

Lecture 27

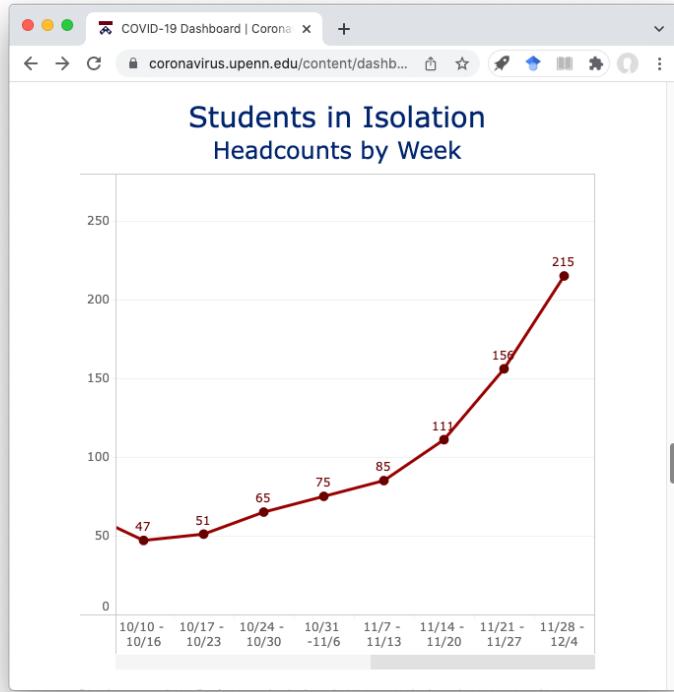
Review issues: Wrapup

Agenda for Last MEAM510 Lecture

01. Some Issues (WiFi subnet, 10k/s, UDP game, ESP stack smash)
02. Recap of lecture topics
03. Short Review Quiz
04. Resources for more Mechatronics

Reminders:

- New UPenn student COVID cases each week:
 - 10/31 28
 - 11/7 37
 - 11/14 62
 - 12/21 72
 - 11/28 **82** (last week!)
- Masks are still required in GM Lab
- Green pass is required to be in any of the shop/lab spaces in Towne
- No eating/drinking in any Lab space



Game Day

- Field will be in Wu & Chen (likely with new WiFi router)
 - We plan to broadcast live on youtube.
 - We plan to have professional videographer taking b-roll and interview as well
-
- Due to COVID, we may restrict audience attendance. Especially if Penn changes to Alert Level 3,



Logistics

- For practice, we will setup a 2nd Vive and possibly field in M81 (*above GM lab*) or 195 Upper (*the room above the ministore*) starting the evening of **Friday Dec. 9th**.
- We will have access to **Wu&Chen** starting 5PM **Thurs Dec. 16**.
- We can do graded evaluations in either **GMlab** or **Wu&Chen** on **Friday Dec 17th**.
- The final competition will be in **Wu&Chen Saturday Dec. 18th.** and **Sunday Dec. 19th**. Both will occur during the afternoon.
(Watch Piazza for announcements)

01

Some Current Issues

WiFi issues

- For sending and receiving both TCP and UDP packets.
- Using STA mode setting IP address:

```
WiFi.config(IPAddress(192, 168, X, yourIP),  
/* gateway */ IPAddress(192, 168, 1, 1),  
/* Subnet mask */ IPAddress(255, 255, 254, 0)  
);
```

- Setting the subnet mask to 254 seems to allow X to be 0 or 1
- If you use X=0 it will work when the subnet mask is 255

11111111 11111111 11111110 00000000	255.255.254.0
11000000 10101000 00000001 xxxxxxxx	192.168. 1.x

Limiting TCP transmission (10K/s limit)

Websites are driven by client side (javascript). HTTP messages have 1K byte overhead (10 per sec max)

- If you have **buttons**,
 - 10 presses/ sec is inhumanly fast.
- If you have **sliders**,
 - use `onchange()`, (on chrome) not `oninput()`.
- If you use **periodic** or **timed calls**
 - If `setInterval()`, or `setTimeout()` use at least 100 ms delay.

Click me!



Direct UDP and TCP packets sent with ESP32 interface.

- Need to keep track of data bytes, add 28-40 byte overhead

Robot UDP sending requirements

- Must set robot ID [1,2,3,4] based on a dip switch
- Every second, robot must always send a UDP message.
- Must send X,Y vive location (when vive LOCKEDON).
- Otherwise send (0,0).

Robot ID	X	Y	Output (11 chars)	Notes
1	4304	5984	1:4304,5984	Normal case (e.g., middle of field)
1	200	9239	1: 0, 0	Bad data (too large or too small)
1	--	--	1: 0, 0	Not lockedon (In dead zone)

Use “PacketSender” to debug.

https://en.wikipedia.org/wiki/Packet_Sender

The screenshot shows the "Packet Sender" application window. At the top, there are fields for "Name" (Packet Name) containing "Packet Name", "ASCII" (BB), and "HEX" (42 42). A red annotation "Set to UDP" points to the "Method" dropdown, which is currently set to "UDP". Below these are fields for "Address" (192.168.1.99), "Port" (2808), "Resend Delay" (0.0/blank), and buttons for "Send" and "Save".

