

# Questions and Answers Vol. 1

*or*

“The quick and the decaf.”

*2AM Edition!*

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30 April 2019

University of Queensland

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But first...

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**A valuable message about safety...**

*Campus Calamities presents*

# *All-Nighter*

**#006**



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# But secondly...

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Some house keeping

# Calendar at a glance

| Week         | Dates       | Lecture                                    | Reviews           | Demos         | Assessment submissions      |
|--------------|-------------|--|-------------------|---------------|-----------------------------|
| 1            | 25/2 – 1/3  | Introduction                               |                   |               |                             |
| 2            | 4/3 – 8/3   | Principles of Mechatronic Systems design   |                   |               | Problem analysis            |
| 3            | 11/3 – 15/3 | Previous years deconstruction case studies |                   |               |                             |
| 4            | 18/3 – 22/3 | Professional Engineering Topics            | Progress review 1 |               |                             |
| 5            | 25/3 – 29/3 | PCB design tips                            |                   |               |                             |
| 6            | 1/4 – 5/4   | Your soldering is (probably) terrible      |                   |               |                             |
| 7            | 8/4 – 12/4  | Introduction to firmware design            | Progress seminar  | 25% demo      |                             |
| 8            | 15/4 – 19/4 | Introduction to firmware design            |                   |               |                             |
| <b>Break</b> | 22/4 – 26/4 |  |                   |               |                             |
| 9            | 29/4 – 3/5  | <i>Q and A sessions</i>                    |                   | 50% demo      |                             |
| 10           | 6/5 – 10/5  | No lecture                                 | Progress review   |               |                             |
| 11           | 13/5 – 17/5 | <i>Q and A sessions</i>                    |                   | 75% demo      | Preliminary report          |
| 12           | 20/5 – 24/5 | <i>Monday lecture!!</i>                    |                   |               |                             |
| 13           | 27/5 – 31/5 | Closing lecture                            |                   | Final testing | Final report and reflection |

*You are here* →

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# No lecture next week

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- I won't be there; neither should you
  - Do not show up
  - Do not pass go
  - Do not collect \$200
  
- Really, it would just be more Q&A, anyway
  - But you know you can always ask me questions via email – I try to respond ASAP
  - But do expect slower responses while I'm away...

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# All's quiet on the western front

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- Nothing is due this week.
- This is... strangely uncomfortable?
- But the 50% demo is this week!
  - You should already have an email from me about that if you requested one

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## Progress review 2 – Electric Boogaloo

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- Next week is the second progress review
  - Just like the first progress review in every way that counts! Except with 300% more progress!
- Sign up via the Doodle poll that will be posted after the lecture – closes Friday
- You know the drill!
  - Include your team number, plus your full name:  
Non-compliant sign-ups will be cleared



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# FAQ Roundup

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- **None as of yet**

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# Here, have a mini lecture on RF

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- Why? No particular reason – I had the notes and thought it might be helpful!

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# Wireless comms

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To radio, and beyond!

