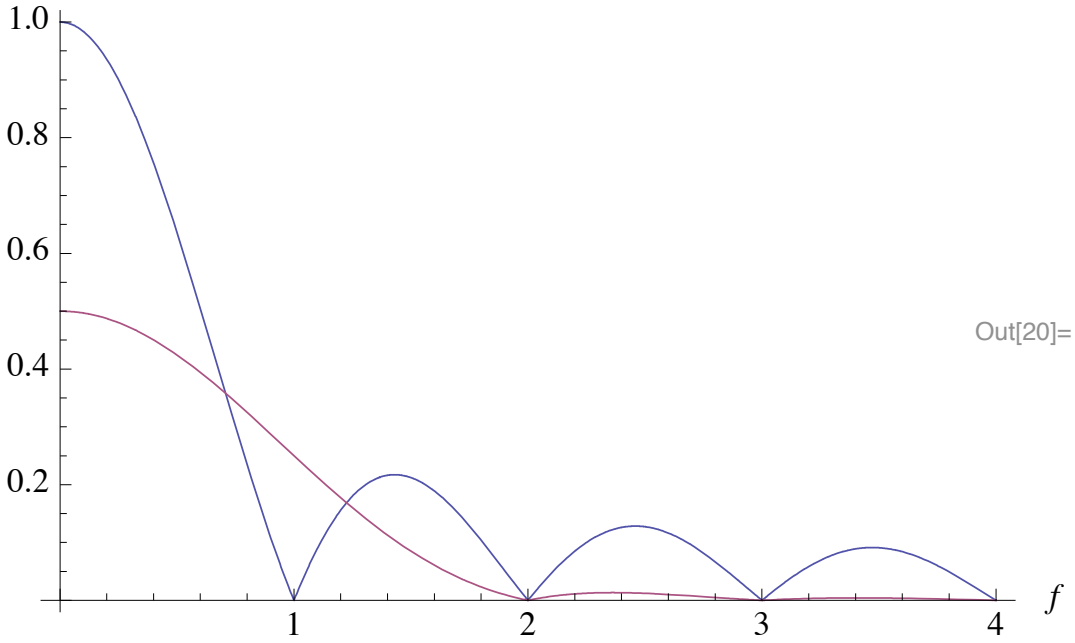
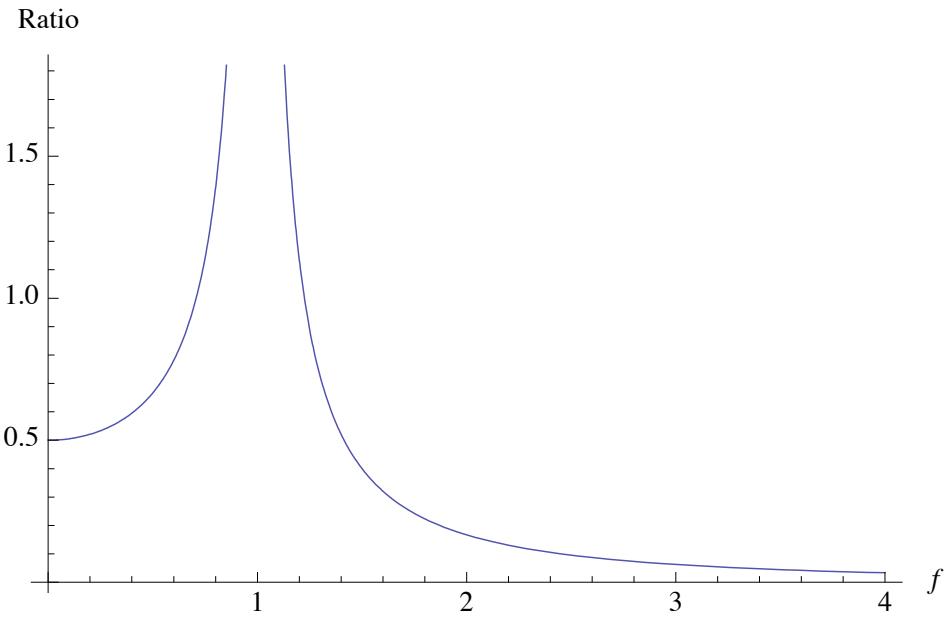
Magnitude of FT