Port parameters

Search Saved Packets... Delete Saved Packet Persistent TCP

Send	Name	Resend (sec)	To Address	To Port	Method	ASCII	Hex

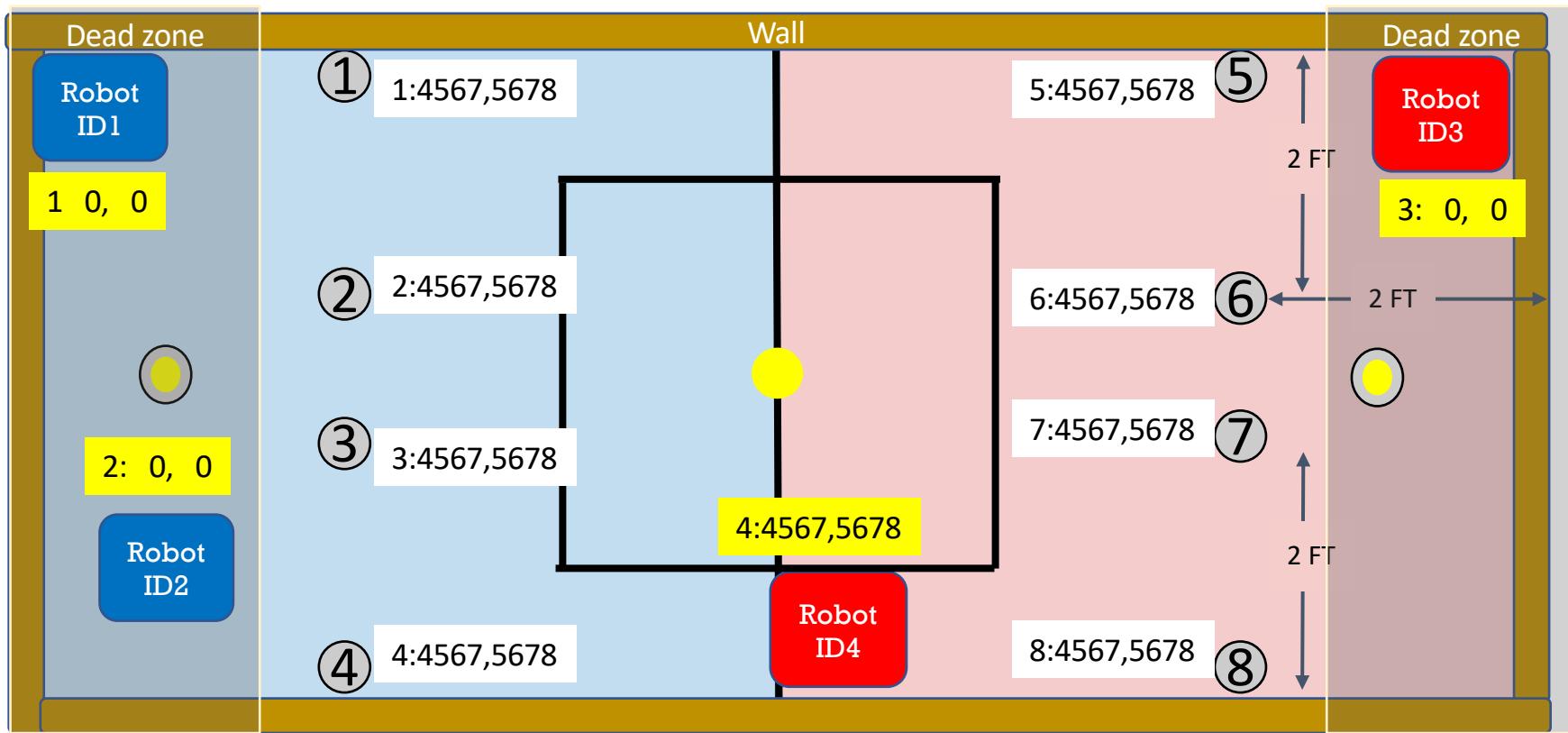
Clear Log Log Traffic Save Log Save Traffic Packet Copy to Clipboard

Time	From IP	From Port	To IP	To Port	Method	Error	ASCII
1 8:40:38.811 pm	You	61846	192.168.1.99	2808	UDP		BB

