EE345M Final Exam study guide (Spring 2014): *Final is both a closed and open book exam. During the closed book part you can have a pencil, pen and eraser. During the open book part, you can also have books, notes, and a calculator.*

Not allowed

laptops, phones, devices with screens larger than a TI-89 calculator, devices with a QWERTY keyboard, devices with wireless communication internet communication

Lecture notes View01 through View28 (no 27-USB, no 28-MicriumOS)

Lab Important Topics

Lab 1, interrupts, Cortex M architecture, fifo queues, serial port, ADC
Lab 2, Real time OS, semaphores, critical sections, synchronization, communication
Lab 3, Debugging, blocking semaphores
Lab 4, FFT, Nyquist Theorem, aliasing, Fifo queues, analog filters, digital filter
Lab 5, File System, SPI
Lab 6, CAN, sensor interfacing, and distributed systems
Lab 7, PWM, control, and abstraction

<u>General Topics</u>

- data flow graphs,
- call graphs,
- device drivers,
- intrusiveness,
- stabilization,
- profiling,
- dumps,
- monitors,
- CPU bound,
- I/O bound,
- SPI/SSI concepts
  - Synchronization
  - Bandwidth
  - Protocol
- Ethernet fundamentals, how is it similar to or different from CAN?
- paging
  - page table,
  - memory size,
  - TLB, CAM
  - access time

<u>OS design and implementation</u>

- PSP/MSP,
- First in first out (FIFO) queue, pipe,
  - implementation
  - usage

- mailbox,
- statically allocated linked lists,
- dynamically allocated linked lists,
- interrupts,
    - arm,
    - enable,
    - protocol, interrupt processing on the LM3S8962
    - fifo
- latency,
- real time interrupts,
- interrupt priority,
- reentrancy,
- critical sections, race condition
- atomic,
- sleeping,
- scheduling,
- stack,
- semaphore
    - implementation,
    - applications study the lecture examples and old tests
- OS Concepts
    - kernel,
    - hooks,
    - bounded waiting,
    - deadlock (detection, prevention),
    - aging,
    - starvation,
    - mutual exclusion,
    - ROMable,
    - portability,
    - scalability,
    - certification,
    - breakdown utilization,
    - Normalized Mean Response Time,
    - Guaranteed ratio,
    - CPU utilization,
- Rate Monotonic Scheduling,
- Path expression,
- fixed rate scheduler,
- microphone interface,
- linear analog circuits,
- analog LPF,
- analog HPF,
- ADC sampling modes,

Signal processing

- spectrum analyzer,
- Nyquist Theorem,
- aliasing,
- DFT definition,
- FFT interpretation,
- FFT design (list the four design factors),
- resolution,
- range,
- precision,
- accuracy,
- Z Transform,
- digital filter
    - design,
    - analysis,
    - fixed point implementation,

File systems

- factors that affect bandwidth in the SD card interface,
- internal fragmentation,
- external fragmentation,
- free space management,
- disk block allocation
    - continuous,
    - linked,
    - indexed,
    - FAT

DMA concepts,

- cycle steal,
- burst,
- single address,
- dual address,
- latency,
- bandwidth,

CAN concepts

- message protocol,
- bandwidth,
- stuff bits,
- error detection,
- conflict resolution

Timing input

- input capture measuring frequency,

- input capture measuring pulse width,
- input capture measuring period,
    - precision,
    - resolution,
    - range
- designing a voltage comparator using a rail-to-rail op amp,

Motor interface

- PWM
    - range,
    - resolution,
    - precision,
- motor interfacing,
- PID control,
- Fuzzy logic control
    - Crisp inputs
    - Fuzzification, input membership set
    - Rules, output membership set
    - Defuzzification, crisp output

heap memory manager

- first fit,
- best fit,
- merge,
- memory leak,
- internal fragmentation,
- external fragmentation
- memory manager for fixed sized blocks

Study ideas not in labs

DMA
PID and Fuzzy logic
Fixed rate scheduler
~~Design for low power~~
~~USB How is it like CAN? How is it different from CAN?~~
Ethernet How is it like CAN? How is it different from CAN?
Memory manager (heap)
Paging

- Design and implementation of thread flags `OS_Wait_Event_Or`
- Design and implementation of thread flags `OS_Wait_Event_And`
- Design and implementation of thread flags `OS_Trigger_Event(Thread)`

