

Questions and Answers Vol. 2

or

“By the bean alone do you set your mind in motion.”

P Pounds

23 April 2018

University of Queensland

But first...

Some house keeping

Calendar at a glance

Week	Dates	Lecture	Reviews	Demos	Assessment submissions
1	19/2 – 24/2	Introduction			
2	26/2 – 2/3	Principles of Mechatronic Systems design			Problem analysis
3	5/3 – 9/3	Professional Engineering Topics			
4	20/3 – 24/3	Introduction to Practical PCB Design	Progress review 1		
5	19/3 – 23/3	Your soldering is (probably) terrible			
6	26/3 – 29/3	Introduction to firmware design			
Break	30/4 – 13/4				
7	16/4 – 20/4		Progress seminar	25% demo	
8	23/4 – 27/4				
9	30/4 – 4/5			50% demo	
10	8/5 – 11/5	No lecture	Progress review		
11	14/5 – 18/5			75% demo	Preliminary report
12	21/5 – 25/5				
13	28/5 – 1/6	Closing lecture		Final testing	Final report and reflection

You are here →

All's quiet on the western front

- Nothing is due this week.
- Nothing is due *next* week.
- This is... strangely uncomfortable?

- But the 50% demo is next week!
 - Send me an email if you want to take part, etc.

PAF 1 results

- I also now have complete PAF 1 results
 - If you are getting less than 90% from your peers, that's a fair sign that they are unhappy with you...
 - If your PAF 2 is also $<90\%$, I'll probably want to talk to you to see if there is a problem
- No PAF 1 result on Blackboard?
 - Let me know!

Seminar and PAF 2 results

- Normally I have a histogram here, but I'm still waiting on Iain Rudge to send marks
 - C'mon, Iain! ಠ_ಠ
 - I'll put them in the online version when finished
- Instead, some general comments:
 - OMG, keep to time! 10 mins means 10 mins
 - Analysis, analysis, analysis.
 - I'm not kidding about this – seriously!

FAQ Roundup

- **None as of yet**

Wireless comms

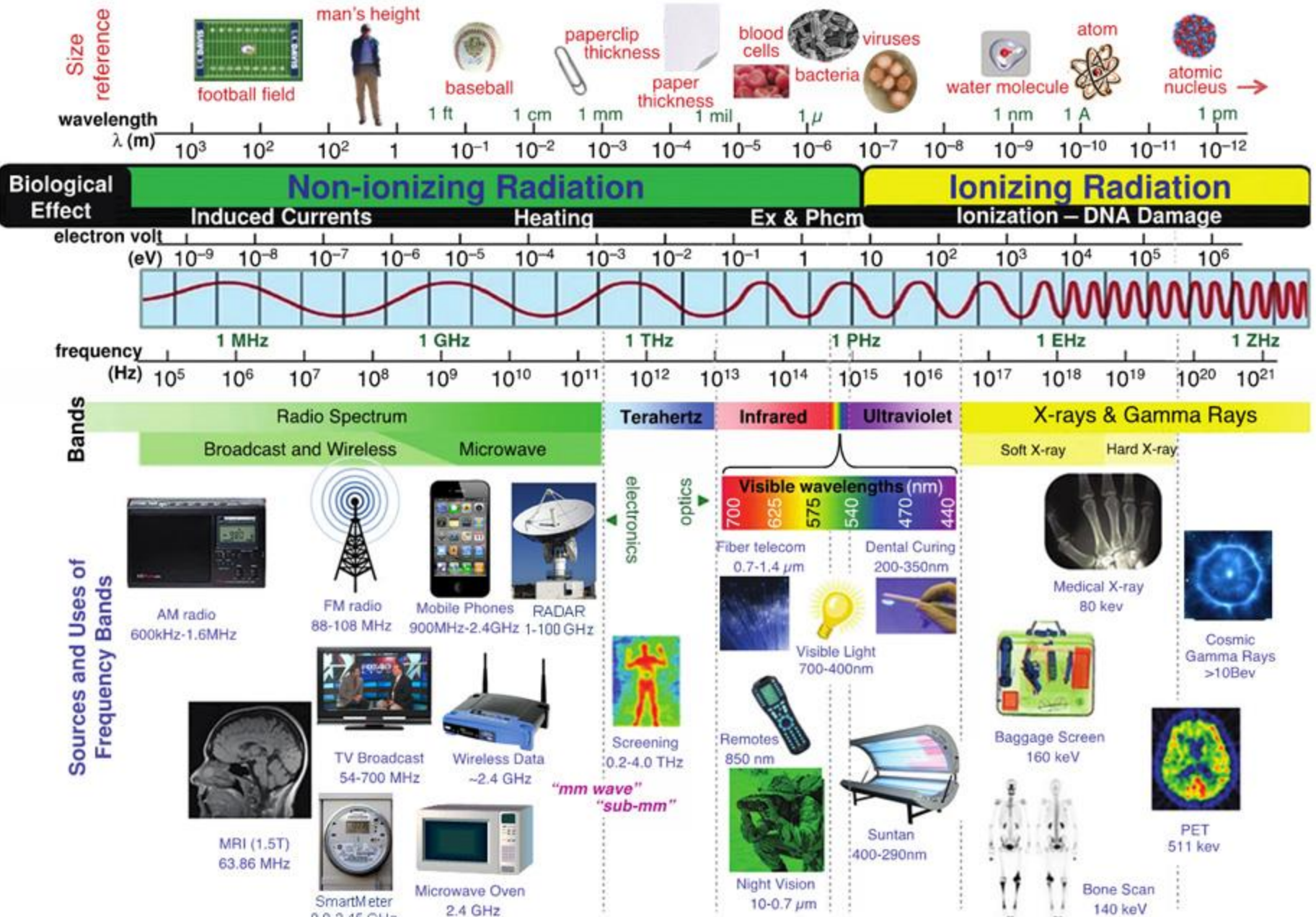
To radio, and beyond!