UDP:61846 TCP:59244 IPv4 Mode

Required Game UDP protocol

- All broadcast UDP messages are asynchronous, update at 1Hz



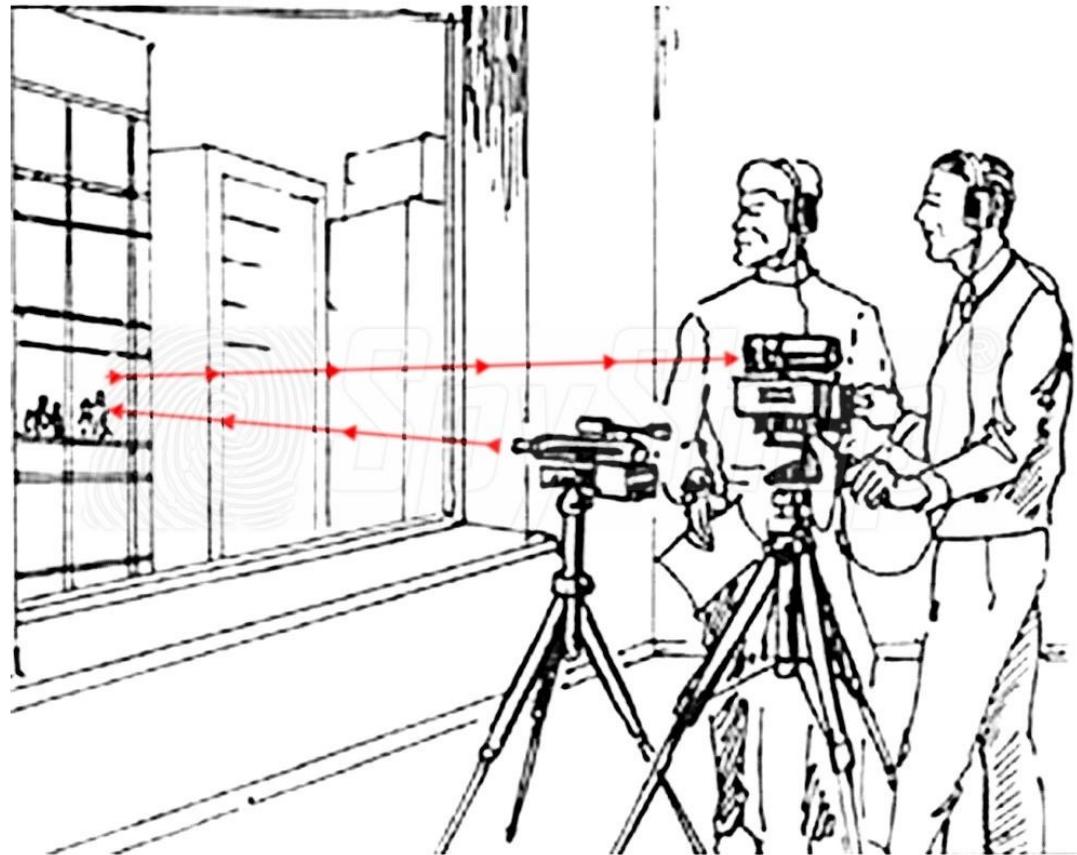
Stack Smash error – Example UDP error

- If ESP32 continuously resets with Stack Smash error, there is something messing up the stack (typically a pointer or array problem)

```
void loop() {  
    char s[13];  
    int x, y; // some data, like xy position  
    // store into a string with format #:###,###, which is robotid, x, y  
    s[12]=0; // be sure string is null terminated  
    sprintf(s,"%1d:%4d,%4d",4, x, y);  
    fncUdpSend(s,13);  
    Serial.printf("sending data: %s",s);  
    delay(100);  
}
```

Beacon Detection Actually Feasible?

- Old IPD516 Lab: Laser Snooper
- Use reflected light to hear vibrations against window
- Used similar 2-stage opamp architecture.

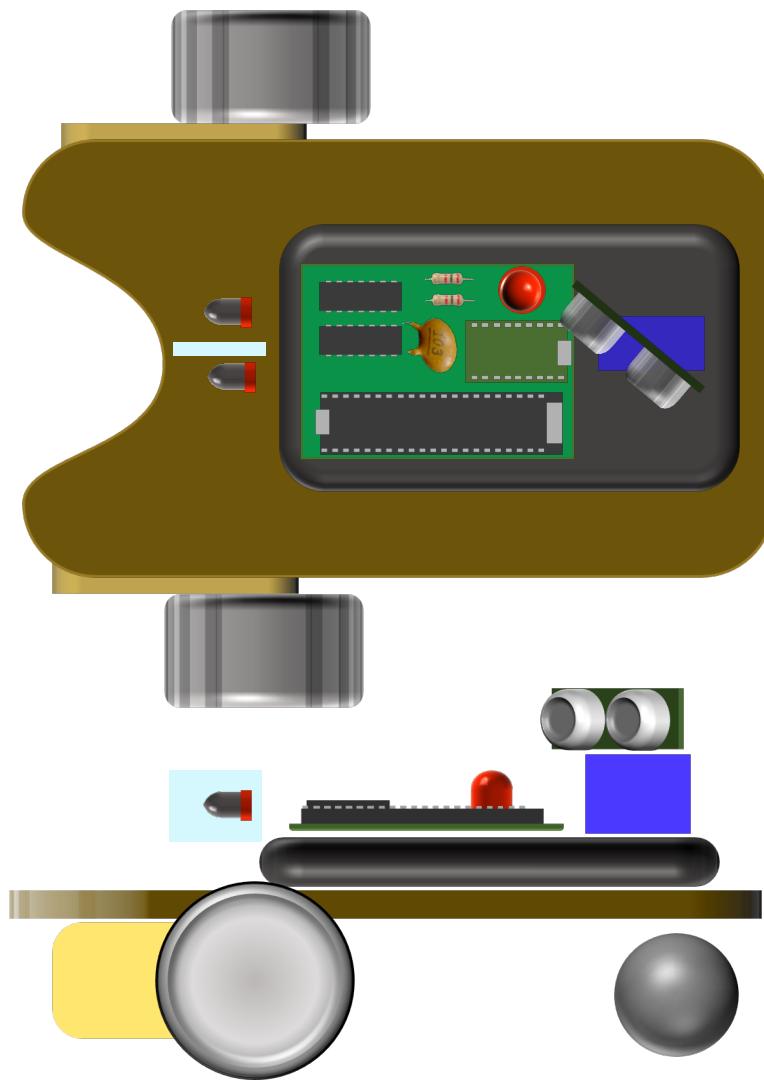


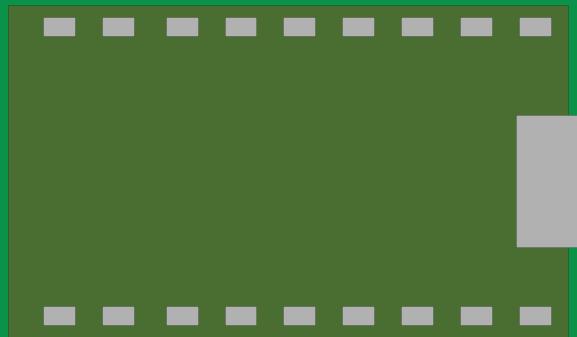
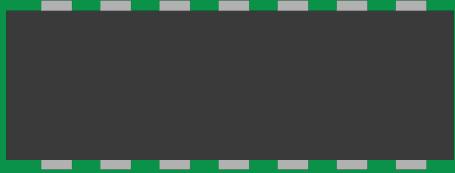
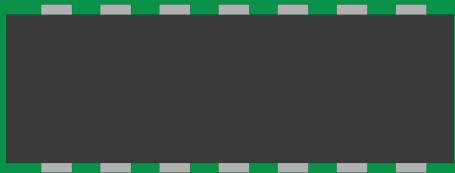
02