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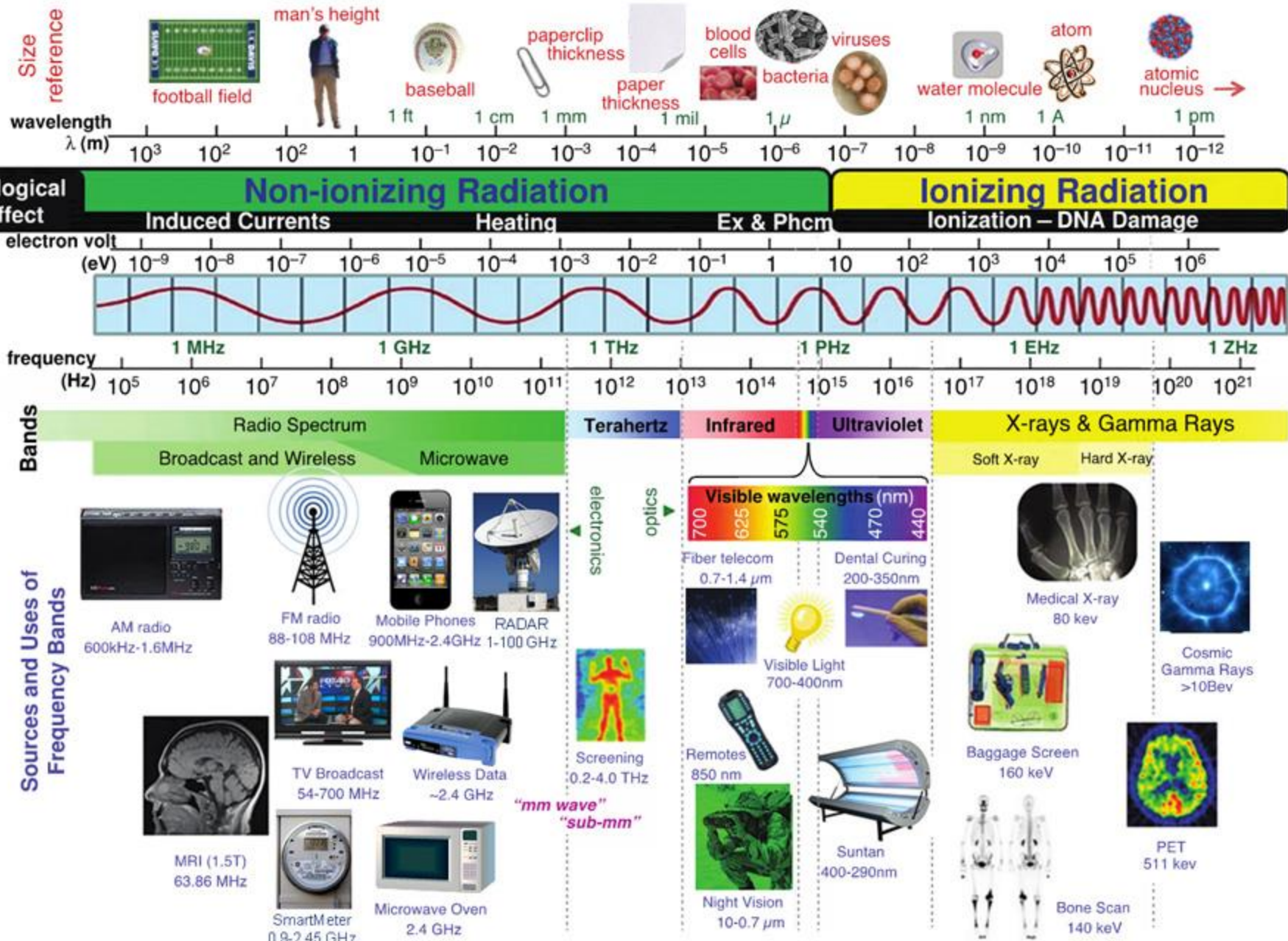
# Mini lecture on wireless comms

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- 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



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# Quick comments the radio spectrum

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- 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

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# Frequency, data rate and power

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- 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                    |
| <b>2.400 GHz</b> | <b>2.500 GHz</b> | <b>100 MHz</b> | <b>2.450 GHz</b> | <b>Worldwide</b>            |
| 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          |
|           | 868 MHz       | 100 m      | 9.6 kbit/s     |                             |
|           | 900/915 MHz   | 20 m       | 115.2 kbit/s   | Wireless POTS phone         |
| 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?    |                             |

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# Pros, cons of comms systems

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|            |                                 |
|------------|---------------------------------|
| 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      |

