



**UNIVERSITY OF MORATUWA**  
Faculty of Engineering  
B.Sc. Engineering  
Semester 3 Examination  
**EN 2532 – ROBOT DESIGN AND COMPETITION**

**Time Allowed: 1 hour**

**June 2017**

**INSTRUCTIONS TO CANDIDATES**

This paper contains **40%** of the total grading of the subject.

This paper contains 50 multiple-choice questions (MCQ) in 6 pages (page 2 to page 7).

Use the provided answer script to cast your answers.

This is a **closed** book exam.

Return the answer script and the **question paper** separately.

1. A microcontroller unit consists of
  - a. a CPU only
  - b. a CPU, memory, and I/O
  - c. a memory only
  - d. a memory and I/O only
2. Speed of a DC motor is proportional to the
  - a. PWM signal frequency.
  - b. voltage.
  - c. current.
  - d. stator magnetic strength.
3. 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  $340 \text{ ms}^{-1}$ )
  - a. 0.51 m
  - b. 0.17 m
  - c. 1.53 m
  - d. 1.02 m
4. 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 not correct.
  - b. regulator specification is correct.
  - c. open circuit voltage is higher than the rated voltage.
  - d. it is wise not to use the regulator.
5. The communication protocol used by the boot loader to communicate with the robot development board is
  - a. USB
  - b. RS232
  - c. RS422
  - d. RS485
6. Which of the following about subsumption architecture is incorrect?
  - a. It provides a procedure to incrementally build and test a complex mobile robot control system.
  - b. It supports parallel computation.
  - c. It uses inhibitors to suppress inputs of layers.
  - d. It avoids centralized control.
7. Subsumption architecture is not appropriate
  - a. for monolithic control loops
  - b. when the robot has multiple objectives to achieve
  - c. when the environment is dynamic and uncertain
  - d. for simple mobile robots
8. SRF05 ultrasound sensor outputs a voltage pulse when it detects the reflection off a nearby object. This output pulse is sensed using a microcontroller timer and the timer increments its value every  $2\mu\text{s}$ . The measured timer value for a particular object in the vicinity is 278. What is the distance between the sensor and the object? (Speed of sound is  $340 \text{ ms}^{-1}$ )
  - a. 18.9 cm
  - b. 9.4 cm
  - c. 37.8 cm
  - d. 28.4 cm
9. Pullup resistors are used in sensor interfacing to improve
  - a. dynamic range
  - b. response time
  - c. linearity
  - d. sensitivity

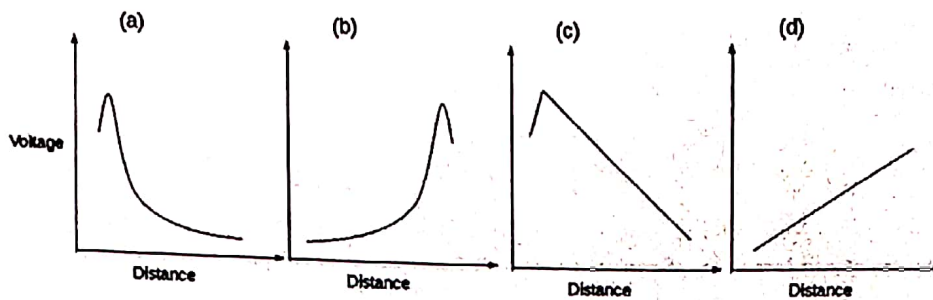
10. Which of the following statements is not true about unipolar step motors?
  - a. unipolar stepper motors have 5 or 6 wires
  - b. direction of motion is changed by changing direction of current through coils
  - c. motor coils can be identified by measuring resistance between wires
  - d. motor speed is proportional to pulse frequency
11. Which of the followings a PIC18f452 microcontroller is not able to perform?
  - a. drive a step motor
  - b. drive servo motor with encoder feedback
  - c. output an analogue signal
  - d. read analogue inputs
12. Which of the following devices could be used for bidirectional DC motor control?
  - a. Diodes
  - b. Triac
  - c. H bridge
  - d. Relays
13. 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
14. Which of the following methods will not reduce the adverse effects due to ambient light in IR sensors?
  - a. Use a shutter in front of the sensor and open it only at the time of reading
  - b. Covering the sensor with a filter that allows only IR waves to pass through
  - c. Correcting for ambient light by taking two readings; one with the emitter turned on, the other with the emitter turned off
  - d. By placing the sensors at properly chosen places with proper orientations
15. A servo system does not generally contain
  - a. a DC motor
  - b. a gear reducer
  - c. a shaft encoder
  - d. a speed sensor
16. Which of the following methods is used in the development board to protect motor control IC against back EMF of the motor?
  - a. Using resistors
  - b. Using free wheeling diodes
  - c. Using voltage regulators
  - d. Using Zener diodes
17. Winch servo
  - a. is a servo motor without feedback signal
  - b. is a modified servo system for speed control
  - c. is a modified servo for more power
  - d. uses the PWM control signal to command the speed
18. 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).



