Indian Institute of Information Technology, Allahabad

Electronics and Communication Engineering Department

Course Name: Radar & Satellite Communication

Experiment No. 5

Aim :- To find out the Time period and frequency of a moving Pendulum for different lengths.

EXPERIMENT No. 5

TIME PERIOD OF PENDULUM

OBJECTIVE:

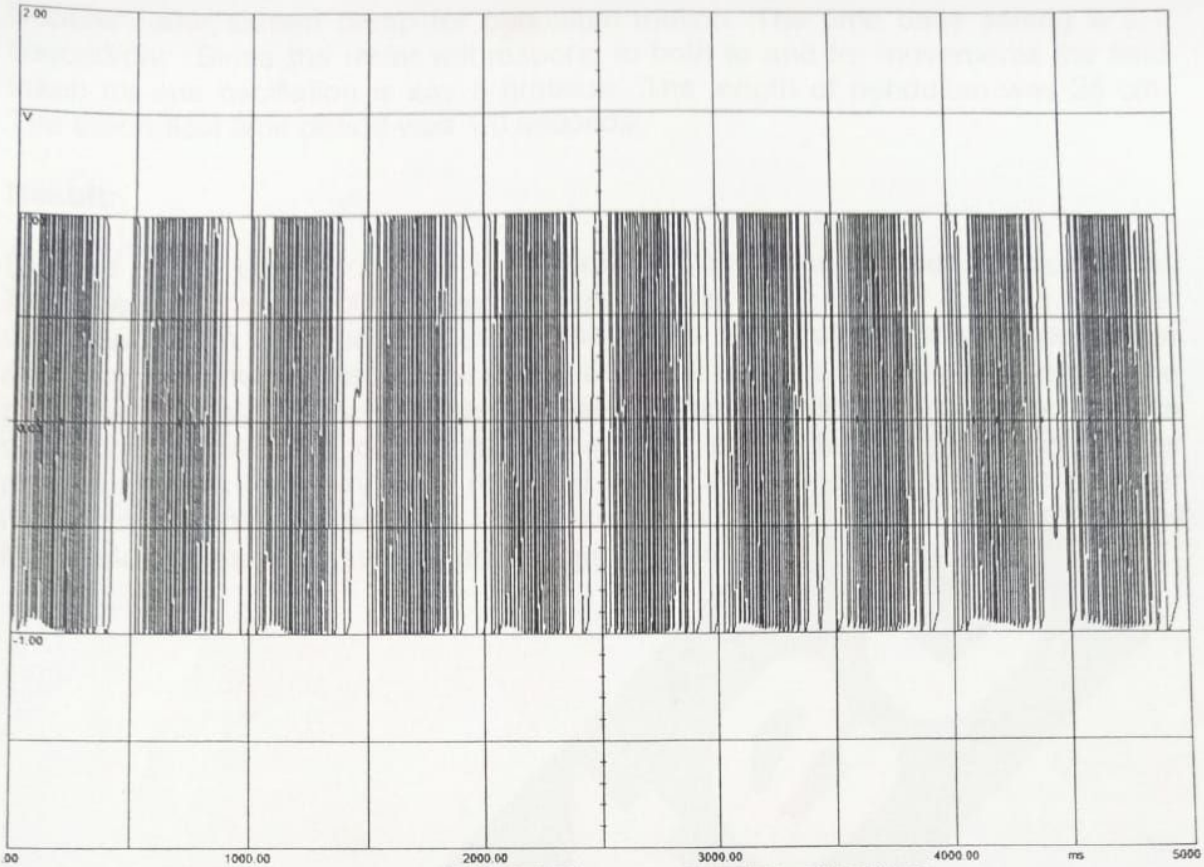
To find out the Time period and frequency of a moving Pendulum for different lengths.

EQUIPMENT REQUIRED:

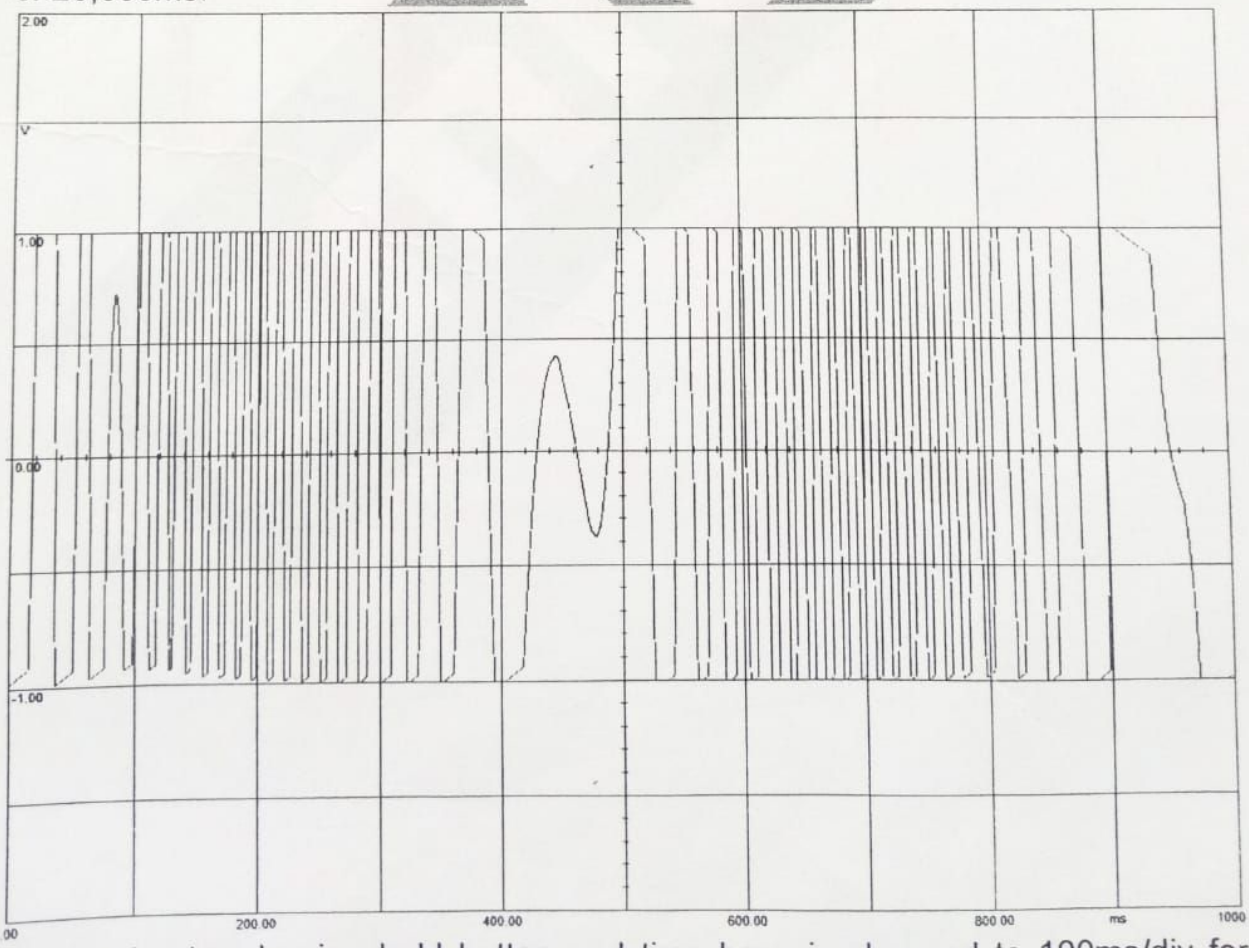
Doppler Radar, PC with multimedia, Pendulum

Procedure:

1. As you have already learnt that Time Period of pendulum is given by: $T = 2\pi . (l/g)^{1/2}$ where l is length of pendulum and g is constant 9.8 m/s^2 meaning time period of pendulum is independent of amplitude of oscillations.
2. When bob of pendulum moves to and fro, it will reflect the incoming microwave signal.
3. The received wave front from bob of pendulum will be different in phase for the two cases- first, when bob is approaching the radar and second, when bob is receding away from radar. The radar may however be unable to distinguish the two.
4. Connect the Doppler radar to the "mic in" input at back of the PC. This input is usually pink in colour and accepts an auxiliary audio signal of 200mV rms amplitude. Select 'mic in' as input in the software.
5. Open the time domain and record the movement of pendulum when the movement of pendulum is perpendicular to the radar. Allow the oscillations to be say 20cm amplitude fro 1m length of pendulum. From the signature the instance can be located when the pendulum crosses the radar. That is when its Doppler shift should be zero. Thus the time period of the pendulum can be calculated by zooming the signal in time domain.
6. In another case move the pendulum in a direction parallel to the axis of the radar. Analyse the difference in their radar signatures.
7. Move the pendulum at different angles to radar and see if the time measurement remains same.
8. Vary length of pendulum, and find out the different Time periods using Radar.
9. Replace the metallic bob with different objects and analyse their signatures. Do bigger objects results in more signal amplitude. Do metallic objects result in more signal amplitude? Why does even non-metallic objects reflect microwaves?
10. Compare the results to the theoretical time periods. Analyse the sources of errors in measurements. If under doubt, use a conventional oscilloscope for measurements.



Pendulum signature capture using radar with 0.5sec/div display setting and buffer of 20,000ms.

