

**UNIVERSITY OF MORATUWA**

Faculty of Engineering

Department of Electronic & Telecommunication Engineering

B.Sc. Engineering

Semester 3 Examination

EN2060 – ROBOT DESIGN AND COMPETITION

Time Allowed: 1 hour

November 2013

INSTRUCTIONS TO CANDIDATES

1. This paper contains **forty five (45)** questions on **nine (09)** pages including this page
2. This examination accounts for **40%** of the module assessment.
3. This is a **CLOSED** book examination.
4. Use the answer script provided to cast your answers.
5. All questions carry equal marks.
6. Return the question paper with the answer script.



1. How can you identify different coils of a step motor?

 - a. using an ohmmeter
 - b. ask the manufacturer
 - c. trial and error
 - d. by a drive test

2. Which of the following components is used to protect the motor control IC from the back EMF of the motor?

 - a. a zener diode
 - b. a voltage regulator IC
 - c. a resistor
 - d. a free-wheeling diode

3. Which of the following pins are used to load the program (Hex file) to the microcontroller when programming using the bootloader?

 - a. The Serial port or UART pins (Tx, Rx)
 - b. The program data and clock (PGD, PGC) pins
 - c. The Serial peripheral interface (SPI) pins
 - d. The I2C pins (SCL, SDA)

4. Passive IR sensors are commonly used to

 - a. measure IR intensity at some place
 - b. measure distances
 - c. measure humidity
 - d. measure temperature

5. A switch sensor can be used for

 - a. contact sensing
 - b. collision detection
 - c. limiting rotation
 - d. all of the above tasks

6. Which of the following is a motor driving IC?

 - a. 16F877A
 - b. dSPIC
 - c. ATmega328
 - d. L298

of the following is not considered when using a digital compass for a toy robot?
 Digital compass must be horizontally installed.

Digital compass must be installed away from the metal parts.

Digital compass gives better readings when installed closer to the earth surface.

Digital compass needs to be calibrated before use it.

8. Which of the followings is not involved in A/D conversion of a PIC microcontroller?

- a. Channel
- b. Voltage reference source
- c. Duty cycle
- d. Clock source

9. A microcontroller has a built-in 8-bit ADC and it operates at 5V. What would be the analog voltage from the sensor when the ADC reading is 150?

- a. 2.92V
- b. 0.64V
- c. 3.00V
- d. 1.50V

10. Which of the following statements is not true about soldering

- a. strip 1/8"- 1/4" insulation at wire ends
- b. tin the ends evenly
- c. always use a standard heat gun for heat shrink
- d. use 1/4" heat shrink tubing

11. Suppose that your robot has two wheels with a diameter of 7cm. You have an encoder with 30 ticks per revolution fixed to the motor shaft. If you need to travel 33cm and stop, what should be the value of TIMER0 to stop the motors? (TIMER0 is 8-bits wide, prescaler 1:1, two motors are identical)

- a. 25
- b. 45
- c. 255
- d. 333

12. How many analogue pins are available in PIC18f452 micro controller?

- a. 5 pins
- b. 8 pins
- c. 10 pins
- d. 12 pins

13. The recommended maximum voltage for analogue input in PIC18f452 is
- 3.3 V
 - 5 V
 - 6 V
 - 12 V
14. How can you use a 9.6V battery to drive 6V servo motor?
- Do not worry about the little extra voltage
 - Use a resistor to drop the voltage
 - It is not possible
 - Use IN4001 diodes to drop the voltage
15. Echo output of a SRF05 sonar gave rise to a pulse of 6ms width. What is the distance to the object? (Speed of sound is 340 ms^{-1})
- 0.51 m
 - 0.17 m
 - 1.53 m
 - 1.02 m
16. Subsumption architecture is not appropriate
- for monolithic control loops
 - when the robot has multiple objectives to achieve
 - when the environment is dynamic and uncertain
 - for simple mobile robots
17. A servo motor turns 90° and 180° positions for a 1.5ms and 1.75ms pulse width respectively. The motor takes 900ms to rotate from 0 degrees to 180 degrees. What is the sum of widths of all the pulses (high state) that should be sent to the motor minimally to turn the motor shaft from 30 degree position to 90 degree position?
- 22.5 ms
 - 26.25 ms
 - 21.25 ms
 - 18.75 ms
18. Proper implementation of pulse width modulation (PWM)
- needs a very high switching frequency
 - is used for speed control of DC motors
 - is used for servo position control
 - can be used for step motor control