Lecture Recap

Class Structure

- Goal is final project
- Learn pieces
- Learn why pieces work
- Integrate in stages
 - Lab 1: Micro
 - Lab 2: Beacon
 - Lab 3: Waldo
 - Lab 4: Mobility







L2. Basic circuits



L5. Photosensor & Input Capture

L6. Opamps

L7. Comparators

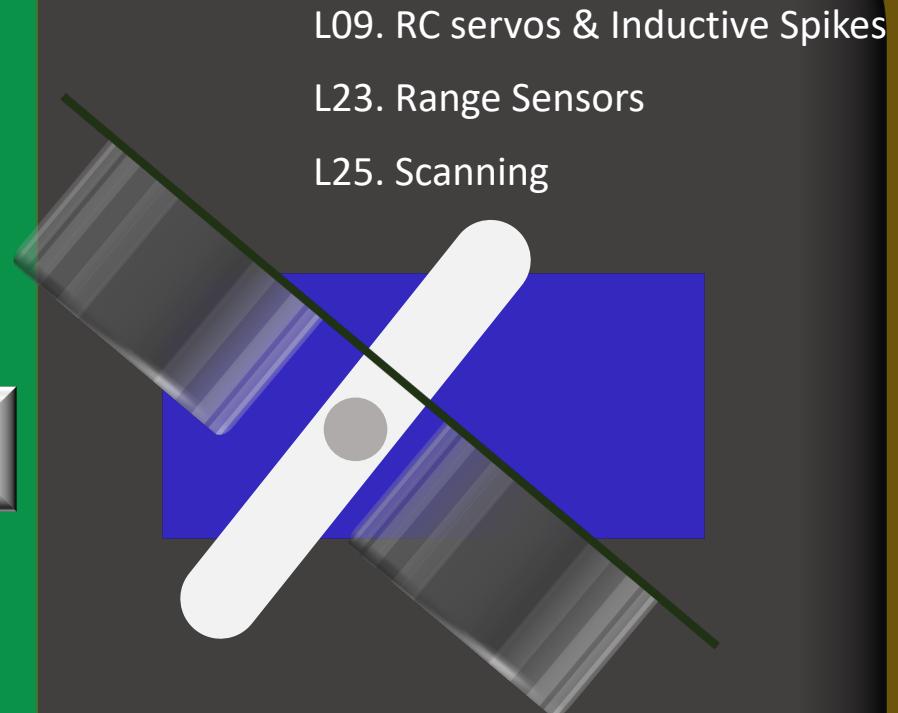
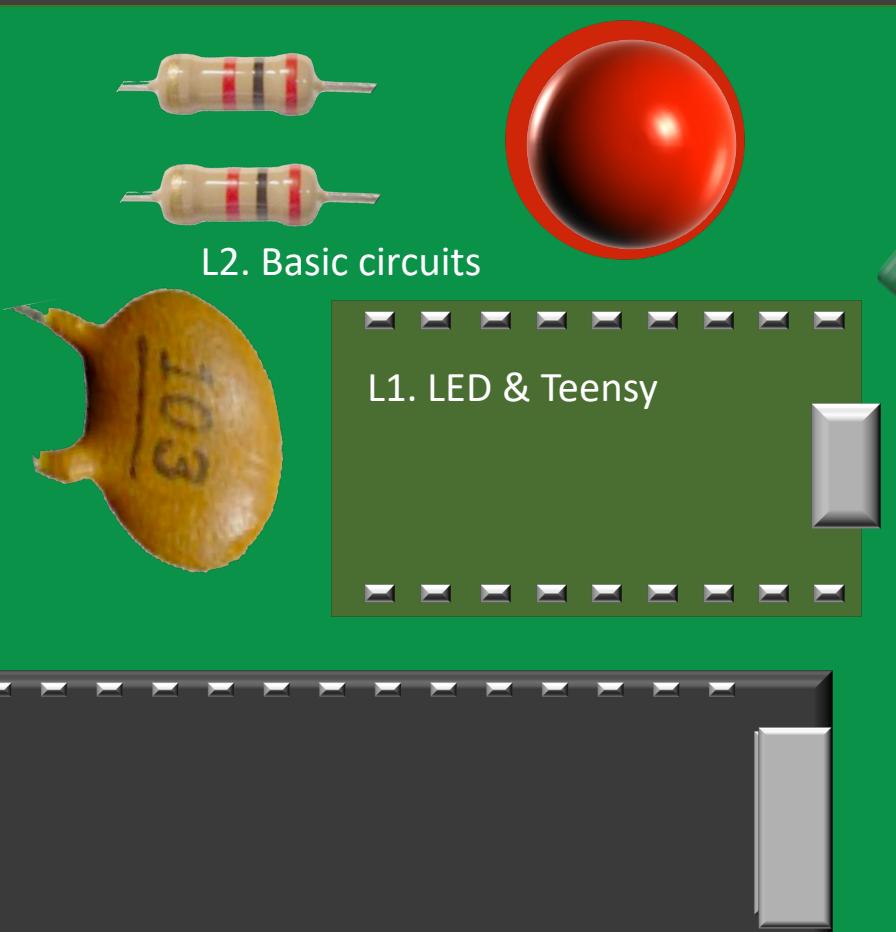
L21. Beacon Tracking



