UNIVERSITY OF MORATUWA
Faculty of Engineering
B.Sc. Engineering
Semester 3 Examination

EN 2532 – ROBOT DESIGN AND COMPETITION

Time Allowed: **1 hour** June 2016

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.

Do not detach the answer script form the question paper. Return the answer script and question paper together.

1. Which of the followings sensors is most suitable for detecting distance to a kindled candle at 30cm?
   a. IR range sensor b. Sonar sensor c. Heat sensor d. Proximity sensor

2. Which of the followings is not possible with a PIC18f452 microcontroller?
   a. Drive a stepper motor
   b. Drive a servo motor with encoder feedback
   c. Read an analogue inputs
   d. Output an analogue signal

3. Passive IR sensors are commonly used to
   a. measure IR intensity at some place
   b. measure distances
   c. measure humidity
   d. measure temperature

4. 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

5. Which of the following is not commonly applicable to both IR and sonar sensor?
   a. Beam width
   b. Blind range
   b. Need to illuminate the subject with input.
   d. Reflection principle

6. Which one of the reason for electrostatic sonar sensors to have a minimum detectable distance?
   a. Circuit refresh time
   b. Signal acquisition delay
   c. Internal oscillations of the emitter
   d. Stabilization of sound pressure

7. Which of the following distances a long range infrared sensor is not able to measure?
   a. 121mm b. 700mm c. 30cm d. 12m

8. 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

9. 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

10. Which of the following statements regarding the photocell (LDR) are true?
   a. It is an active sensor that generates a voltage using photovoltaic effect
   b. It has two terminals. One should be connected to the GND and the other to an analog input pin of a microcontroller
   c. It is responsive to a wide range of frequencies like IR, visible light and UV
   d. Its internal resistance changes proportional to light intensity

11. 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

12. 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

13. 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

14. Which of the following statements is true about active IR range sensor?
   a. It has only one IR detector b. It has only one IR emitter
   c. It has one IR emitter and one IR detector d. It has one IR filter

15. How can a servo motor be reengineered for bidirectional speed control?
   a. Swapping power and ground b. Removing the feedback
   c. Inverting the sign of feedback d. Clamping the feedback

16. Which of the following is not a feature of the four freewheeling diodes in H-Bridge DC motor drive?
   a. They provide an alternative path to divert inductive energy of the motor.
   b. They can divert kinetic energy of the motor to the power source.
   c. They protect CE junctions of BJTs from large reverse voltages.
   d. They can be used to avoid discontinuous currents through the H-Bridge circuit.

17. You are requested to build a robot that is capable of building the map of a maze. If the robot is placed inside a maze facing along an arbitrary direction, what is the best sensor combination will you suggest?
   a. Line sensor panel, IR range finders, and wheel encoders.
   b. Sonar sensors, proximity sensors, and wheel encoders.
   c. Wheel encoders, proximity sensors, and digital compass
   d. Touch sensors, digital compass, Gyroscope.

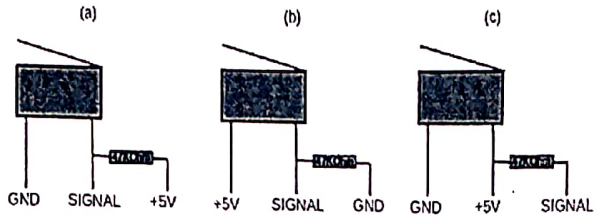
18. Which of the following scenarios can easily distract a mobile robot navigated using IR sensors?
   a. navigation in a maze with white walls
   b. tracking a white line in black background
   c. navigating in dark environment
   d. navigation in bright daylight

19. 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)
   a. 0.51 m b. 0.17 m c. 1.53 m d. 1.02 m

20. The communication protocol used by the boot loader to communicate with the robot development board is
   a. USB b. RS232 c. RS422 d. RS485

21. What types of motors are generally used in hobby robotics?
   a. brushed DC motor, AC motor, RC servo motor
   b. brushed DC motor, stepper motor, RC servo motor
   c. AC motor, stepper motor, RC servo motor
   d. brushless DC motor, Stepper motor, RC servo.

22. 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

23. 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.

24. The most common small robot controller is
   a. P controller b. PD controller c. PI controller d. PID controller

25. A servo system does not generally contain
   a. a DC motor b. a gear reducer c. a shaft encoder d. a speed sensor

26. Speed of a DC motor is proportional to the
   a. PWM signal frequency. b. voltage. c. current. d. stator magnetic strength.

