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

2. 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

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

4. 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. 25 ms b. 40 ms c. 100 us d. 200 us

5. Which of the following techniques is more appropriate for wheel speed measurement at low speeds?
   a. Counting pulses using a break-beam sensor
   b. Measuring time between break-beam pulses
   c. Use a tachometer
   d. Use a proximity sensor

6. Maximum resolution of the A/D converter of PIC18F452 is
   a. 128 bits b. 256 bits c. 512 bits d. 1024 bits

7. 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

8. Which of the following devices can be used for bidirectional dc motor control?
   a. Triac b. H-bridge c. Relays d. Diodes

9. 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

Continued...

10. 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

11. 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

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

13. 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.

14. 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.

15. A motor control board is rated for 6 V. 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

16. The output voltage of an unregulated 12V power pack used in robot control boards is measured when is not connected to the robot. The reading will roughly be
   a. 12 V b. 10 V c. 15 V d. 13 V

Continued...

17. Referring to the Figure 1, which of the following statements is true about the error amplifier?

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

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

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

19. 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

20. 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

21. A PWM motor control circuit is shown in the 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

22. 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

$3Y0 \times 10 \times 10^{-6}$

23. 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.

Continued...

24. 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

25. 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.

26. Torque of a DC motor is proportional to
a. motor current
b. PWM frequency
c. motor voltage
d. motor speed

27. For which of the following applications passive IR sensors could commonly be used?
a. To measure IR intensity
b. To measure distance
c. To measure humidity
d. To measure temperature

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

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

30. 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.

Continued...

39. Which of the following is not a characteristic of SRF04 ultrasound sensor?
   a. It has a wide view of angle
   b. It has a larger depth of view compared to IR sensor
   c. It can be used to measure the velocity of a moving object
   d. It gives the round trip time taken by the reflected sound wave

40. Select from the following attributes the one which has no effect on the echo strength of an ultrasound sensor.
   a. The color of the object surface.
   b. The distance from the object to the receiver.
   c. The texture of the object surface.
   d. The material used to build the object.

41. Which of the following techniques is effective in eliminating the spikes on the output voltage of the SHARP GP2D120 IR sensor?
   a. Taking average of the voltage reading samples.
   b. Reducing time between two consecutive readings.
   c. Taking average of the defined set of recent samples.
   d. Taking the middle value of the defined set of recent samples.

42. A servo motor turns 90 degree and 180 degree positions for a 1.5 ms and 1.75 ms pulse widths respectively. The motor takes 900 ms 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. 26.25ms b. 21.25ms c. 18.75ms d. 22.5ms

43. Which of the following is the most significant realistic impact if the servo motor is driven using the CCP module of the microcontroller PIC16F877A in PWM mode?
   a. It will give better control over the operating range of the motor because there are 256 levels.
   b. It will enable us to signal the motor using a higher frequency square wave.
   c. It will enable speed control of the servo motor.
   d. It will greatly reduce the usability as the usable range of PWM duty ratios for driving the motor is small.

44. What is the most practical way of generating the square waveform to drive the servo motor?
   a. The CCP module in PWM mode
   b. Using timer generated signals with interrupts to control timing.
   c. Running a while loop inside the main function and controlling the driving pin voltage.
   d. Use a separate microcontroller to drive each motor.

Continued…

45. Select the correct statement regarding supplying power to a servo motor that is usually used in robots.

a. It is recommended not to share servo power rail of the control board with other modules.
b. The recommended way to supply is from the microcontroller board.
c. It is recommended to use a separate battery for servo motors.
d. A servo motor runs only on 12V.

46. PIC16F877A has three built in timers. The first one is the Timer0 module. This is an 8-bit counter and counter value is located at TMR0 register. If the TMR0 value is 255 (0xFF) and it is incremented by one, then the TMR0 register will become 0 (0x00) and the TMR0 interrupt shall be raised. The Timer0 module uses some bits from the OPTION_REG register for setting it up.

OPTION_REG REGISTER

R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1
$\overline{\text{RBPU}}$	INTEDG	T0CS	T0SE	PSA	PS2	PS1	PS0
bit 7							bit 0

bit 7 **$\overline{\text{RBPU}}$**

bit 6 **INTEDG**

bit 5 **T0CS**: TMR0 Clock Source Select bit
1 = Transition on T0CKI pin
0 = Internal instruction cycle clock (CLKOUT)

bit 4 **T0SE**: TMR0 Source Edge Select bit
1 = Increment on high-to-low transition on T0CKI pin
0 = Increment on low-to-high transition on T0CKI pin

bit 3 **PSA**: Prescaler Assignment bit
1 = Prescaler is assigned to the WDT
0 = Prescaler is assigned to the Timer0 module

bit 2-0 **PS2:PS0**: Prescaler Rate Select bits

Bit Value	TMR0 Rate	WDT Rate
000	1 : 2	1 : 1
001	1 : 4	1 : 2
010	1 : 8	1 : 4
011	1 : 16	1 : 8
100	1 : 32	1 : 16
101	1 : 64	1 : 32
110	1 : 128	1 : 64
111	1 : 256	1 : 128

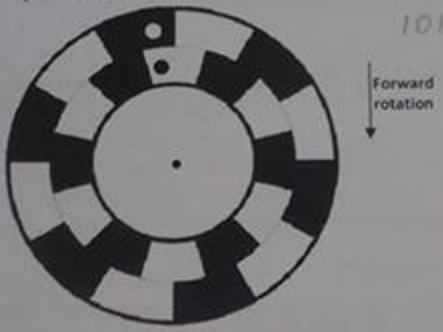
The prescaler is set to Timer0, whose value is 0x00. The 3 PS bits (OPTION_REG <2:0>) have the value '101'. After how many counts the TMR0 Interrupt will occur?

a. After 16384 counts
b. After 16320 counts
c. After 255
d. After 64

Continued...

47. Which of the following is the code segment to set-up the Timer0 module to count the encoder pulses present at the TOCKI pin.
   a. TRISA.F4 = 1; OPTION_REG = 0b00011100;
   b. TRISA.F4 = 0; OPTION_REG = 0x38;
   c. TRISA.F4 = 1; OPTION_REG = 0x28;
   d. TRISA.F3 = 1; OPTION_REG = 0b00110100;

48. Following illustration is a simple design of an optical encoder which is capable of handling the direction of rotation. White and black dots represent two optical sensor units which are placed on the outer encoder wheel and the inner encoder wheel respectively. Which of the following is the synchronized pattern combination of outer and inner sensor units for forward motion if sensor output is 1 for black?



   a. 01100110 and 11001100
   b. 10011001 and 11001100
   c. 01010101 and 10101010
   d. None of the above is possible

49. Within the specified range, the output voltage of the SHARP GP2D120 IR sensor
   a. linearly decreases with the increase of obstacle distance.
   b. is inversely proportional to the obstacle distance.
   c. linearly increases with the increase of obstacle distance.
   d. is inversely proportional to the intensity of the light that falls on.

50. In which of the following applications an ultrasound range sensor can be used?
   a. To detect a vehicle coming towards the sensor with a velocity of 10m/s.
   b. To detect an object that is 3mm away from the sensor.
   c. To detect an object that is 10^0 inclined to the axis and 50mm away from the sensor.
   d. To detect a vehicle moving away from the sensor with a velocity of 5m/s.

Continued