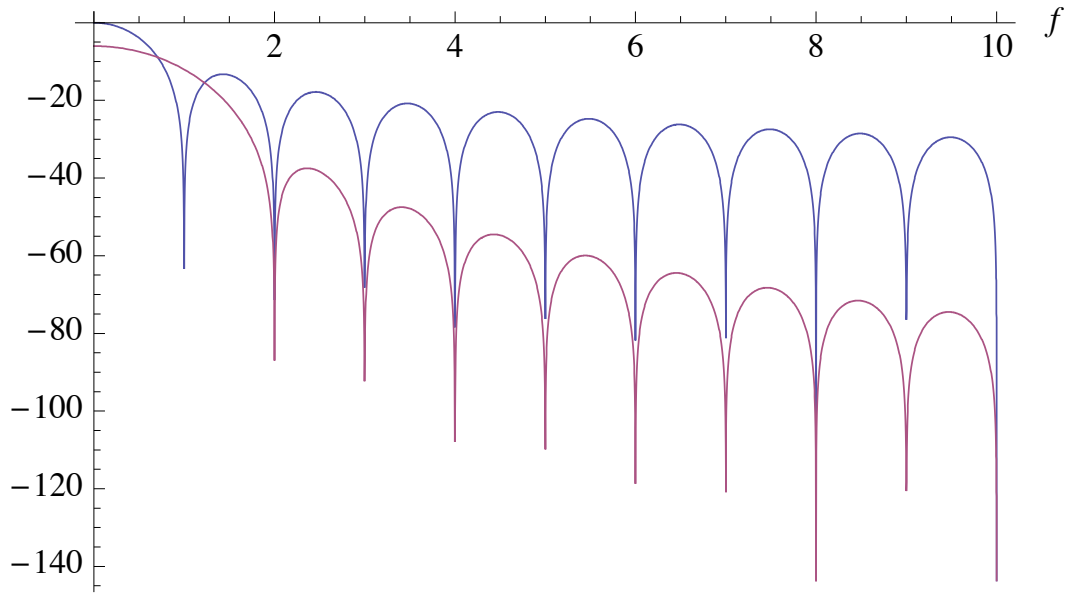


In[20]:= `Plot[Abs[1 / (2 (1 - f^2))], {f, 0, 4}, AxesLabel → {f`

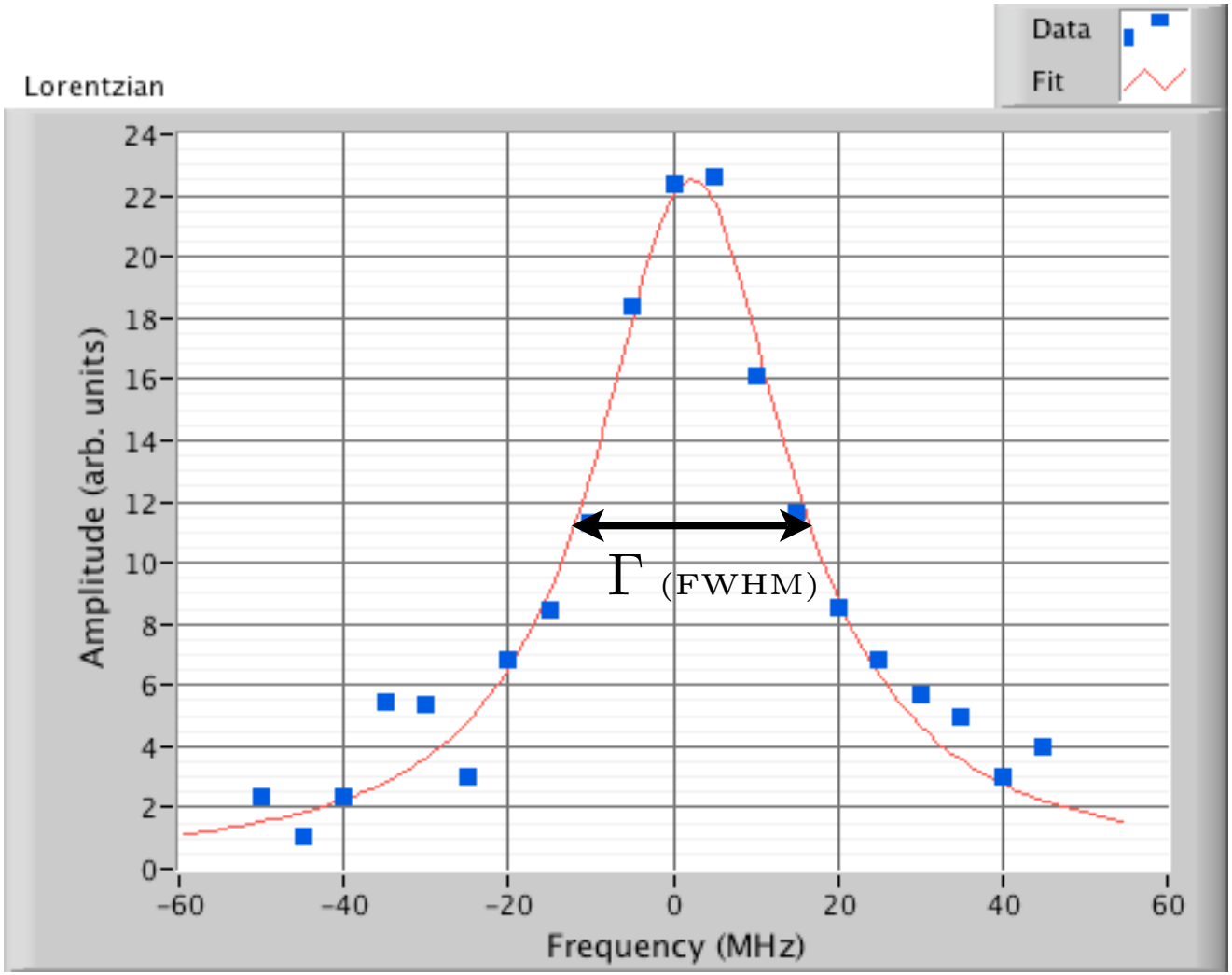
Out[20]=



Magnitude of FT (dB)



