Cairo University *Time Allowed: One Hour*
Biomedical Engineering Department *Open-Book/Open-Notes*

Medical Electronics III -Term Exam
Part II – Solution Guide

January 20, 2008

Solve as Much as You Can – Maximum Grade: 37.5 Points

Q1. Answer the following questions by marking the best answer among the choices given (1 point each):

1. For a differential signal amplifier, we must use …
    a. Instrumentation amplifier (*)
    b. Logarithmic amplifier
    c. Non-inverting amplifier
2. If an OP AMP based amplifier that has a maximum power supply range of ±12V is operated at a power supply of ±18V, the following will happen …
    a. The amplifier will not work (*)
    b. The saturation levels will be ±12V
    c. The saturation levels will be ±18V
3. Heavier load in DC motors require …
    a. More current for the same speed (*)
    b. Faster signals for the same current
    c. More voltage for the same current
4. To interface a microcontroller port to multiple circuits, we must have …
    a. Low current rating for the connected circuits
    b. A Buffer to protect the microcontroller pin output circuits (*)
    c. 3.3V compatible devices
5. Analog-to-digital converter reference voltage determines …
    a. Number of samples per second
    b. Number of bits per sample
    c. Range of voltage input that correspond to full-scale digital output (*)
6. For a +5V to –15V DC/DC converter based on a switched-mode power supply with an output power of 5W, the input power will be around …
    a. 2 W
    b. 6 W (*)
    c. 10 W
7. 5V-tolerant 3.3V port circuits allow …
    a. Input digital signals from a 5V source to be tolerated
    b. Output digital signals to a 5V source to be correctly assigned their logic level
    c. Both of the above (*)
8. The … ADC requires a DC shift circuit to work with physiological signals.
    a. Unipolar (*)
    b. Bipolar
    c. Tripolar

9. In very high speed data bus applications such as PCI-Express computer buses, serial data transmission is used to …
    a. Avoid errors due to delays among different parallel lines (*)
    b. Limit excessive data rates by the many parallel lines
    c. Reduce PCB sizes and hence device size
10. To make a stepper motor run faster, …
    a. Apply the stepping waveforms faster (*)
    b. Increase the current of the stepping waveforms
    c. Increase the voltage of the stepping waveforms
11. Addressing modes refer to …
    a. The way operations perform a CALL
    b. The way program instructions are called
    c. The way operands are obtained to perform an operation (*)
12. Functions are preferred to macros when …
    a. Small project code size is most important (*)
    b. Critical project timing is most important
    c. Organization of project is most important.
13. Real-time systems are characterized by …
    a. Timing correctness
    b. Logical correctness
    c. Both of the above (*)
14. Design of real-time systems is … design of other embedded systems that are not.
    a. Easier than
    b. More difficult than (*)
    c. As easy as
15. The critical parts of hemodialysis systems should be designed as …
    a. Hard real-time embedded systems (*)
    b. Soft real-time embedded systems
    c. Real-time operating system
16. Concurrent tasks mean …
    a. Tasks that execute in sequence
    b. Tasks that execute in parallel (*)
    c. Processes that finished execution
17. RTOS can be summarized in one word as a …
    a. Communicator
    b. Scheduler (*)
    c. Synchronizer
18. Programming embedded systems under RTOS has the advantage of …
    a. Multitasking (*)
    b. Efficient code length
    c. Faster execution
19. The primary means for resource reservation under RTOS is …
    a. Event flags
    b. Mailboxes
    c. Semaphores (*)

20. Messages can be exchanged between tasks using …
    a. Mutexes
    b. Event flags
    c. Mailboxes (*)
21. Parallel execution in Round-Robin multitasking is really …
    a. Time slicing (*)
    b. Priority assignment
    c. Sequential execution of one task after another
22. To program a microcontroller to generate a 1 kHz square wave, we need to program a … block with the correct values.
    a. Timer (*)
    b. Counter
    c. Clock generator
23. Timer output is usually in the form of …
    a. Timer interrupt (*)
    b. Square wave on an I/O pin
    c. Both of the above
24. Counter clock may come from …
    a. A software clock
    b. An external pin (*)
    c. An interrupt from another block
25. If an interrupt pending flag is set while all interrupts are enabled, …
    a. Current instruction is aborted then ISR is executed
    b. Current instruction is completed then ISR is executed (*)
    c. Interrupt pending flag is ignored by the hardware

Q2. Mark the following statement as either True (T) or False (F) (½ point each):

1. Tristate outputs are useful in sourcing high current rates from microcontrollers (T)
2. Switched-mode power supplies are suitable for high current low ripple computer power supplies. (T)
3. Stepper motor interfacing utilizes special binary waveforms. (T)
4. TRIACs work well for fast switching applications. (T)
5. Analog anti-aliasing filters must be used whenever an ADC is used (T)
6. Starting from a 12V/2W power supply, one can design a 5V/3W power supply (F)
7. No heat sinks are necessary with linear regulators (F)
8. Linear regulators are best suited for low noise applications. (T)
9. Rise and fall times of a serial digital signal indicate how fast the signal may go. (T)
10. Parallel interfacing is always preferred to serial interfacing. (F)
11. Different microcontrollers differ in their instruction sets. (T)
12. Different microcontrollers differ in their available addressing modes (T)
13. Functions take longer time to write than macros containing the same code (F)
14. Macros take faster time to execute than functions (T)

15. Small stack size may cause run-time errors when using macros (F)
16. Embedded systems rely mainly on hardware to perform their dedicated tasks (F)
17. Multiple embedded systems may exist within the same system (T)
18. Semaphores must be binary flags (F)
19. Mutexes allow a resource to be exclusively accessed by two processes at once (F)
20. Timer clock input is always the same as that of its microcontroller (F)
21. Interrupt sources may have different priority levels (T)
22. Program flow remains the same after interrupt is handled (T)
23. Interrupt sources can be enabled or disabled by the embedded system software (T)
24. One can find ADCs with either unipolar or bipolar inputs (T)
25. SIGMA-DELTA ADCs can achieve high resolution at high sampling rates (F)

Q3. [10 Points] Design an AC-powered microcontroller based multi-channel data acquisition and display system with the following specs:

1. 8 channel input
2. Each channel may have bandwidth up to 1 kHz
3. Signals in all channels are all bipolar
4. Channels usually come from a direct contact with a patient
5. Signals in all channels are in the range of 100 μV
6. Output display is in the form of 8 LED indicators to indicate that each of the input channels have signal (i.e., their power is higher than a threshold)

Please provide the following in your description of your design:

1. Block diagram of the system including a block for every stage
2. Suitable specs for all components
3. Specs for power supplies to be used and their type
4. How your design matches each of the above required specifications.

Best of Luck!
Dr. Yasser Kadah