L2. Basic cir



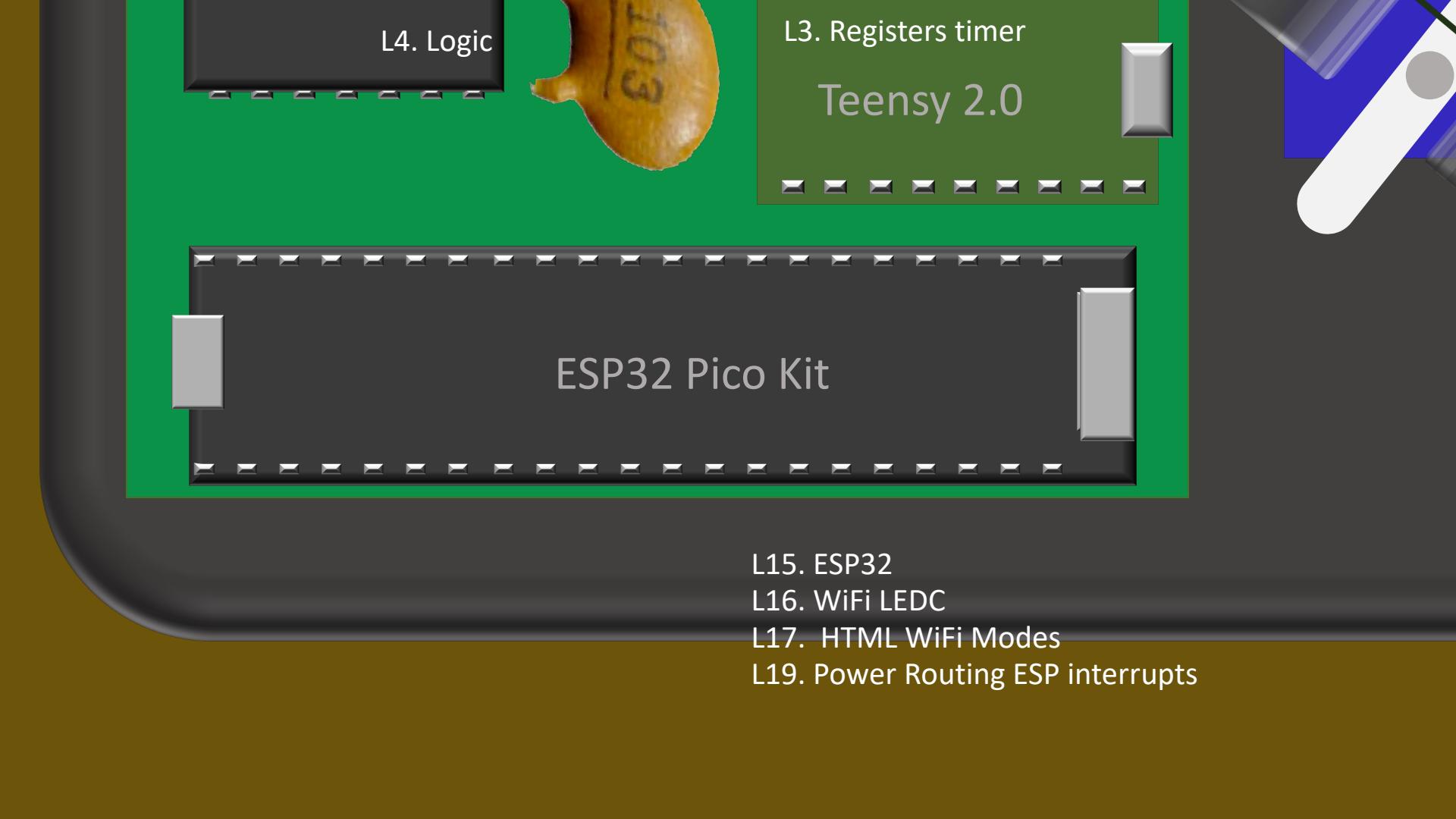
L1



L09. RC servos & Inductive Spikes

L23. Range Sensors

L25. Scanning



L4. Logic

L3. Registers timer

Teensy 2.0

ESP32 Pico Kit

L15. ESP32

L16. WiFi LEDC

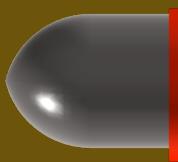
L17. HTML WiFi Modes

L19. Power Routing ESP interrupts

L18 Batteries

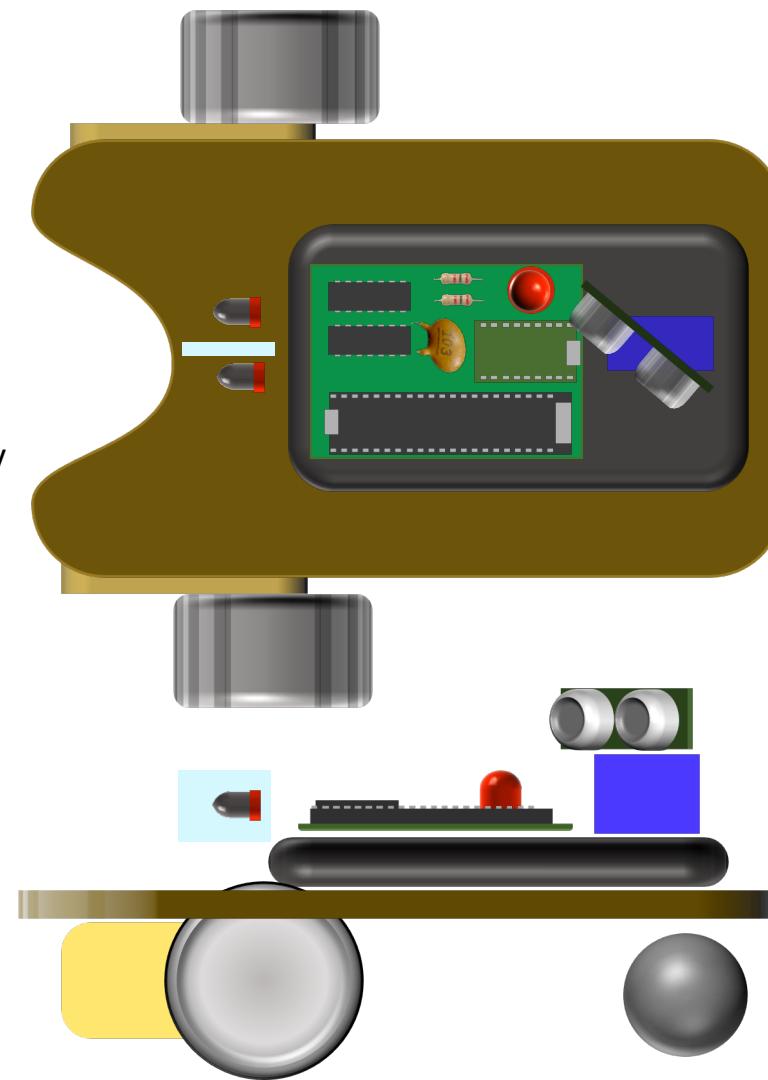
L7. Encoders
L13. Transistors
L14. Driving Motors

L5. Photosensor & Input Capt
L6. Opamps
L7. Comparators
L20. Beacon Tracking



- L8. ADC
- L10. Pointers, Event-based programs
- L11. Interrupts
- L20. Failure and Debugging
- L22. Vive and UDP
- L24. WIred Comms
- L25. Noise & Scanning

- L1. Basic circuits
- L2. LED & Teensy
- L3. Registers timer
- L4. Logic Gates & Logic Levels
- L5. Photosensor Input Capture & Switches
- L6. Opamps
- L7. Comparators & Encoders
- L8. ADC and Digital filters
- L9. RC servos & Inductive Spikes
- L10. Event based programs & Notch filter & Array
- L11. Interrupts
- L13. Transistors
- L14. Motors Solenoids & Driving Motors
- L15. ESP32 & Arduino
- L16. WiFi & LEDC on ESP32
- L17. HTML & WiFi modes & Mobility
- L18. Batteries & Voltage Regulators
- L19. Power Routing & ESP Interrupts
- L20. Debugging & Heat Sinks
- L22. Vive & UDP for final game
- L23. Range Sensing & I2C
- L24. Wired Comms & ESP Now
- L25. Scanning & Dealing with Noise



03

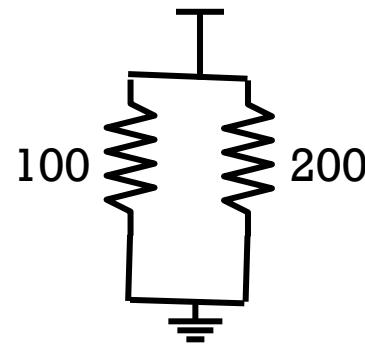
Review Quiz