Lorentzian: $L(f) = \frac{A}{\pi} \frac{\Gamma/2}{(f - f_0)^2 + (\Gamma/2)^2}$



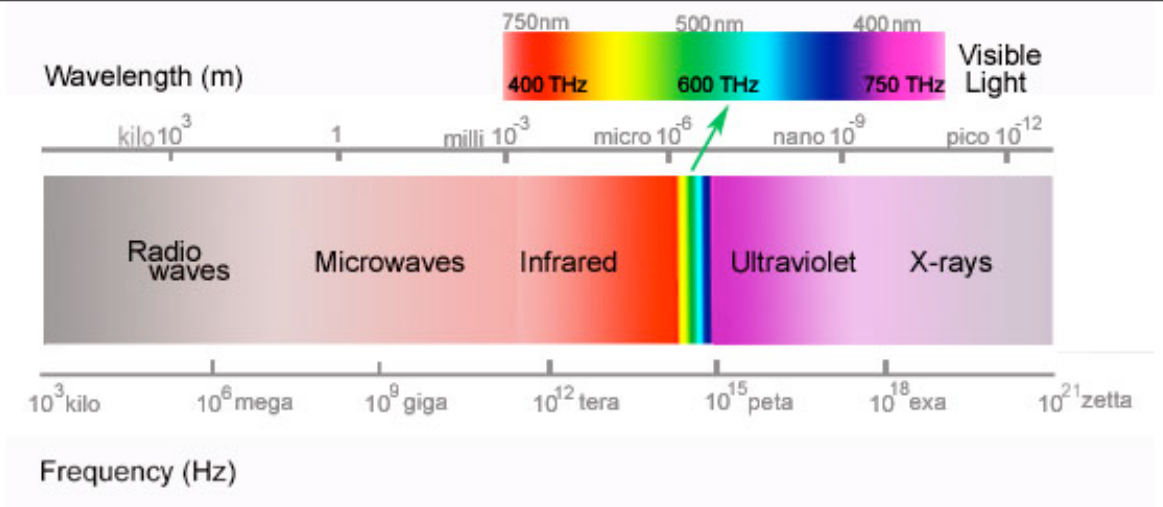
$^{87}\mathrm{Rb}\ \mathrm{D}_2\ (5^2\mathrm{S}_{1/2} \rightarrow 5^2\mathrm{P}_{3/2})$

