

Chapter 1 - Experiments

An experiment is performed to determine the velocity profile along a wind tunnel's test section using a pitot-static tube. Identify the independent, dependent, extraneous and parameter variables.

Tunnel rpm

Station position

Environment p and T

ρ

Δp

U

Chapter 2 - Units

- Your brain weighs 8.0 pounds on Earth. Find

SI weight =

SI mass on Pluto ($g_{\text{Pluto}} = 0.05 g_{\text{Earth}}$)

Weight in pounds on Pluto

Age of our universe

Chapter 2 – Significant Figures

027.08450

MSD?

LSD?

Number of significant figures =

Rounded off to 5 significant figures =

Chapter 3 - Number and Unit Formats

- Identify any format errors in the following.
- 2 – 3 m/sec
- 42%
- Body temperature, T , equals $98.6^{\circ}F$.
- 1×10^{-4} J
- One ft. equals 12 in. exactly.
- 25,233⁰
- 4E+4 ppm

Basic Electronics – R, C and L

- Knowing R, C, L, V and I, determine

Potential difference across a resistor, capacitor and inductor in series

Current across a resistor, capacitor and inductor in parallel

Current related to charge

DC potential difference across 2 inductors in parallel

Chapter 4 – Wheatstone Bridge

- Given R_1 , R_2 , R_3 , R_4 , E_i and E_o ,

Derive the basic Wheatstone bridge equation

What does this become when the bridge is balanced ?

When all R 's are initially the same and the bridge is used in the deflection mode ?

Voltage/force relation for same on a cantilever beam

Chapter 4 – Miscellaneous

When measuring a voltage, the input impedance of the voltmeter must be

When measuring a current, the input impedance of the ammeter must be

What is the resistance of a typical strain gage ?

What is the basic relation between R and T (temperature) for a wire?

Chapter 5 - Calibration

- What is the static sensitivity of the calibration curve
 $F = 250 W + 125$ at $W = 2$?
- What is the order of each of the following systems ?

Strain gage

Pressure Transducer

Accelerometer

RC circuit

Thermocouple

Pitot-static tube

Chapter 5 – Dynamic Response

- For a RC circuit ($R = 2 \Omega$; $C = 0.5 \text{ F}$) with step input forcing from 0 V to 1 V:

What is the V of the circuit at 1 s ?

What is the V of the circuit at 5 s ?

What is the % dynamic error at 1 s ?

- Now with sine input forcing of $3\sin 2t$:

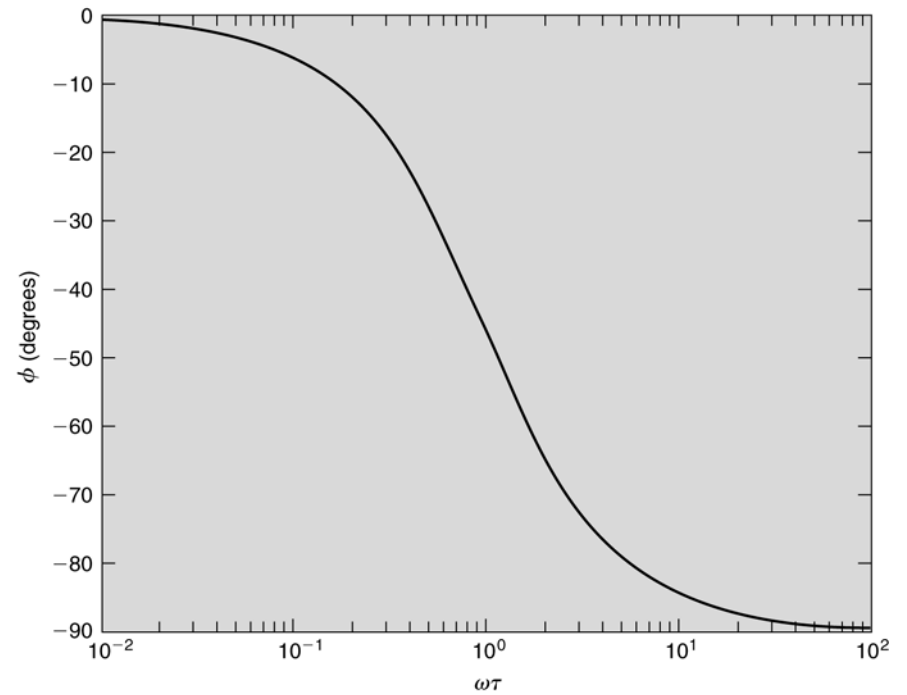
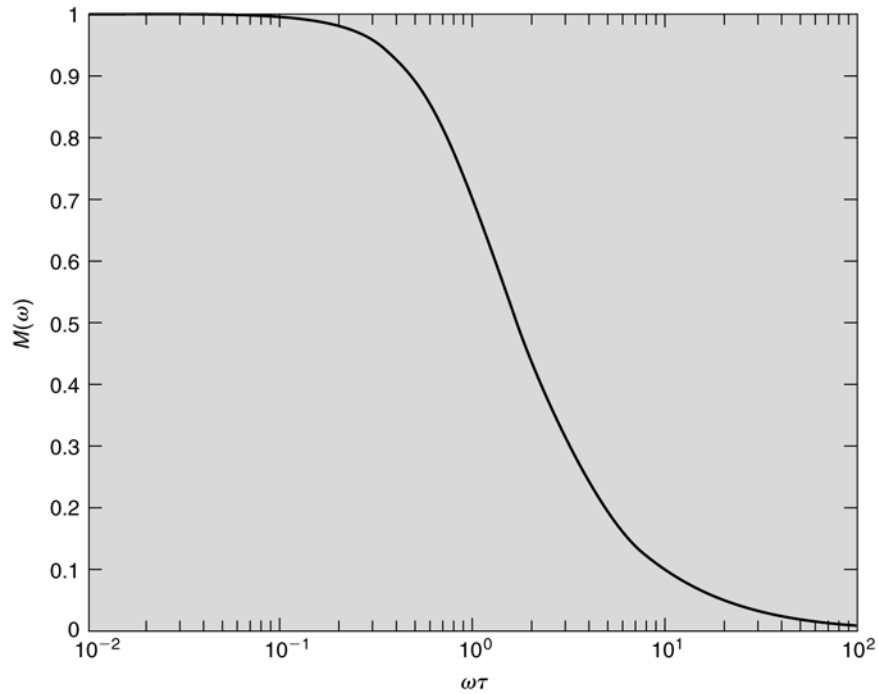
What is its phase lag in degrees?