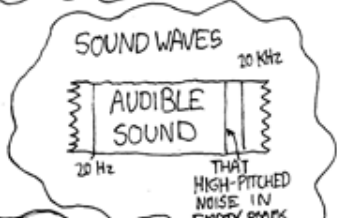
# THE ELECTROMAGNETIC SPECTRUM

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

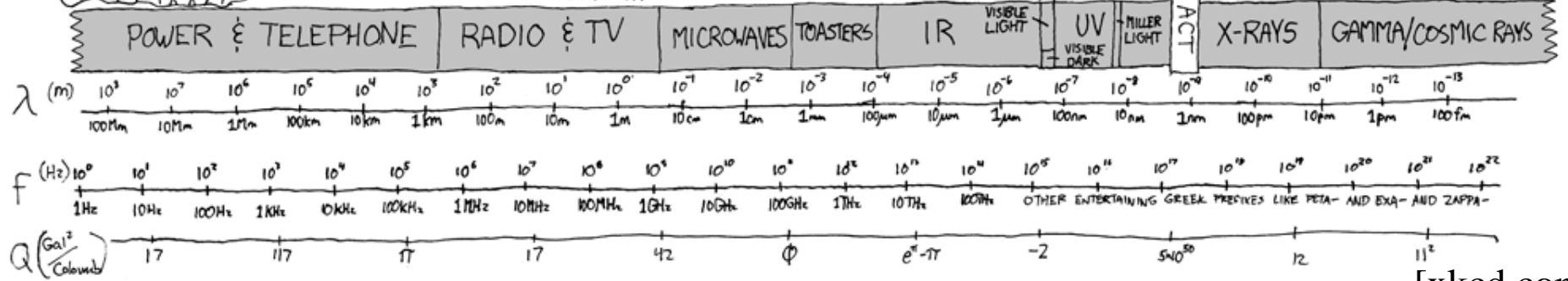
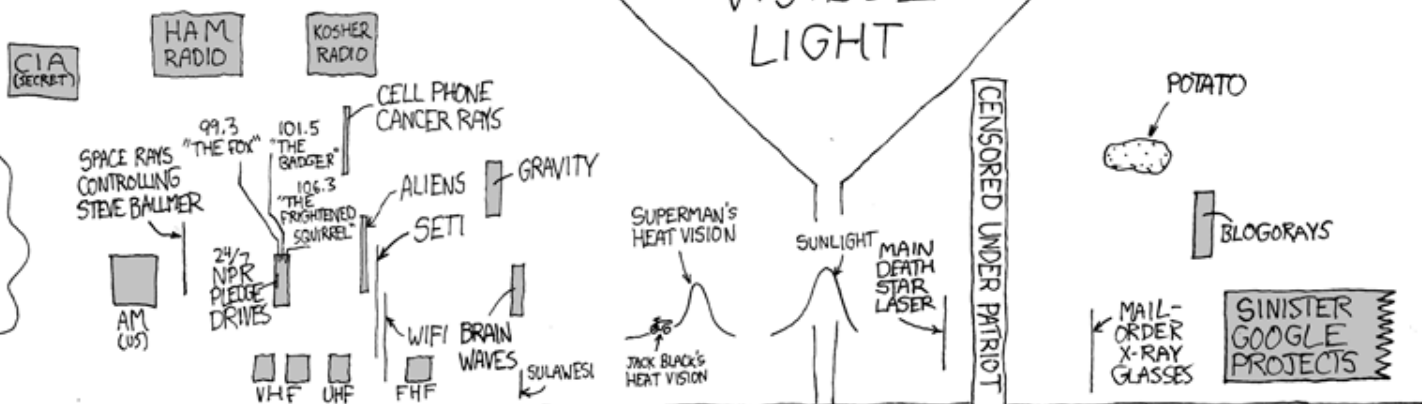
## ABSORPTION SPECTRA:



## OTHER WAVES:



SHOUTING CAR DEALERSHIP COMMERCIALS



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# And now...

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*Gratuitous project tips*

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# Gratuitous project tips!

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- *Why* are you doing what you're doing?
  - Analysis is token and unconvincing across many teams
  - 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

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# Gratuitous project tips!

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- No rhyme or reason to the placement of motors, transmissions, brackets, etc.
  - You really need to think this through!
  - Summation of error is death
  
- Are you wobbly? Probably!
  - This is a (potentially) really bad thing
  - Maybe you need a way to tweak it precisely...

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# Gratuitous project tips!

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- Your dynamical control is (almost certainly) terrible
  - No really – it sucks. Your lousy approach will be your undoing. It will make you sad.
  - Slow and accurate or fast and sloppy?
  - How much give is there in your transmission?

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

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# Gratuitous project tips!

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- 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 stiffer, but much harder to move... and add sag



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# Questions

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# Tune-in next time for...

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## Questions and Answers Vol. 2

*or*

“By caffeine alone do you set your mind in motion”

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