Medical Electronics III Mid-Term Exam Part II – Solution Guide

Time Allowed: One Hour – Open-Book/Open-Notes

November 19, 2007

Solve as Much as You Can – Maximum Grade: 100 Points

Q1. Answer the following questions by marking the best answer among the choices given (2 points each):

1. For a physiological signal amplifier, we must use …
    a. Instrumentation amplifier (*)
    b. Logarithmic amplifier
    c. Non-inverting amplifier
2. Tristate outputs are usually connected to …
    a. Pull-up resistor
    b. Pull-down resistor
    c. Any of the above (*)
3. If an OP AMP based amplifier that has a maximum power supply range of ±18V is operated at a power supply of ±12V, the following will happen …
    a. The amplifier will not work
    b. The saturation levels will be ±12V (*)
    c. The saturation levels will be ±18V
4. The TRIAC is switched on when …
    a. Sufficient current flows into its gate (*)
    b. Sufficient current flows into its coil
    c. Sufficient current flows between its terminals
5. Optocouplers appear like a … from their input.
    a. LED (*)
    b. Transistor
    c. Resistance
6. Optocouplers act like a … when they are turned on.
    a. LED
    b. Transistor (*)
    c. Resistance
7. Hall effect sensors are used for …
    a. Proximity sensing (*)
    b. Voltage sensing
    c. Current sensing
8. Optocouplers can work as …
    a. Switches (*)
    b. Transistors
    c. Amplifiers
9. The following sensor changes its resistance with temperature …
    a. Thermocouple
    b. Thermostat
    c. Thermistor (*)

10. LVDT is used to detect …
    a. Magnetic field
    b. Linear motion (*)
    c. Reflection from an object
11. A mechanical switch connected to a microcontroller requires …
    a. Debouncing hardware
    b. Debouncing software (*)
    c. Both of the above
12. 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
13. To interface a microcontroller port to multiple circuits, it is preferred to have …
    a. High current rating for microcontroller
    b. Tristate outputs (*)
    c. Both of the above
14. Interrupts cause the program flow to …
    a. Run a subroutine (*)
    b. Halt current program and start allover in another location
    c. Continue after a short delay
15. Multiplexers can work on …
    a. Analog signals
    b. Digital signals
    c. Both of the above (*)
16. Analog-to-digital resolution refers to …
    a. Number of samples per second
    b. Number of bits per sample (*)
    c. Range of voltage input
17. Solenoids are similar to … in their interfacing.
    a. TRIACS
    b. Relays (*)
    c. Mechanical switches
18. For a 9V to 5V DC/DC converter based on a linear power supply with an output power of 3W, the input power will approximately be …
    a. 2 W
    b. 6 W (*)
    c. 10 W
19. Step-up switching regulators are based on … regulator configuration.
    a. Buck
    b. Boost (*)
    c. Inverting
20. Power density of linear regulators is usually … than linear regulators.
    a. Lower (*)
    b. Higher
    c. More powerful

21. It is not possible to use a switching regulator after a linear regulator because of …
    a. The reduced output ripple.
    b. The low efficiency problem of linear regulators (*)
    c. Both of the above
22. Given a switching regulator with input source voltage of 200V DC @ 1A and output voltage of 12V@10A, it can be modified it to generate a 15V@9A by …
    a. Changing the input voltage
    b. Changing the feedback resistors that control the pulse width modulation (*)
    c. Changing the capacitance of the boost circuit
23. 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 (*)
24. It is always better to … output digital signals from a microcontroller port.
    a. Buffer (*)
    b. Amplify
    c. Invert
25. For isolating analog circuits from the digital circuit using optocouplers, … ADC is preferred.
    a. Flash
    b. Parallel
    c. Serial (*)
26. The … ADC requires a DC shift circuit to work with physiological signals.
    a. Unipolar (*)
    b. Bipolar
    c. Tripolar
27. In very high speed data bus applications such as PCI-Express computer buses, … data transmission is used.
    a. Parallel
    b. Serial (*)
    c. both of the above
28. 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
29. 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 (*)
30. Microcontrollers interface to the outside world using …
    a. Timers
    b. Memory map
    c. Ports (*)

Q2. Mark the following statement as either True (T) or False (F) (1 point each):

1. Any analog circuit interfacing to a microcontroller does not require a filter (F)
2. Tristate outputs are useful in interfacing multiple outputs to a bus (T)
3. Hall effect sensors need magnetic materials to work. (T)
4. Linear power supplies are suitable for high current low ripples computer power supplies. (F)
5. Debouncing of a switch is required only in turning on the switch. (F)
6. Brushless DC motor interfacing utilizes special binary waveforms. (F)
7. Relays work well for fast switching applications. (F)
8. In microcontroller software, data may accidentally overwrite program memory. (F)
9. Digital anti-aliasing filters offer an advantage over analog ones. (F)
10. Load regulation is better in switched regulators than linear regulators (F)
11. Line regulation is better in linear regulators than switching regulators (T)
12. Transient recovery is better in switching regulators than linear types (F)
13. Starting from a –5V, one can design a power supply circuit that produces +5 V (T)
14. No heat sinks are necessary with linear regulators (F)
15. There exist variable output linear regulators. (T)
16. The switching regulators are best suited for low noise applications. (F)
17. With a 5V @5A input, we can achieve a 12V @1A output using an amplifier (F)
18. Rise and fall times of a serial digital signal indicate how fast the signal may go. (T)
19. With microcontrollers, one can move all analog filters to the digital domain. (F)
20. Parallel interfacing is always preferred to serial interfacing. (F)
21. Different microcontrollers differ in their instruction sets. (T)
22. Different microcontrollers differ in their available addressing modes (T)
23. "Hi-Z" refers to a logic state of 1. (F)
24. Reference voltage of an ADC refers to the maximum analog voltage that can be converted.(T)

Q3. Design a battery-powered microcontroller based 3-channel ECG monitor. In particular, describe the following components in your design:

1. Block diagram of the system including a block for every stage (10 points)
2. Specs of suitable physiological signal amplifiers (3 points)
3. Specs for ADC (3 points)
4. Specs for power supplies to be used and their type (3 points)
5. Explain how you will handle 3 channels (3 points)
6. Explain how you will achieve patient safety (if necessary) (3 points)

Best of Luck!