UNIVERSITY OF MORATUWA
Faculty of Engineering
B.Sc. Engineering
Level 2 – Semester 1 Examination
EN 2060 – ROBOT DESIGN AND COMPETITION

Time Allowed: **1 hour and 30 minutes** January 2010

INSTRUCTIONS TO CANDIDATES

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

This paper has two sections: **Section A** and **Section B**. Both sections and all questions in them are compulsory.

Section A carries **30%** of the final grading. **Section B** carries **10%** of the final grading.

Section A contains 45 multiple-choice questions (MCQ) in 6 pages (page 3 to page 8). Use the paper provided for answering for this section.

Section B contains 2 essay type questions. Use the answer booklet for answering

Section A
[carries 30% of the final grading]

1. Which of the followings is not involved in A/D convertion of a PIC microcontroller?
   a. Channel
   b. Voltage reference source
   c. Duty cycle
   d. Clock source

2. In a four-phase unipolar step motor
   a. 8-step sequence doubles the resolution of motion
   b. 8-step sequence increases torque by 1.4 times
   c. energizing two coils at a time increases resolution of motion
   d. energizing two coils at a time doubles the torque

root 2 times

winch motor
can change direction,speed by giving pulse width
DC motor
use H bridge to change the direction

3. Proper implementation of pulse width modulation (PWM)
   a. needs a very high switching frequency
   b. is used for speed control of DC motors
   c. is used for servo position control
   d. can be used for step motor control

use 1 kHz normally

Use PWM for - DC motors - speed of the moter
Servo motor - angle

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

5. Refering to the figure 1, the error amplifier
   a. is an operational amplifier with positive feedback
   b. always tries to minimize the difference between inverting (negative) and non-inverting (positive) inputs by driving its output in the appropriate direction
   c. is an electronic circuit which converts a pulse width signal to a voltage signal
   d. is a position sensor

not transmit IR

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

active sensors eg: IR sensors - pass the signal and deside the step
passive sensors

7. The register that is used to set the direction of PIC microcontroller pins is
   a. INTCON
   b. STATUS
   c. PIR
   d. TRIS

ADCON - A/D converter ON / OFF

8. 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

9. The block C in figure 1 is

a. a position sensor
b. an error amplifier
c. a pulse width to voltage converter
d. a pulse generator

10. In an active IR sensor

a. there is only IR detector
b. there is only IR transmitter
c. both IR emitter and detector exist
d. there is IR reflector

11. How can you identify different coils of a stepper motor?

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

12. A PWM motor control circuit is shown in figure 2. 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

13. A servo system does not generally contain

a. a DC motor
b. a gear reducer
c. a shaft encoder ← position detector
d. a speed sensor

14. Which of the following statements most accurately describes 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

15. Which of the following statements is not true about unipolar stepper 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

16. If the external oscillator of a microcontroller (PIC18f452) has a value of 40MHz, then what is the time taken to execute one instruction cycle?
   a. 25ms
   b. 40ms
   c. 100us
   d. 200us

$\frac{1}{40 \times 10^6}$

1×10^{-7} s

17. DC motor torque is proportional to
   a. PWM frequency
   b. motor current
   c. motor speed
   d. motor voltage

18. How many analogue pins are available in the PIC18f452 microcontroller?
   a. 5
   b. 10
   c. 8
   d. 12

19. 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

20. 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

21. Which of the followings is not applicable for asynchronous serial transmission?
   a. baud rate — data rate — while programming
   b. voltage level
   c. modulation frequency
   d. communication protocol

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

23. 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

24. Which of the following devices can be used for bidirectional dc motor control?
    a. triac
    b. H-bridge
    c. relays
    d. diodes

25. 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

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

Max232 - IC - convert 13V to 5V in serial communication Protocol

27. 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

28. The standard servo pulse period is
    a. 20us
    b. 2ms
    c. 1us
    d. 20ms

50 Hz

29. Wheel speed measurement in low speed is to be done
    a. by counting pulses of a break-beam sensor
    b. by measuring time between break-beam pulses
    c. by using a tachometer
    d. by using a distance sensor

30. 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

31. 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

answer

devided to layers
sence plan act
subsumption
three layer

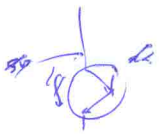
32. Which of the following scenarios can easily distract a mobile robot navigated using IR sensors?
   a. navigation in maze with white walls
   b. tracking a white line in black background
   c. navigating in dark environment
   d. navigation in bright daylight

33. How can you use a 9.6 V battery to drive a 6 V servo motor?
   a. do not worry about the little extra voltage
   b. use a resister to drop the voltage
   c. not possible
   d. use IN4001 diodes to drop the voltage

34. 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. 6.8cm.
   b. 3.4cm.
   c. 1.7cm.
   d. 7.2cm.

