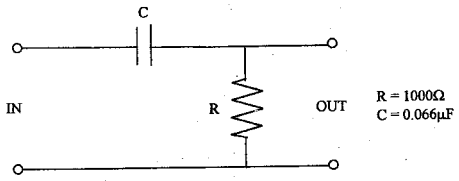

FIGURE 3 HIGH PASS FILTER (Ref1 Fig 7.27b)

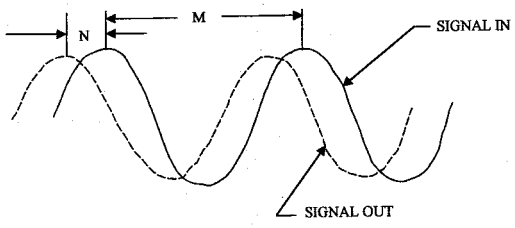

FIGURE 4 PHASE CHANGE