Mini lecture on wireless comms

- Wireless communications is fascinating, and you can practically get a whole degree on just it alone.
- For mechatronics engineers, it boils down to “Which radio module should I buy?”

*Every discussion of RF starts with
the electromagnetic spectrum*

ELECTROMAGNETIC RADIATION SPECTRUM



Quick comments the radio spectrum

- Radio spectrum is extremely valuable
 - You don't get much to play with
- “Open” spectrum is predominantly concentrated in the ISM bands
 - ISM: Industrial, Scientific and Medical
- Fortunately, most of the RF compliance work has been done for you

Frequency, data rate and power

- The higher your radio frequency, the faster you can transfer data
 - But also the more difficult filtering becomes, thus shorter range
- The more power you transmit with, the greater your range
 - But also the more interference you cause

The ISM bands*

Frequency range		Bandwidth	Center frequency	Availability
6.765 MHz	6.795 MHz	30 kHz	6.780 MHz	Subject to local acceptance
13.553 MHz	13.567 MHz	14 kHz	13.560 MHz	Worldwide
26.957 MHz	27.283 MHz	326 kHz	27.120 MHz	Worldwide
40.660 MHz	40.700 MHz	40 kHz	40.680 MHz	Worldwide
433.050 MHz	434.790 MHz	1.74 MHz	433.920 MHz	Region 1
902.000 MHz	928.000 MHz	26 MHz	915.000 MHz	Region 2
2.400 GHz	2.500 GHz	100 MHz	2.450 GHz	Worldwide
5.725 GHz	5.875 GHz	150 MHz	5.800 GHz	Worldwide
24.000 GHz	24.250 GHz	250 MHz	24.125 GHz	Worldwide
61.000 GHz	61.500 GHz	500 MHz	61.250 GHz	Subject to local acceptance
122.000 GHz	123.000 GHz	1 GHz	122.500 GHz	Subject to local acceptance
244.000 GHz	246.000 GHz	2 GHz	245.000 GHz	Subject to local acceptance

[wikipedia “Radio Regulations”, International Telecommunications Union-R 2012]

* “ISM” is a great name for a rock band

A brief survey of radio standards

Module	Frequency	Typ. range	Typ. data rate	Typical application
FM	433/434 MHz	100 m	4.8 kbit/s	Garage door opener Wireless POTS phone
	868 MHz	100 m	9.6 kbit/s	
	900/915 MHz	20 m	115.2 kbit/s	
Zigbee	868 MHz	70 m	40 kbit/s	Wireless sensor networks
	915 MHz	70 m	45 kbit/s	
	2.4 GHz	70 m	250 kbit/s	
Nordic	2.4 GHz	50 m	1 Mbit/s	Wireless sensor networks
Bluetooth	2.4 GHz	10-100 m	0.7 – 2 Mbit/s	Laptop/cellphone peripheral
Wi-Fi	2.4 GHz	30 m	11 Mbit/s+	Mobile network
0G	Various	80 km	9.6 kbit/s	Cellular telephony and data
1G	150 Mhz	40 km+	14.4 kbit/s	
2G	0.9 – 1.8 GHz	35 km	144 kbit/s	
3G	0.4 – 3 GHz	30 km	2 Mbit/s	
4G	1.7 – 1.8 GHz	5 km	100 Mbit/s?	