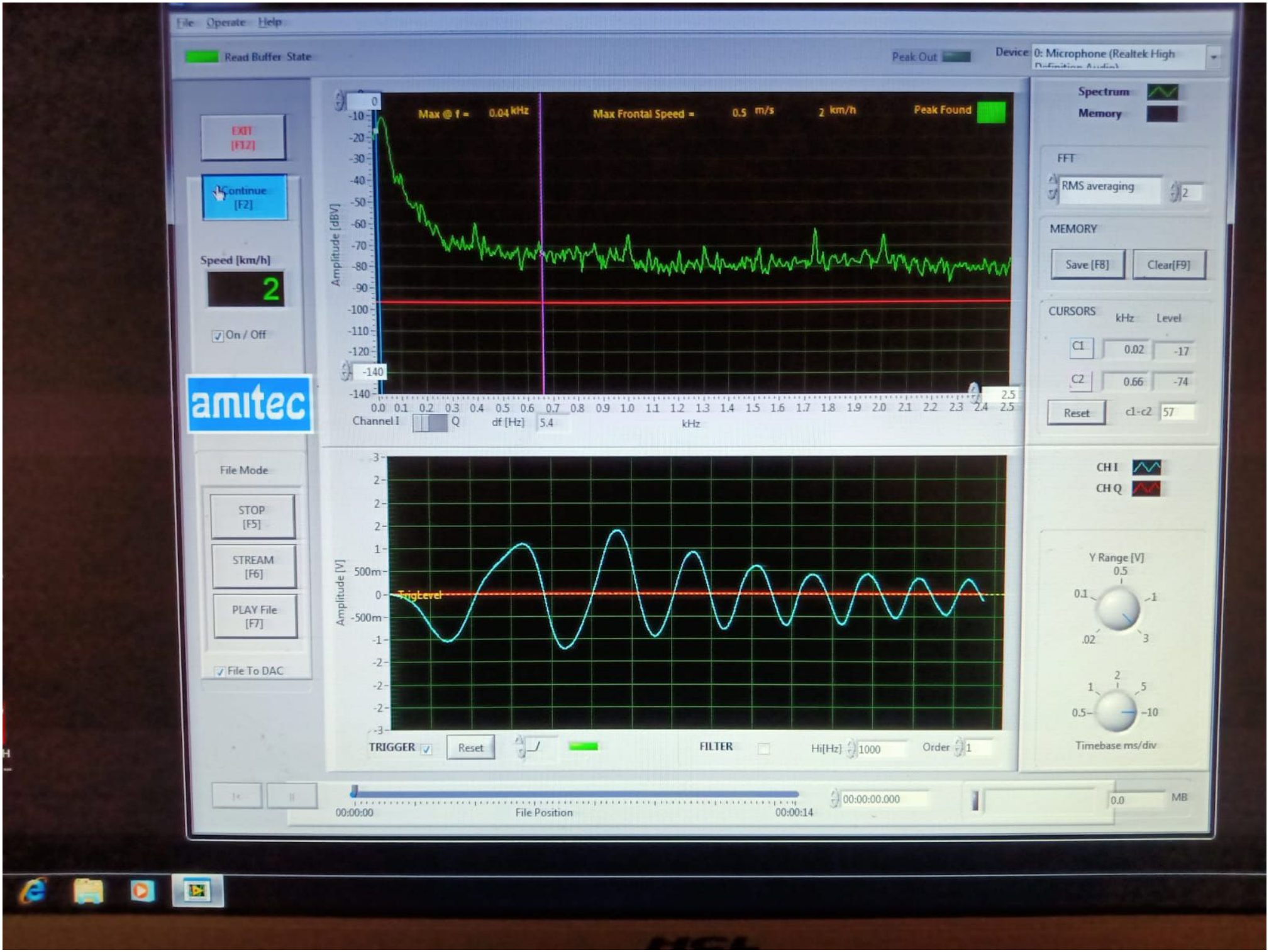


Display is stored using hold button and time base is changed to 100ms/div for zooming in.

Doppler radar screen dump for pendulum motion. The time base setting is 0.1 second/div. Since the radar will respond to both to and fro movements the time taken for one oscillation is say 5 graticule. The length of pendulum was 25 cm. The theoretical time period was 1.0 seconds.

Result:

Doppler radar can be useful in determining the time period of oscillations. Movement of the reflecting object parallel to the radar results in more Doppler signature. From the signature the instance can be located when the pendulum stops for a moment at its highest point or when it crosses the radar. Thus the time period of the pendulum can be calculated. Non-metallic objects reflect due to difference in dielectric constants of media at air & dielectric junction. Bigger pendulum bobs result in more reflected signal amplitude as they offer a bigger radar cross section to incoming microwaves. Using a metallic painted rubber ball for pendulum results in similar radar cross-section of a metallic ball.


File Operate Help
Read Buffer State
Peak Out
Device 0: Microphone (Realtek High
EXIT [F12]
Continue [F2]
Speed [km/h]
2
On / Off
amitec
File Mode
STOP [F5]
STREAM [F6]
PLAY File [F7]
File To DAC
Max @ f = 0.04 kHz
Max Frontal Speed = 0.5 m/s 2 km/h
Peak Found
Amplitude [dBV]
Channel I Q
df [Hz] 5.4
kHz
Spectrum
Memory
FFT
RMS averaging 2
MEMORY
Save [F8]
Clear[F9]
CURSORS kHz Level
C1 0.02 -17
C2 0.66 -74
Reset
c1-c2 57
CH I
CH Q
Amplitude [V]
TrigLevel
Y Range [V]
Timebase ms/div
TRIGGER
Reset
FILTER
Hi[Hz] 1000
Order 1
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