Agenda for Last MEAM510 Lecture

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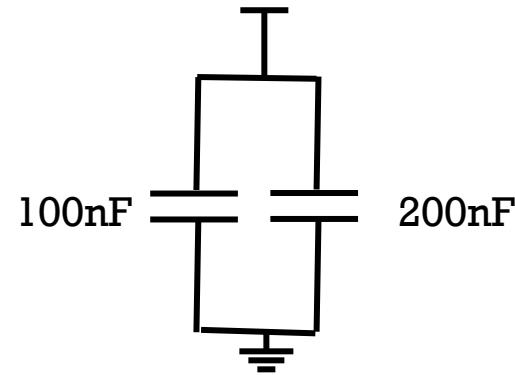
Question 1

- The equivalent resistance for these two resistors in parallel is
 - A. 300
 - B. 100
 - C. 66
 - D. 50



Question 2

- The equivalent capacitance for these two capacitors in parallel is
 - A. 300nF
 - B. 100nF
 - C. 66nF
 - D. 50nF



Question 4

- If you have an "open-collector" or "open-drain" output device, for normal logic level use, you must add
 - A. a decoupling capacitor across power and ground
 - B. a pullup-resistor to the output
 - C. a pulldown-resistor to the output
 - D. a buffer to the output

Question 5

- Which is **not** a type of electrical noise coupling medium?
 - A. Conductive
 - B. Inductive
 - C. Convective
 - D. Capacitive
 - E. Radiative

Question 6

- Which is true when all else being equal:
 - A. TCP/IP is faster than UDP but less reliable
 - B. TCP/IP is slower than UDP but less reliable
 - C. TCP/IP is faster than UDP and more reliable
 - D. TCP/IP is slower than UDP and more reliable

Question 7

- Which battery has the highest power density?
 - A. Lithium Polymer (LiPo)
 - B. Nickel Metal Hydride (NiMH)
 - C. Alkaline
 - D. Lead Acid

Question 8

- Which is not a standard communications protocol
 - A. SPI
 - B. I2S
 - C. I2C
 - D. CAN
 - E. CANT

Question 9

- [True/False] When shielding a cable you should attach ground to both ends of the cable.