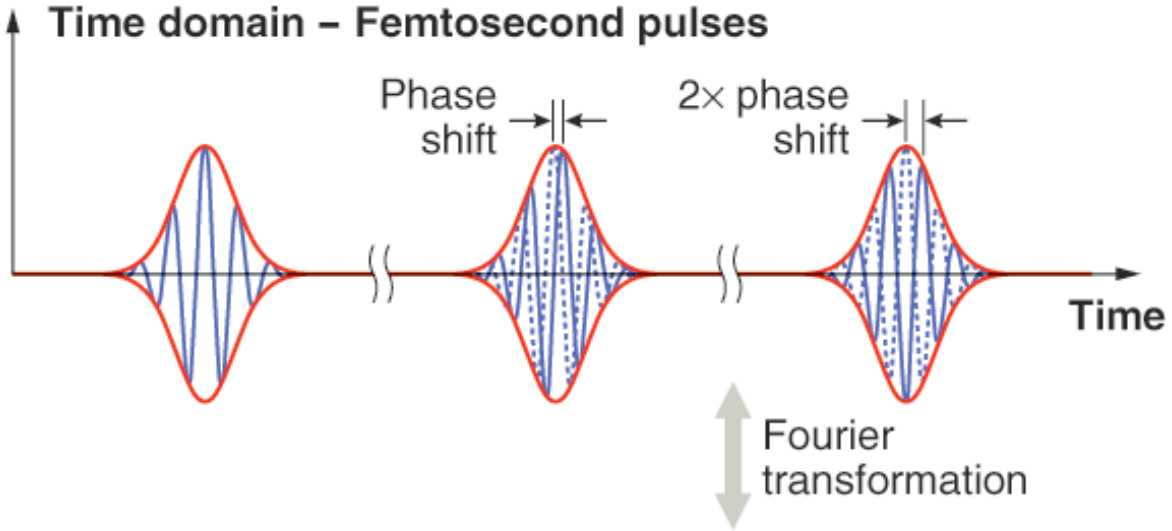
$f_0 = 384.230484\ \mathrm{THz}$

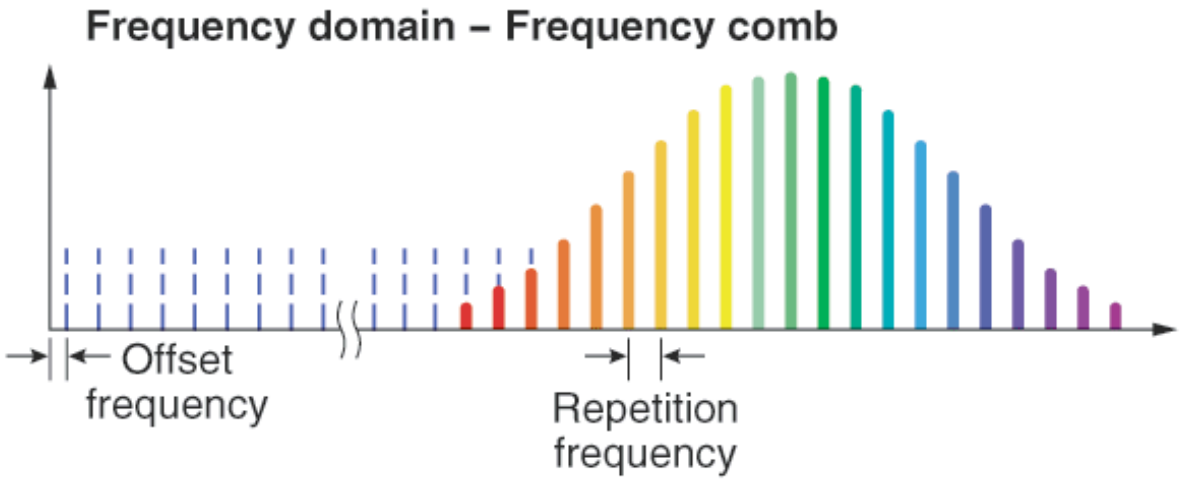
$\lambda = 780.2412\ \mathrm{nm}$

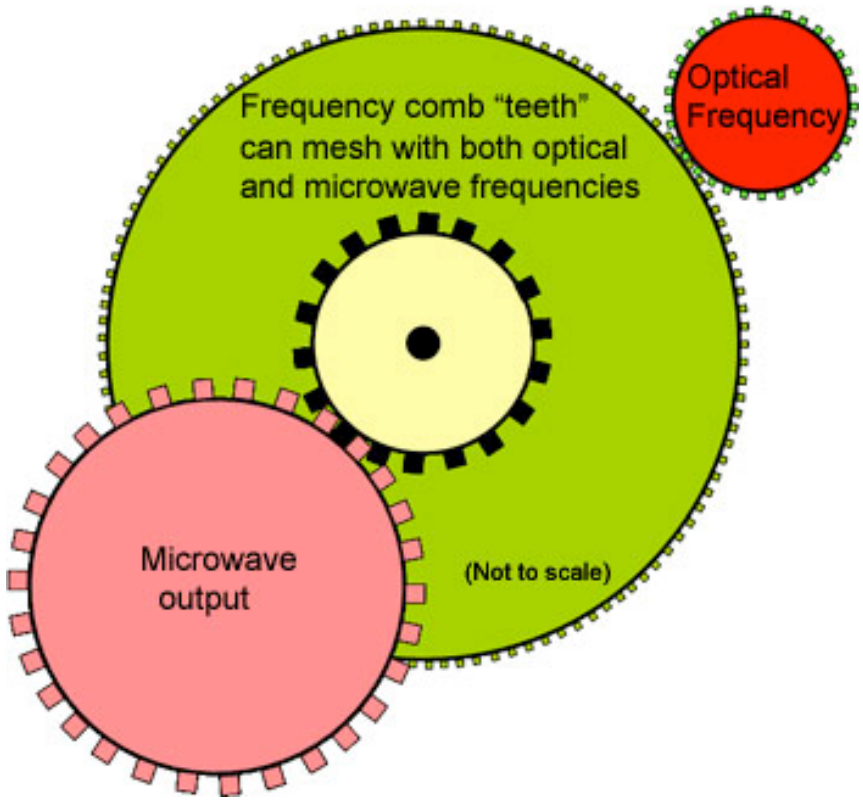
$\tau = 26.24\ \mathrm{ns}$

$$\mathcal{F}^{-1}_{f,t}\left[\frac{A}{\pi}\frac{\Gamma/2}{(f - f_0)^2 + (\Gamma/2)^2}\right] = A\, e^{-i(2\pi f_0 t) - \Gamma\pi|t|}$$


Wavelength (m)
750nm
500nm
400nm
400 THz
600 THz
750 THz
Visible Light
kilo 10^3
1
milli 10^{-3}
micro 10^{-6}
nano 10^{-9}
pico 10^{-12}
Radio waves
Microwaves
Infrared
Ultraviolet
X-rays
10^3 kilo
10^6 mega
10^9 giga
10^{12} tera
10^{15} peta
10^{18} exa
10^{21} zetta
Frequency (Hz)


Time domain – Femtosecond pulses
Phase shift
2× phase shift
Time
Fourier transformation


Frequency domain – Frequency comb
Offset frequency
Repetition frequency


Optical Frequency
Frequency comb "teeth" can mesh with both optical and microwave frequencies
Microwave output
(Not to scale)

0) Accomplishments in Phys 331

1) Course Evaluation

2) PID-Temperature Controller

3) Phys 332 - Plan

Accomplishments in Physics 331

Analog and Digital Electronics

- Complex impedance - advanced use of concept
- Sophisticated understanding of transistor operation
- Ability to analyze and construct complicated transistor circuits
- Advanced understanding of operational amplifiers
- Design sophisticated analog filters
- Basic digital electronics (switches, flip flops, ...)

Scientific Paper Writing

- Format of tables, figures, captions, ...
- Nature of introduction, conclusion
- Structure of report

LabVIEW

- Solid understanding of the programming language
- Experience with DAQ boards
- Construction of the digital thermometer

Building a functioning device used in research:

PID controller

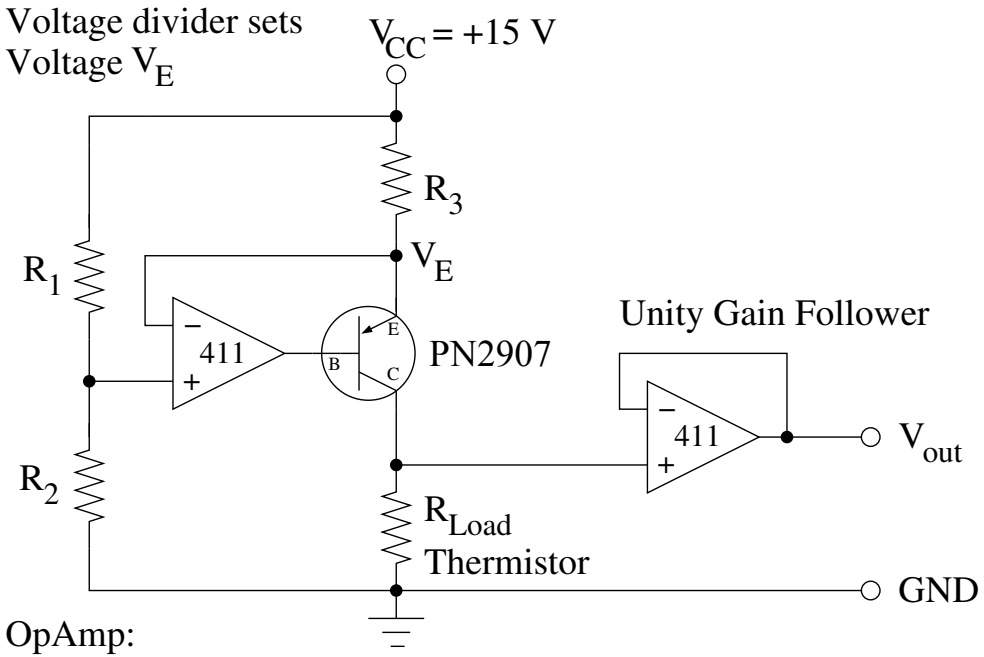
Final Project

PID-Temperature Controller

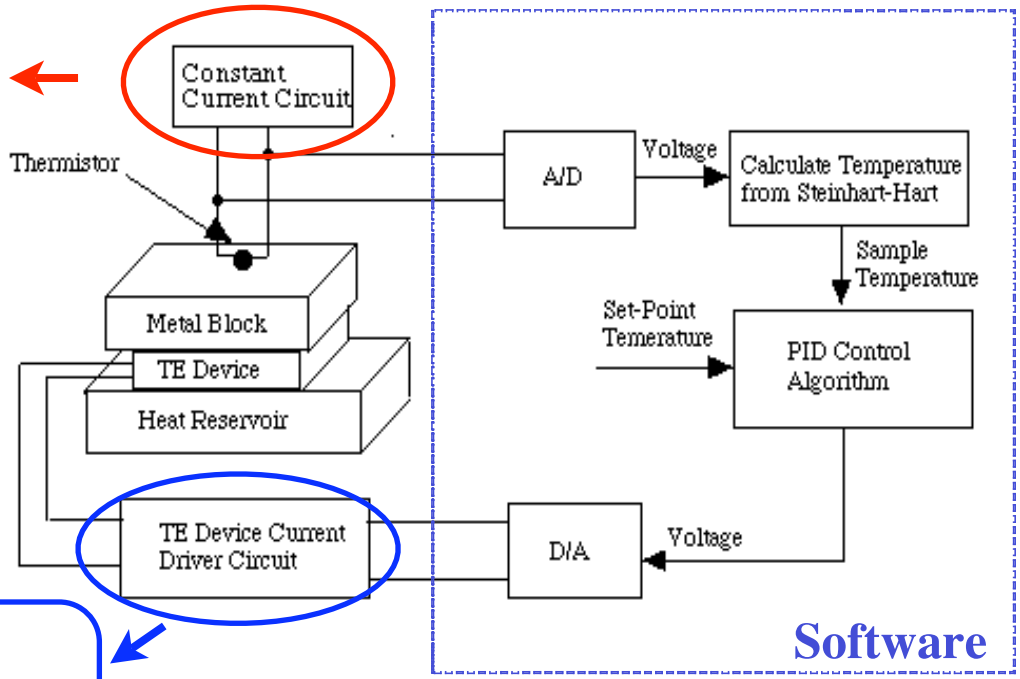
http://en.wikipedia.org/wiki/PID_controller