What is its phase lag in s ?

What is its magnitude ratio ?



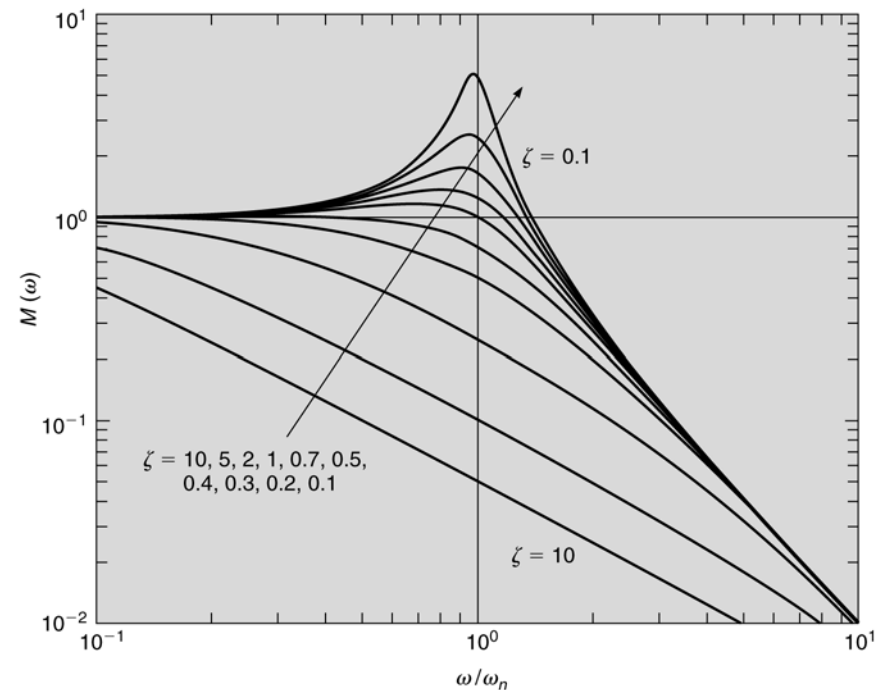
First Order – Sine Input



Chapter 5 – Dynamic Response

- Is the RLC circuit ($R = 2 \Omega$; $C = 0.5 \text{ F}$; $L = 0.5 \text{ H}$) underdamped, critically damped, or overdamped ?
- With sine input forcing of $3\sin 2t$:

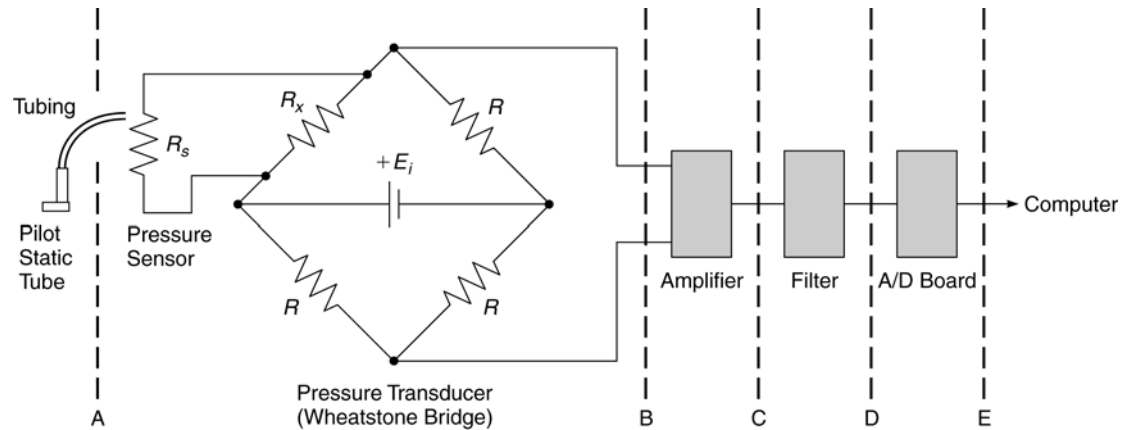
What is its magnitude ratio ?



Chapter 5 – Some more ?s

- What is $M(\omega)$ at -6 dB ?

Chapter 6 – Measurement Systems



A: What is the flow velocity if $\Delta p = 58 \text{ Pa}$?

A-B: If $R = 100 \, \Omega$ and $R_s = 200 \, \Omega$ at $U = 0$, $E_i = 5.0 \text{ V}$, what is R_x to have $E_o = 0 \text{ V}$?



Chapter 6 – Measurement Systems

A-B: At the highest U , the parallel combination of R_x and R_s increases by 20 %. What is E_o ?

B-C: What is the amplifier gain to achieve 80 % of the full-scale range of the A/D board at the highest U ?

B-C: If a non-inverting opamp is used, what should be the values of its resistances ?



Chapter 6 – Measurement Systems

C-D: What type of filter would be appropriate to use ?

D-E: What bit A/D board is required to have less than 0.2 % error in the voltage reading of the highest-U condition ?



Chapter 7 – Normal Probability

- What is the probability that a student will score between 75 and 90 on an exam, assuming that the scores are distributed normally with a mean of 60 and a standard deviation of 15 ?

Chapter 8 – Student-t Statistics

- What is the probability that a student will score between 75 and 90 on an exam, assuming that the scores are based on 9 students, with a mean of 60 and a standard deviation of 15 ?

Chapter 8 – Statistical Estimates

- Given the mean and standard deviation are 10 and 1.5, respectively, for a sample of 16, estimate with 95 % confidence the ranges within which are the true mean and standard deviation.

Chapter 8 – χ^2 Statistics

- The sample standard deviation of the length of 12 widgets taken off of an assembly lines is 0.20 mm. What must be the widget population's standard deviation to support the conclusion that the probability is 50 % for any difference between the sample's and population's standard deviations to be the result of random effects ?

Chapter 9 – Uncertainty

- A calibrated force balance is used to determine the lift coefficient of an airfoil. N force measurements are made under 'fixed' wind tunnel conditions. The output of the force balance is recorded by a computer. Identify and state how to quantify all the possible uncertainties.

Chapter 9 – Uncertainty

- How are all of these uncertainties combined to give the final estimate of C_L ?
- If $r = x^n$, what is the fractional uncertainty in r ?

Chapter 10 – Regression

- Can a least-squares linear regression analysis be used to determine the best fit of (F,V) data to the nonlinear expression $V = k + bF^c$, where k is V when F = 0 ?

Chapter 10 – Regression

- What regression parameter quantifies the quality of the best-fit?

Chapter 11 – Signal Characterization

- A collection of time-history records is called an
- When the ensemble-averaged values of a random signal equal the corresponding average values computed over time for an arbitrary, single time history in the ensemble, the signal is
- When $f(t) = f(t + T)$, the signal is and T denotes the signal's

Chapter 11 – Signal Characterization

- Given $y(t) = C\sin(n\omega t + \phi)$, what symbol and units denote
phase
amplitude
cyclic frequency
- Arrange in order of descending value:
mean, rms, standard deviation
- Know how to compute a Fourier series.

Chapter 12 – Digital Signal Analysis

- What must f_s be to avoid aliasing ?
- What must f_s be to avoid amplitude ambiguity ?

Chapter 12 – Digital Signal Analysis

- At what cyclic frequency will $y(t) = 3\sin(4\pi t)$ appear if $f_s = 6$ Hz?

$$f_s = 4 \text{ Hz ?}$$

$$f_s = 2 \text{ Hz ?}$$

$$f_s = 1.5 \text{ Hz ?}$$

- Amplitude ambiguity occurs at what above f_s 's ?