Question 10 - Did you notice?

- How many questions have been asked in this quiz including this one (without going back)?

A. 9

B. 10

C. 11

D. None

How you feel about the final project?

1. I am very nervous because I don't know what to do
2. I am nervous because I am behind in work
3. I am slightly nervous but not excited
4. I think I'm on track to do enough
5. I'm excited but I think I won't get as far as I'd like
6. I'm excited and I think the project will be so fun.

Resistor Colors



Resistor colors

- What number is?
 - grey
 - yellow
 - red
 - orange
 - green
- What color is
 - six
 - zero
 - nine
 - one
 - seven

04

More Mechatronics

Some Other Resources

Learning C

- <http://www.learn-c.org/>

OpAmp Tutorial

- http://www.electronics-tutorials.ws/opamp/opamp_1.html
Advanced OpAmps - Book edited by Walt Jung available online
 - <http://www.analog.com/en/education/education-library/op-amp-applications-handbook.html>

ESP32 ESP-IDF – not Arduino, but reasonable

- <https://docs.espressif.com/projects/esp-idf/en/latest/esp32/>
- Noise Reduction Techniques by Henry Ott

Other Resources For Electronics

- Digikey.com
 - Quick highlight of important parameters for classes of devices

LED Lighting - White DigiKey																				
Image	Digi-Key Part Number	Manufacturer Part Number	Manufacturer	Description	Quantity Available	Unit Price USD	Minimum Quantity	Packaging	Series	Part Status	Color	CCT (K)	Flux @ 85°C, Current - Test	Flux @ 25°C, Current - Test	Current - Test	Voltage - Forward (Vf) (Typ)	Lumens/Watt @ Current - Test	CRI (Color Rendering Index)	Current - Max	V
	MTGBEZ-01-0000-0NUUH030F-ND	MTGBEZ-01-0000-0NUUH030F	Cree Inc.	LED XLAMP 3000K EASY WHT SMD	0 Standard Lead Time 7 Weeks	\$168.30000	100 Non-Stock	Tape & Reel (TR)	EasyWhite™ XLamp® MT-G2	Active	White, Warm	3000K 4-Step MacAdam Ellipse	580 lm (560 lm ~ 600 lm)	-	185mA	36V	87 lm/W	90	500mA	115
	XPGBWT-B1-0000-00HE3-ND	XPGBWT-B1-0000-00HE3	Cree Inc.	LED XLAMP XP-G2 COOL WHT 5000K	0	\$137.50000	-	Tape & Reel (TR)	XLamp® XP-G2	Not For New Designs	White, Cool	5000K	144 lm (139 lm ~ 148 lm)	-	350mA	2.8V	147 lm/W	70	1.5A	115
	XPGBWT-L1-R250-00AE8-ND	XPGBWT-L1-R250-00AE8	Cree Inc.	LED XLAMP XP-G2 WARM WHT 2700K	0	\$131.67000	-	Tape & Reel (TR)	XLamp® XP-G2	Not For New Designs	White, Warm	2700K	91 lm (87 lm ~ 94 lm)	-	350mA	2.8V	93 lm/W	80 (Typ)	1.5A	115
	1214-1185-ND	SBT-90-W65S-F71-NB102	Luminous Devices Inc.	LED SBT-90 COOL WHITE 6500K 2SMD	42 - Immediate	\$74.11000	1	Tray	SBT-90	Active	White, Cool	6500K	-	1770 lm (1710 lm ~ 1830 lm)	9A	3.5V	59 lm/W	70 (Typ)	9A	
	1214-1186-ND	SBT-90-W65S-F71-NB101	Luminous Devices Inc.	LED SBT-90 COOL WHITE 6500K 2SMD	137 - Immediate	\$72.26000	1	Tray	SBT-90	Active	White, Cool	6500K	-	1770 lm (1710 lm ~ 1830 lm)	9A	3.5V	59 lm/W	70 (Typ)	9A	
	1537-1172-ND	LZP-00GW00-0027	LED Engin Inc.	LED WARM WHITE 2700K 98CRI 24SMD	99 - Immediate	\$67.97000	1	Tray		Active	White, Warm	2700K 3-Step MacAdam Ellipse	-	2775 lm (2350 lm ~ 3200 lm)	4 x 700mA	19.4V	51 lm/W	98	1A	110

Reading Datasheets

- http://www.egr.msu.edu/classes/ece480/capstone/read_datasheet.pdf
- www.sparkfun.com/tutorials/223

There will always be a date. Datasheets do change, especially if Preliminary or Advance. Check the date!

February 2000

LM555 Timer



Look up here to see if the datasheet is Advance Information or Preliminary.

LM555 Timer

General Description

The LM555 is a highly stable device for generating accurate time delays or oscillation. Additional terminals are provided for triggering or resetting if desired. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor. For astable operation as an oscillator, the free running frequency and duty cycle are accurately controlled with two external resistors and one capacitor. The circuit may be triggered and reset on falling waveforms, and the output circuit can source or sink up to 200mA or drive TTL circuits.