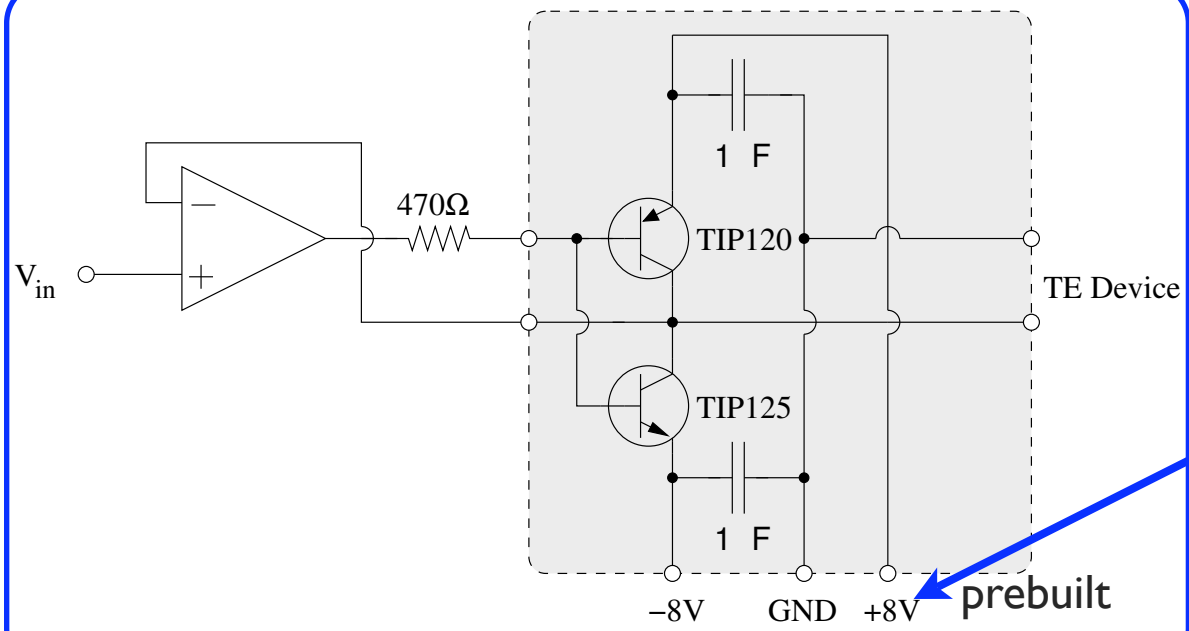
proportional–integral–derivative controller (PID controller) is a generic control loop feedback mechanism (controller) widely used in industrial control systems.

Analog Hardware



OpAmp:
Decouples Voltage Divider
Sets base voltage such that emitter voltage is constant