Pros, cons of comms systems

FM:	Very cheap, lousy transfer rate
Bluetooth:	Good speed, limited range
Zigbee:	Mesh networking, limited speed
Wi-Fi:	Great speed, lots of overhead
Cellular:	Wide reach, very expensive
Satellite:	Global reach, crazy expensive
Pigeon:	High bandwidth, unreliable

THE ELECTROMAGNETIC SPECTRUM

THESE WAVES TRAVEL THROUGH THE ELECTROMAGNETIC FIELD. THEY WERE FORMERLY CARRIED BY THE AETHER, WHICH WAS DECOMMISSIONED IN 1897 DUE TO BUDGET CUTS.

ABSORPTION SPECTRA:

HYDROGEN:

HELIUM:

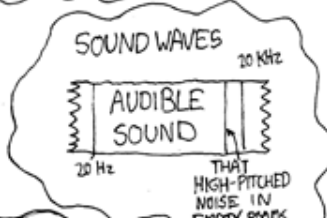
DEPENDS®:

TAMPAX®:

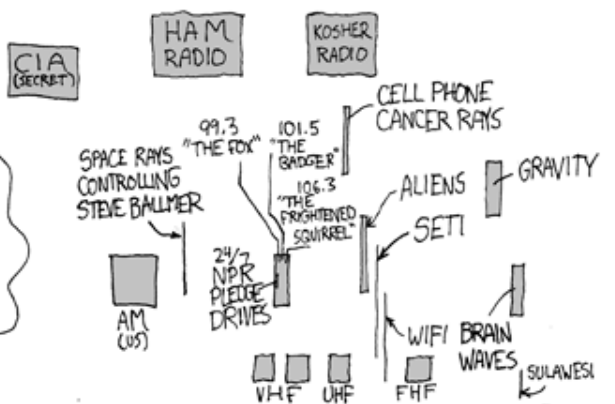


VISIBLE LIGHT

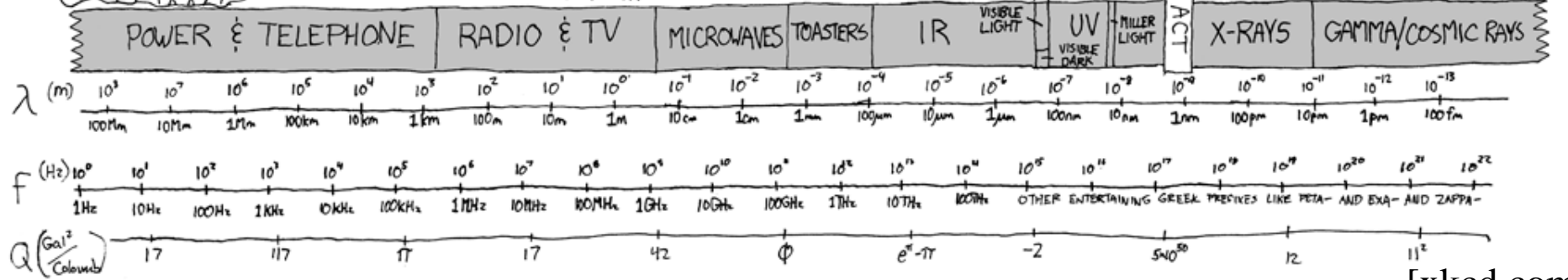
OTHER WAVES:



SHOUTING CAR DEALERSHIP COMMERCIALS



CENSORED UNDER PATRIOT ACT



And now...



Gratuitous project tips

Gratuitous project tips!

- *Why* are you doing what you're doing?
 - Analysis is token and unconvincing across (almost) the entire class
 - This is *easily* the difference between a 7 and a 4
- I will *not* cut you slack, nor save your butts
 - Follow the process: spec', analysis, design, test
 - I will let you fail this course if you do not put adequate analysis in

Gratuitous project tips!

- No rhyme or reason to the placement of motors, sensors, batteries, etc.
 - You really need to think this through!
 - Precision balancing of your craft is critical

- Are you off-centre? Probably!
 - This is a (potentially) really bad thing
 - Maybe you need a way to tweak it precisely...

Gratuitous project tips!

- Your orientation sensing is (almost certainly) terrible
 - No really – it sucks.
 - Your lousy approach will be your undoing.
 - It will make you sad.

Think very carefully about how to do this.
There are (probably) no easy solutions to it.

Gratuitous project tips!

- Find someone else's codebase and use it
 - Some other poor schmuck, somewhere, has probably already solved your problem
 - There is no shame in open source
- Why do you need all that bulk, anyway?
 - Big, clunky, heavy things are harder to move

Questions



Tune-in next time for...

Questions and Answers Vol. 3

or

“I came to the lecture and all I got was
educated and this lousy cup of coffee”

Fun fact: Money cannot buy happiness, but an annual income of \$70,000
is correlated with the highest level of life satisfaction.