19. The components of a RC servo motor are
- Stepper motor, Motor driver, Gear system, Electronic control circuit.
 - DC motor, Motor driver, Gear system, Optical encoder, Electronic control circuit.
 - DC motor, Motor driver, Gear system, Potentiometer, Electronic control circuit.
 - AC motor, Motor driver, Gear system, Optical encoder, Electronic control circuit.
20. The parameters to be considered when generating a PWM waveform using a microcontroller are
- duty cycle, frequency, and resolution.
 - duty cycle, amplitude, and resolution.
 - phase, duty cycle, and resolution.
 - resolution, frequency, and phase.
21. A servo system does not generally contain
- a DC motor
 - a gear reducer
 - a shaft encoder
 - a speed sensor
22. What does the C18 instruction "TRISCbits.TRISC7 = 1 stand for?
- Setting PORTC7 pin direction as input
 - Setting PORTC7 register value as 1
 - Setting PORTC7 pin direction as output
 - Setting TRISC7 register direction as input
23. Maximum range of a sonar sensor is 8.5 m. Width of the echo output is measured by an 8 bit timer module. Clock of the PIC is 4 MHz and an Instruction takes 4 clock cycles. In order to get the correct distance measurement what can be the lowest possible prescaler value. (Answer may not be a practical value). Speed of sound is 340 m/s.
- 64
 - 128
 - 256
 - 512
24. What types of motors are generally used in hobby robotics?
- brushed DC motor, AC motor, RC servo motor
 - brushed DC motor, stepper motor, RC servo motor
 - AC motor, stepper motor, RC servo motor
 - brushless DC motor, Stepper motor, RC servo.

25. Which of the followings a PIC18f452 microcontroller is not able to perform?
- drive a step motor
 - drive servo motor with encoder feedback
 - output an analogue signal
 - read analogue inputs
26. Which of the followings can directly be controlled by the current through a DC motor?
- torque on the motor shaft
 - speed of the motor
 - the voltage across the terminal
 - all of the above
27. Referring to the Figure 1, which of the following statements is true about the error amplifier?
- It is an operational amplifier with positive feedback
 - It always tries to minimize the difference between the inverting (negative) and non-inverting (positive) inputs by driving its output in the appropriate direction
 - It is an electronic circuit which converts a pulse width signal to a voltage signal
 - It is a position sensor
28. The standard servo pulse period is
- 20us
 - 2ms
 - 1 μ s
 - 20ms
29. The maximum current that can be drained from a 2200mAh 25C LiPo battery is
- 22A
 - 25A
 - 55A
 - 2.2A
30. Which of the followings is not possible with a PIC18f452 microcontroller?
- Drive a stepper motor
 - Drive a servo motor with encoder feedback
 - Read an analogue inputs
 - Output an analogue signal

31. If the external oscillator of a microcontroller (PIC18f452) has a value of 40MHz, then what is the time taken to execute one instruction cycle?
- 25ms
 - 40ms
 - 100 μ s
 - 200 μ s
32. Your motor control board allows 1A. Which of the following techniques will you adopt if you need to drive 2A?
- piggyback another motor driving IC on the same board
 - change the board to 2A rated one
 - use the same board with short duty ratios
 - none of the above
33. Which of the following statements is not true about IR sensors?
- they are susceptible to ambient light
 - they always need signal conditioning for proper operation
 - they can be used as an analog or a digital sensor
 - they need to be calibrated
34. Which of the following is the main advantage of using I2C over UART as a communication protocol?
- I2C is a serial communication method
 - In I2C, more than one device can be connected to the same bus
 - I2C uses only 2 wires for communication except the ground wire
 - A microcontroller can be connected easily to a computer using I2C
35. Speed of a DC motor is proportional to the
- PWM signal frequency.
 - voltage.
 - current.
 - stator magnetic strength.
36. Quadrature shaft encoding
- has two break-beam sensors
 - has a lookup table
 - senses direction of motion of the wheel
 - all of the above statements are true

37. Which of these statements is not true about servo motors?

- a. a servo motor has three wires
- b. PWM is used for reference command
- c. its shaft can be positioned anywhere within 360°
- d. it does not allow speed control

38. Which of the following devices could be used for bidirectional DC motor control?

- a. Diodes
- b. Triac
- c. H bridge
- d. Relays

39. What are the parameters that are to be considered for generating a PWM waveform using a microcontroller?

- a. duty cycle, frequency, resolution
- b. duty cycle, amplitude, resolution
- c. phase, duty cycle, resolution
- d. resolution, frequency, phase

40. Which of the followings is not applicable for asynchronous serial transmission?

- a. baud rate
- b. voltage level
- c. modulation frequency
- d. communication protocol

41. DC motor torque is proportional to

- a. PWM frequency
- b. motor current
- c. motor speed
- d. motor voltage

42. Which of the followings is the most affecting in practical use of an infrared sensor?

- a. Blind range
- b. Narrow beam width
- c. Interference from ambient Sun light
- d. Nonlinearity of the output

Which of the following properties has the most significant contribution in determining the range of an ultrasound sensor?

- a. Frequency of the ultrasound signal
- b. Power of the ultrasound burst
- c. Power of the ultrasound burst
- d. Input voltage of the sensor

44. Torque of a DC motor is proportional to

- a. motor current
- b. PWM frequency
- c. motor voltage
- d. motor speed

45. Your DC power adapter is rated for 9V/500mA. You check the output voltage without a load connected and found that it reads 14V. What is your conclusion?

- a. regulator specification is wrong
- b. regulator specification is correct
- c. open circuit voltage is higher than the rated voltage
- d. it is wise not to use the regulator

→ End of Paper →