Sometimes the General Description will tell you about a feature or usage not mentioned anywhere else! For example, you might need to hold a specific pin low for some operation.



Features tell you general characteristics--always check the Electrical Characteristics for conditions and exceptions.

Features

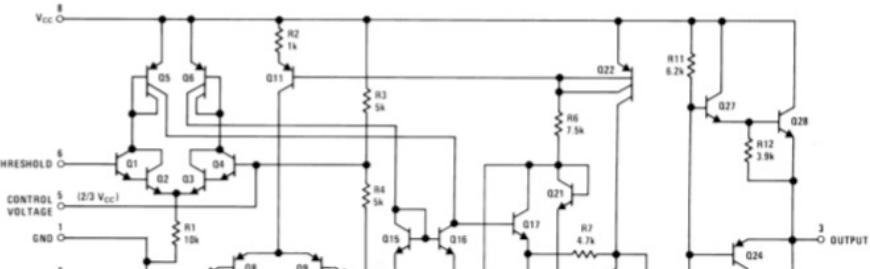
- Direct replacement for SE555/NE555
- Timing from microseconds through hours
- Operates in both astable and monostable modes
- Adjustable duty cycle
- Output can source or sink 200 mA
- Output and supply TTL compatible
- Temperature stability better than 0.005% per °C
- Normally on and normally off output
- Available in 8-pin MSOP package

Applications

- Precision timing
- Pulse generation
- Sequential timing
- Time delay generation
- Pulse width modulation
- Pulse position modulation
- Linear ramp generator

Application suggestions can often tell you quickly if this device is in the ballpark for what you want to do, but these lists are often very general.

Schematic Diagram



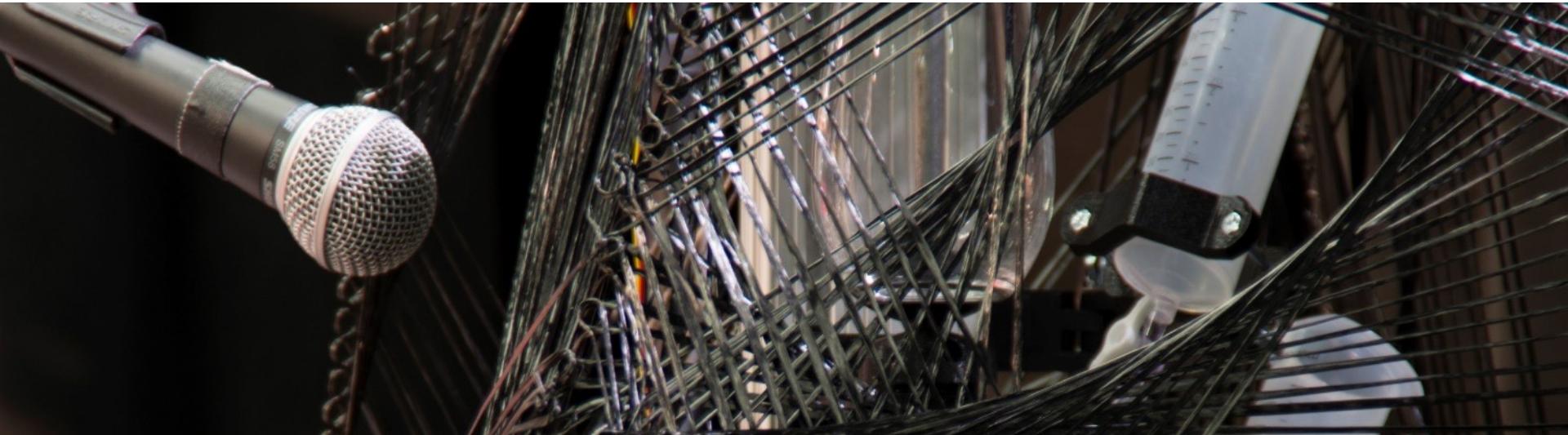
Some nice ESP32 youtubers

In-depth teaching descriptions (including github links to code)

- Andreas Spiess – ESP32 tools, tools RF WiFi remote comparisons
 - https://www.youtube.com/channel/UCu7_D0o48KbfhpEohoP7YSQ
- Atomic14 – sensors, audio, laser projects
 - <https://www.youtube.com/channel/UC4Otk-uDioJN0tg6s1QO9lw>
- Bitluni – wacky ESP32 projects – CNC camera 3D displays
 - <https://www.youtube.com/user/bitlunislab>
 - https://youtu.be/T_n8PtMMLiQ?t=351

Future Classes

- IPD516 Advanced Mechatronics in Reactive Spaces
 - Mendelssohn Chorus of Philadelphia performance at Fillmore
- We are increasing enrollment (assuming we can get a bigger classroom). Will run in conjunction with ARCH732.
- Project based, less labs, more independence, less hand holding.



Things still to do (reminder)

- Final Report Documentation
 - Document your progress.
 - Everytime you get something working, take a short video (so you can prove things were working – in case it breaks later).
 - Plan to get practice on the field before grading. You will likely want to practice at least twice.
- Final Project Competition logistic details will be posted to Piazza.
- Pickup T-shirt during TA OH.
- Feedback Survey on Piazza (important to me)
- Think about TAing in the Fall

Thanks to the TA's



Thanks!

- For bearing with the teaching staff during this on-line hybrid experiment.
- For paying attention and working on learning with us.
- For making the best of challenging times.

ধন্যবাদ

Class picture time

- Everyone online turn on your cameras.
- Everyone in class come up to the stage, but stay 6' apart... (?)