Analog circuits

Spring 2013 final… all of it is relevant change LM3S8962 to TM4C123/LM4F120
Spring 2012 final… all of it is relevant change LM3S8962 to TM4C123/LM4F120
Spring 2011 final… all of it is relevant change LM3S8962 to TM4C123/LM4F120
Spring 2010 final… change STM32 to TM4C123/LM4F120
Real time OS, semaphores, critical sections, synchronization, communication
Spring 2001,Quiz2, Question 2, Sleep primitive
Fall 2001,Quiz2, Question 4, Priority scheduler, deadlock
Spring 2002, Quiz1, Question 3, Dynamic thread allocation, thread Kill
Fall 2002, Quiz2, Question 2, application of semaphores
Fall 2002, Final, Question 4, use of semaphores
Fall 2002, Final, Bonus questions 1,2,6, assembly language used in OS programming
Fall 2003, Quiz1, Question 2, use of semaphores
Fall 2003, Quiz1, Question 3, changing the TCB
Fall 2003, Quiz1, Question 4, definition of time jitter
Fall 2003, Quiz1, Question 5, implementation of OS_Wait
Fall 2003, Final, Question 14, definitions of OS concepts/terms
Fall 2004, Quiz2, Question 2, Three thread rendezvous
Fall 2004, Quiz2, Question 3, Binary semaphore
Fall 2004, Final, Question 9, Path expression
Fall 2005, Quiz2, Question 4, Reader/writer problem
Fall 2005, Quiz2, Question 5, Cooperative thread scheduler
Fall 2006, Quiz2, Question 9, Fork
Fall 2006, Quiz2, Question 5, Resource allocation graph
Fall 2006, Final, Question 5, Exponential Queue or multi-level feedback queue scheduling
Spring 2008, Quiz2, Question 4, use of semaphores
Spring 2008, Final, Question 2, Effect of OS on time-jitter while sampling an ADC
Spring 2008, Final, Question 5, Critical section, design new instruction
Spring 2009, Quiz 2, Question 4, Critical section
Spring 2009, Quiz 2, Question 5, Fork and join
Spring 2009, Final, Question 5, kill threads that finish executing

General questions
Fall 2003, Quiz1, Question 1, SCI interrupts and use of fifo
Fall 2003, Final, Question 7, Sequence of events in a SCI interrupt
Fall 2003, Final, Question 8, SCI data flow graph
Fall 2004, Quiz2, Question 4, Time-jitter
Fall 2004, Quiz2, Question 5, Definitions and a word bank
Fall 2005, Quiz2, Question 6, Time-jitter
Fall 2006, Final, Question 4, Critical section
Spring 2009, Quiz 2, Question 3, FIFO implementation

FFT questions
Spring 2008, Quiz1, Question 4, FFT interpretation
Spring 2008, Final, Question 6, FFT interpretation
Spring 2009, Quiz2, Question 2, FFT interpretation

Spring 2009, Quiz1, Question 4, 60Hz noise
Spring 2009, Final, Question 6, FFT design choices
Spring 2009, Final, Question 6, FFT interpretation

Digital Filter

Fall 2004, Quiz1, Question 5, Digital filter implementation
Fall 2005, Quiz1, Question 1, Fixed point
Fall 2005, Quiz1, Question 4, Pole-zero plot
Fall 2006, Quiz1, Question 4, Pole-zero plot
Spring 2008, Quiz1, Question 3, Pole-zero plot
Spring 2009, Quiz1, Question 2, Pole-zero plot
Spring 2009, Quiz1, Question 3, Digital filter equation from H(z)

Analog interface

Fall 2004, Quiz1, Question 6, Transducer interface
Fall 2005, Quiz1, Question 6, Transducer interface
Fall 2005, Final, Question 1, Analog circuit design
Fall 2005, Final, Question 2, LPF design
Fall 2006, Quiz1, Question 5, Transducer interface
Spring 2008, Quiz1, Question 5, Transducer interface
Spring 2009, Quiz1, Question 5, Transducer interface
Spring 2009, Final, Question 4, LPF design

File System

Fall 2005, Quiz1, Question 5, Internal fragmentation
Fall 2006, Quiz1, Question 2, Bit vector free space
Fall 2006, Quiz1, Question 3, File system
Spring 2008, Quiz1, Question 1, File translation table
Spring 2008, Quiz1, Question 2, Block size
Spring 2009, Quiz1, Question 1, Contiguous Allocation

Misc

Fall 2005, Quiz2, Question 4, Time jitter
Fall 2005, Quiz2, Question 6, Time jitter
Fall 2004, Quiz1, Question 2, SPI master
Spring 2009, Final, Question 2, Power budget

CAN

Fall 2005, Final, Question 4, CAN bandwidth
Fall 2005, Final, Question 5, CAN latency (although the solution for this question is specific to the 9S12, it could be asked in general, or in specific for the STM32)
Fall 2006, Final, Question 3, CAN Id
Spring 2008, Final, Question 1, Noise
Spring 2008, Final, Question 7, Fifo queue
Spring 2009, Final, Question 1, General concepts, ACK

Motors and Control

Fall 2005, Final, Question 8, Design of a PID controller
Fall 2006, Final, Question 1, Tach interface
Fall 2006, Final, Question 2, Measure motor current

Fall 2006, Final, Question 6, Design of a PID controller
Spring 2008, Final, Question 3, Motor interface
Spring 2008, Final, Question 4, PWM and motor control
Spring 2009, Final, Question 3, Motor interface
Spring 2009, Final, Question 7, Measure motor current

Topics on old exams no longer covered

- 9S12 ports, interface and software
- Memory interfacing
- 9S12 paging
- Timing diagrams