19. An ultrasound sensor consists of an ultrasound transmitter and a receiver. Ultrasound sensors turn off its receiver when transmitting the ultrasound burst to avoid receiver being saturated from the transmitting signal. A particular ultrasound sensor turns on its receiver, 100us after transmitting the ultrasound burst. Given the speed of sound as 340m/s, the minimum distance which can be measured by the sensor is  
 a. 6.8 cm    b. 3.4 cm    c. 1.7 cm    d. 7.2 cm
20. Which of the following is not considered when using a digital compass for a toy robot?  
 a. Digital compass must be horizontally installed.  
 b. Digital compass must be installed away from the metal parts.  
 c. Digital compass gives better reading when installed closer to the earth surface.  
 d. Digital compass needed to be calibrated before using it.
21. Which of the followings is not related to A/D converter in a PIC microcontroller?  
 a. select channel  
 b. select duty cycle  
 c. select voltage reference source  
 d. select clock source
22. Which of the following statements is not true about Sense-Plan-Act strategy of robot control?  
 a. it slows down robot motion  
 b. it is not appropriate to achieve multiple objectives  
 c. at each step, sensor fusion, world modeling, and planning take place  
 d. is not applicable for complex, dynamic environments
23. A particular servo motor comes to the center position (0 degrees) for a pulse width of 1.5ms and to the left most position of -100 degrees for a pulse width of 700us. What is the most likely estimate for the pulse width corresponding to the angle +20 degrees?  
 a. 160 us    b. 1340 us    c. 1740 us    d. 1660 us
24. The nominal voltage of a 4 Cell LiPo battery and the voltage when it is fully charged are  
 a. 12.4V, and 14.8V  
 b. 14.8V, and 16.8V  
 c. 12.4V, and 15.2V  
 d. 14.8V, and 15.2V
25. Which of the following scenarios can easily distract a mobile robot navigated using IR sensors?  
 a. navigation in a maze with white walls  
 b. tracking a white line in black background  
 c. navigating in dark environment  
 d. navigation in bright daylight
26. Stall current of a motor is  
 a. the maximum current it draws.  
 b. the maximum current it can handle.  
 c. measured when the motor runs at rated RPM.  
 d. always written on the motor cover plate.
27. A switch sensor can be used for  
 a. contact sensing  
 b. collision detection  
 c. limiting rotation  
 d. all of the above tasks

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28. DC motor torque is proportional to
    - a. PWM frequency
    - b. motor current
    - c. motor speed
    - d. motor voltage
  29. A microcontroller has a built-in 8bit ADC and it operates at 5V. What would be the analog voltage from the sensor when the ADC readout is 150?
    - a. 2.93V
    - b. 0.64V
    - c. 3.00V
    - d. 1.50V
  30. The register that is used to set the direction of PIC microcontroller pins is
    - a. INTCON
    - b. STATUS
    - c. PIR
    - d. TRIS
  31. Which of the following statements most accurately describe an H-bridge?
    - a. It is used for direction control of DC motors.
    - b. It has 4 switching signals.
    - c. It has 3 logic control signals.
    - d. It has 4 logic gates.
  32. Quadrature shaft encoding
    - a. has two break-beam sensors
    - b. has a lookup table
    - c. senses direction of motion of the wheel
    - d. all of the above statements are true
  33. For a DC motor control using PWM, the acceptable frequency range for the PWM frequency is
    - a. 20Hz – 200Hz
    - b. 1kHz – 20kHz
    - c. 2kHz – 1MHz
    - d. 2MHz – 20 MHz
  34. 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
  35. When does a motor draw maximum current?
    - a. when it starts
    - b. when the motion is blocked
    - c. when it runs with maximum speed
    - d. when it drives its rated load
  36. Which of the following statements regarding sensors are true?
    - a. Sensors allow a robot to interact with its environment in a flexible manner
    - b. Sensors should not disturb the physical quantities they measure
    - c. Sensors should be linear. i.e. they should maintain the same sensitivity within the entire dynamic range
    - d. first and second statements