27. If the TIMER0 of PIC 18f452 has been configured 10bit, PS=2 (prescaler) with 40 MHz external oscillator, what will be the time taken for a one timer counter?
   a. 0.1 us b. 0.4 us c. 0.25 us d. 0.8 us

28. The maximum PWM resolution that can be achieved using PIC18F452 is
   a. 1024 b. 512 c. 256 d. 128

29. How many analogue pins are available in PIC18f452 micro controller?
   a. 5 pins b. 8 pins c. 10 pins d. 12 pins

30. 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 360deg
   d. it does not allow speed control

31. A switch sensor can be used for
   a. contact sensing
   b. collision detection
   c. limiting rotation
   d. all of the above tasks

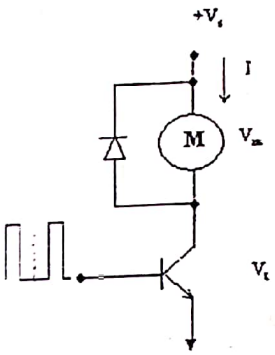
32. What does the C18 instruction "TRISCbits.TRISC7 = 1 stand for?
   a. Setting PORTC7 pin direction as input
   b. Setting PORTC7 register value as 1
   c. Setting PORTC7 pin direction as output
   d. Setting TRISC7 register direction as input

TRISCbits.RC7 = 1 (C7) make it input.
TRISCbits.RC7 = 0 make it output
PORTCbits.RC7 = 1 output value of C7 is High.

33. 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. written on the motor cover plate

34. Which of the followings can directly be controlled by the current through a DC motor?
   a. torque on the motor shaft.
   b. speed of the motor.
   c. the voltage across the terminal
   d. all of the above

35. A PWM motor control circuit is shown in the figure. Which of the following statements is not true about it?
   a. motor draws roughly 2/3 of the rated power
   b. motor runs at roughly 2/3 of its rated speed
   c. motor draws roughly 2/3 of the rated current
   d. diode conducts when the transistor is OFF



36. Motor driving IC should be able to
   a. deliver rated current of the motor intermittently
   b. deliver stall current of the motor at rate speed
   c. deliver rated current of the motor continuously
   d. deliver the stall current of the motor continuously

37. Which of the following could affect the sonar sensor reading?
   a. Width of the object.
   b. Inclination of the surface to the sonar beam.
   c. Surface material of the object.
   d. (a) and (b)

38. 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

39. For DC motor control using PWM, the acceptable PWM frequency range should be
   a. 20Hz – 200Hz
   b. 2KHz – 1MHz
   c. 2MHz – 20 MHz
   d. 1KHz – 20KHz

40. 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

50Hz pulse value

41. A servo motor turns 90 degree and 180 degree 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?

(a) 22.5 ms b. 26.25 ms c. 21.25 ms d. 18.75 ms

42. Torque of a DC motor is proportional to

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

43. Which of the following methods will not reduce the adverse effects due to ambient light in IR sensors?

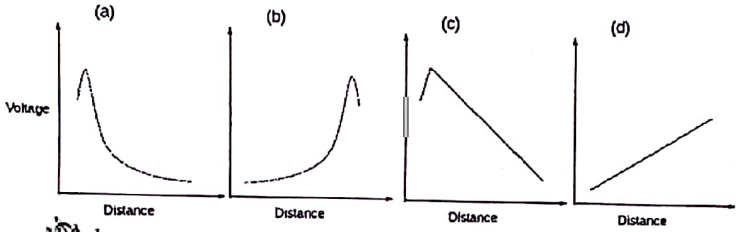
(a) Use a shutter in front of the sensor and open it only at the time of reading

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

44. 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

45. A motor control board is rated for 6V. Which of the following statements is not true about this board?

a. you can drive a 9V motor from the board at 66% duty

b. a 5V motor will run faster when driven by the board

c. you can drive a 9V motor from the board at slow speeds

(d) you can continuously drive 4V motor from the board

46. Suppose there is an encoder with a resolution of 1000 per revolution. What is the minimum prescaler value of the TIMER0 such that it will not overflow before one rotation of the wheel? (TIMER0 is 8-bits wide)

a. 1 to 2 b. 1 to 4 c. 1 to 8 d. 1 to 16

47. The components of a RC servo motor are

a. Stepper motor, Motor driver, Gear system, Electronic control circuit.

b. DC motor, Motor driver, Gear system, Optical encoder, Electronic control circuit.

(c) DC motor, Motor driver, Gear system, Potentiometer, Electronic control circuit.

d. AC motor, Motor driver, Gear system, Optical encoder, Electronic control circuit.

48. Choose the correct statement regarding encoders

a. Phase shift encoders can decide direction of rotation

b. Quadrature shaft encoders output 4 pulse trains, with phases 0, 90, 180 and 270 degrees

c. The two commonly used encoder types are optical encoders and magnetic encoders

(d) An absolute encoder needs no initialization and generates a parallel bit stream

49. When the control signal is applied to a servo motor, it starts rotating quickly and gradually slows down as it reaches the reference position. What could be the reason for this motion profile?

a. To allow the user to indirectly control the speed of rotation.
b. In order to quickly come to the desired position while avoiding overshoot.
c. To reduce power consumption of the motor.
d. To reduce the complexity of the control circuit.

50. 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