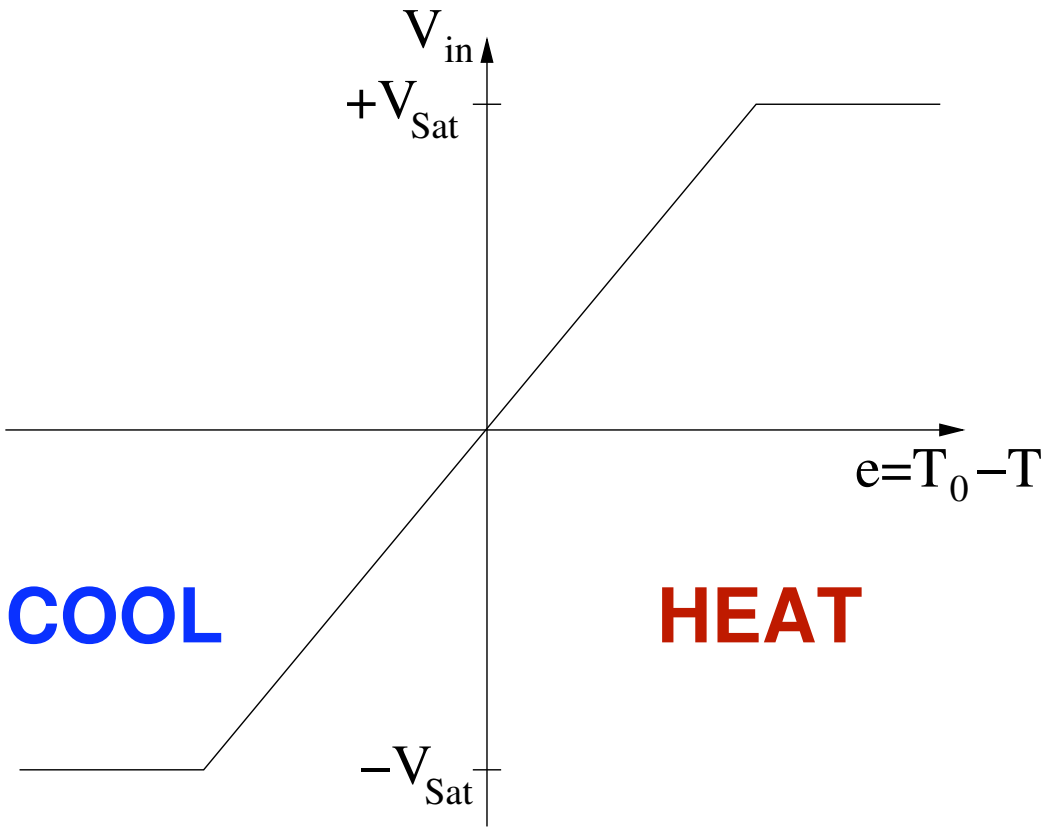




PS280 Power supply

prebuilt

Saturation Condition



iteration n

Software

Thermistor SubVI

Read and find average thermistor voltage $V_{thermistor}$

Calculate thermistor resistance $R_{thermistor}$

Calculate temperature T_n via Steinhart-Hart Equation
(A=? B=? D(or C)=?)

PID VI

Calculate error : $E_n = T_{set} - T_n$

Calculate PID Control Voltage:

$$V_{PID} = K_p\, E_n + K_i\, \Delta t \sum_{m=0}^{n} E_m + K_d\, \frac{1}{\Delta t}\,(E_n - E_{n-1})$$

Implement Saturation condition

Write V_{PID}

PID - parameter tuning

http://en.wikipedia.org/wiki/PID_controller

Effects of increasing parameters				
Parameter	Rise Time	Overshoot	Settling Time	S.S. Error
Kp	Decrease	Increase	Small Change	Decrease
Ki	Decrease	Increase	Increase	Eliminate
Kd	Small Decrease	Decrease	Decrease	None

P and PID

http://www.youtube.com/watch?v=ALVo4aJpcF0

Phys 332

Outlook

A) Finish up LabVIEW - GPIB
B) 3 Experiments (2 Guided, 1 Independent)
C) Presentation

J-Lab Instrumentation

FUNCTION	COMPONENT TYPE INSTRUMENT
PRODUCE LIGHT	Visible/IR Monochromator Pulsed and Continuous Diode Laser Pulsed Nitrogen Laser Helium-Neon Laser Argon Ion Laser
DETECT LIGHT	High Resolution Spectrometer Photon Counting Detector Photodiode Detector Scintillation Detectors Fabry-Perot Etalon Telescope with CCD Detector Radio Receiver
CONTROL TEMPERATURE	Closed Cycle Helium Refrigerator PID Temperature Controller
APPLY EXTERNAL FIELDS	Voltage Sources NMR Magnet
MEASURE ELECTRICAL SIGNALS	Lock-In Amplifier Digitizing Oscilloscopes Fast-Timing Electronics

Chemistry	NMR Spectrometer
L. Illing	Telecommunication laser, detector, modulators + Fast Oscilloscope
J. Powell	FTIR Spectrometer

PHYSICS EXPERIMENTS

GUIDED EXPERIMENTS
(last year):

- Doppler-Free Saturated Absorption Spectroscopy (Laser Diodes)
- Chaos in an Optoelectronic Feedback System (Fiber Optics, RF Electronics)
- Isotope Shift of Balmer Series in Hydrogen (Spectrometer)
- Mass and Velocity of Cosmic Ray Muon (Fast-Timing Electronics)
- Fabrication of Fullerenes (Materials Fabrication)
- Optical Bandgap of Semiconductor (Monochromator)

PHYSICS EXPERIMENTS

INDEPENDENT PROJECTS
(Excerpt - past years):

Temp. Dependence of Diodes Saturation Current

Zeeman Effect

High-Temperature Superconductor

Minority Carrier Lifetime In Silicon

Holograms

Modes and Coherence Length of Laser

Chaotic Electric Circuit/ Chaos Control

Sonoluminescence

Leidenfrost Effect

Imaging Moons of Jupiter

Optical Tweezers

Advanced Electronics: Phase-locked loops (PLL)

Single Photon Generation

PRESENTATION TOPICS

- Lock-In Amplifiers
- Vibrational Isolation
- Diode Laser
- Ion Laser
- fs-pulsed Ti:Sapph Laser
- Roughing Pump
- Turbo Pumps
- Ion Pumps
- Magneto-Optic Traps
- Spontaneous Parametric Down Conversion
- Avalanche Photodiodes
- Photomultipliers
- CCD Arrays
- Fast Fourier Transform
- NMR Spectroscopy
- Raman Spectroscopy
- Time Resolved Spectroscopy
- Scanning Electron Microscope
- Scanning Tunneling Microscope
- Atomic Force Microscope
- Two Photon Excitation Microscope

Have a wonderful winter break

www.phdcomics.com