37. Which of the following graphs shows the correct relationship between the distance to an obstacle and the output voltage for an IR sensor?

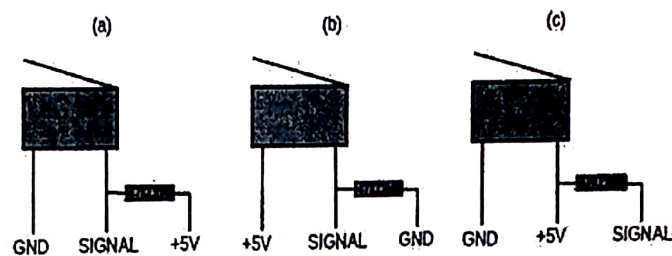


a. a      b. b      c. c      d. d

38. 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 motor
39. Which of the following is not true about a differential drive robot?
- A differential drive robot can contain one or more caster wheels.
  - A differential drive robot cannot move in the reverse direction.
  - A differential drive robot uses two independent motors to drive the wheels.
  - On the spot rotation can be achieved on a differential drive robot.
40. Which of the following is true about gears?
- Teeth are not parallel to the axis of rotation in spur gears.
  - Helical gears tend to be noisy at high speeds.
  - Using bevel gears it is possible to change the operating angle.
  - Worm gear consists of a ring, a sun, planets and an arm.
41. Which of the following statements is true about robot mechanisms?
- Conversion between reciprocating motion and rotational motion can be achieved by crank mechanism.
  - The quick return mechanism is used in pressing and cutting applications.
  - The intermittent rotation mechanism holds the piece of interest in place for a brief duration.
  - All of the above
42. A LiPo battery has the following numbers printed on it: 2200mAh, 2S, 25C continuous, 35C climb outs and 50C max bursts. If a 2A load is connected to the battery, roughly how long can the battery survive without draining?
- 66 minutes
  - 33 minutes
  - 22 minutes
  - 122 minutes
43. What are the continuous and the short-period currents that can be drawn from the LiPo battery mentioned in question 42?
- 48A, and 55A
  - 77A, and 48A
  - 55A, and 77A
  - 77A, and 55A
44. Which of the following statements is true about LiPo batteries?
- LiPo batteries have a significantly high life span.
  - A LiPo battery has 3 connectors: one for output, one for balancing and one for charging.
  - LiPo batteries require proper care for charging, discharging and storage.
  - All of the above



45. Which of the following statements is true about odometry?
- Odometry is an absolute positioning technique.
  - Odometry usually suffers from error accumulation problem.
  - Wheel odometry is calculated using inertial measurement sensors.
  - All of the above
46. In order to calculate wheel odometry, which of the following is not needed?
- Wheel radius
  - Wheel base
  - Gear ratio
  - Wheel mass
47. Which of the following configurations illustrate the correct way of connecting a tactile switch to a microcontroller?



- a. a                      b. a and b                      c. a and c                      d. a, b and c

48. Which of the following statements is not true about motor control?
- A 12V motor runs too slowly when powered by a 9V supply.
  - A 6V motor can be continuously powered by a 9V battery without affecting its operating life.
  - Motors should be provided with the rated voltage to operate properly.
  - All of the above
49. Which of the following statements best describes the sensitivity of a sensor?
- Sensitivity is a measure of min. & max. values of the input signal for which the sensor responds.
  - Sensitivity is the time taken by the sensor to respond to the stimuli.
  - Sensitivity is the change in sensor output for a unit change in input.
  - None of the above
50. Which of these statements is not true about servo motors?
- a servo motor has three wires
  - PWM is used for reference command
  - its shaft can be positioned anywhere within 360 deg
  - it does not allow speed control