50μs × 340
1.7cm.

35. Pull-up resisters are used in sensor interfacing to improve
   a. dynamic range
   b. response time
   c. linearity
   d. sensitivity



36. 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.

37. 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

38. 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

$(PR_2+1)\, T_{osc} \times 4 \times$ prescaler

39. For a DC motor control using PWM, the acceptable frequency range for the PWM frequency is

a. 20Hz – 200Hz servo
b. 1kHz – 20kHz
c. 2KHz – 1MHz
d. 2MHz – 20 MHz

40. 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

41. The recommended maximum voltage for analogue input in PIC18f452 is

a. 3.3 V
b. 5 V
c. 6 V
d. 12 V

42. Which of the followings is possible for a PIC18f452 microcontroller?

a. drive a stepper motor
b. drive servo motor with encoder feedback
c. output an analogue signal
d. read analogue inputs

43. Refering to the figure 1, if the circuit finds the angle position of the RC servo motor is not correct

a. the motor shuts off
b. the motor will turn for 180 degrees
c. it will always try to minimize the difference between the inverting (negative) and non-inverting (positive) inputs by driving its output
d. it will stop implementing PWM

44. Maximum resolution of the A/D converter of PIC18F452 is

a. 128 bits
b. 256 bits
c. 512 bits
d. 1024 bits 10 bit

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

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

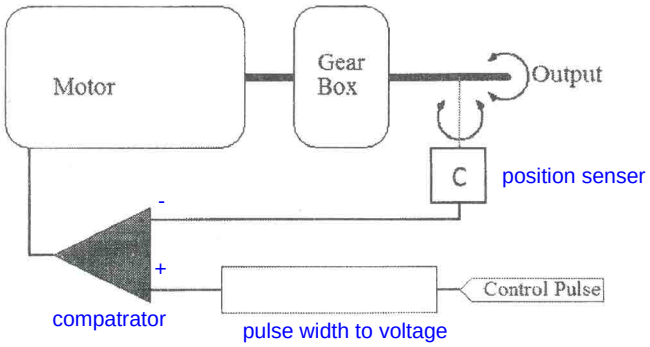


Figure 1

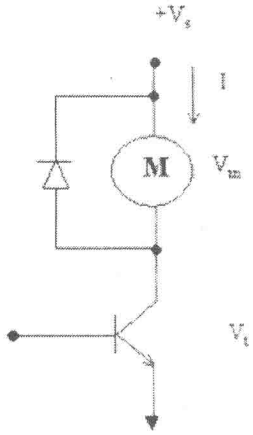


Figure 2

Section B
[carries 10% of the final grading]

Question 1

a) Mention the protection circuits used in power supply when driving microcontroller circuits and other ICs on a single board. Draw necessary diagrams to clarify your answer. **[10marks]**

b) Mention the protection methods and circuits used in designing a DC motor controller **[7 marks]**

c) Draw a basic schematic diagram of a DC motor controller circuit including the protection circuits that you have mentioned above. **[8 marks]**

Question 2

a) Compare the features and advantages of using the PIC18F452 microcontroller instead of the PIC16F877A microcontroller for your robot applications. **[6 marks]**

b) Explain how you can interface a digital encoder module to the microcontroller to get a feedback of the motor movement. Draw the necessary circuit and interfacing diagrams of the motor, encoder, and the microcontroller. **[9 marks]**

c) Extend your circuit to measure the rotation speeds and distances travelled of each motor in a two-wheel robot to increase the quality of line following. Mention the methodologies and algorithms used (diagrams if needed) to clarify your answer. **[10 marks]**