1) Outline the difference between a Jump instruction and a conditional Jump instruction.

2) What would be the result in register AL if the instruction SHR AL, CL, where AL contains 8Ah and CL contains 3h, is executed? If the command SHR is replaced by SAR a different answer is obtained. Explain why this occurs giving the new result.

3) What would be the result in register AL if the instruction ROL AL, CL, where AL contains 2Ah and CL contains 5h, is executed? If ROL is replaced by RCL, what would be the new result?

4) Write the instructions that would negate the current value in register AL and then mask the lowest two bits.

5) A relay connected to bit 5 of port 56h needs to be toggled after a small delay. Assuming that this delay is obtained by loading CX with 05FFh, write a small program that implements the above.

6) Write a program that performs the following mathematical operation, storing the result in AH: 9Fh + 25h – 4Ah.

7) A non-linear pH meter reads the pH of the liquid in volts (range 0 – 110) by means of a probe connected at port 5Fh. Write a program that converts this voltage to pH according to the formula given below and outputs the value on an LCD display at port 01E8h. \( PH = ((\text{volts} + 15) \times 5) / 45. \)

8) Write a program to find the lowest among 8 grades and write the result in register DL. The grades are: 89, 78, 84, 65, 54, 48, 68, and 59.

1) By using a suitable diagram, indicate how the following definitions will be written in the data segment:

```
VAR_1 DB  ?
VAR_2 DW 3452h
VAR_3 DB 11010110b
STR_1 DB “TESTING”
VAR_4 DT  ?
NUM_1 DB 3, 5, 6, 8
```
9) Write a program that reads a byte of data from port 45h and after processing this value, outputs the result to port 6Ah. The processing of the data consists in multiplying the value by four, decrements the result by 1, and ANDs the result with FEh. The output is held for a certain time (for delay procedure take CX = 2435h) before repeating the sequence. During the program execution an interrupt on NMI can occur. When this happens the program outputs FFh to the output port to indicate an alarm and calls the delay procedure to keep this signal on for some time.

10) Explain line by line the function of the following programs:

a) CODE SEGMENT
ASSUME CS: CODE, DS: CODE, SS: CODE
ORG 0
START: MOV SP, OFFSET TOP_OF_STACK
TOP:
   IN AL, 0A2H
   CMP AL, 54H
   JA NEXT
   ADD AL, 25H
NEXT:
   OUT 07H, AL
   MOV CX, 0E45H
SELF:
   LOOP SELF
   JMP TOP

DB 25 DUP (?)
TOP_OF_STACK: DB 0
CODE ENDS
END START

b) CODE SEGMENT
ASSUME CS: CODE, DS: CODE, SS: CODE
ORG 0
START: MOV SP, OFFSET TOP_OF_STACK
   XOR AX, AX
   MOV ES, AX
   MOV WORD PTR ES:08H, OFFSET ISR_ROUT
   MOV WORD PTR ES:0AH, 50H
   MOV AL, 90H
   OUT 7, AL
   MOV AL, 1
   TOP:
   OUT 3, AL
   CALL DELAY
   ROL AL, 1
   JMP TOP

DELAY:
   PUSH AX
   IN AL, 1
   MOV CL, 0
   MOV CH, AL

Dr Ing. Carl James Debono
ONE:   PUSH CX
       MOV CX, 0F0CEH
SELF:  LOOP SELF
       POP CX
       LOOP ONE
       POP AX
       RET
ISR_ROUT: PUSH AX
          MOV AL, 0FFH
          OUT 7, AL
          CALL DELAY
          POP AX
          IRET

DB 25 DUP (?)
TOP_OF_STACK: DB 0
CODE ENDS
END START

11) Assuming a 4 MHz clock calculate the time required to execute the following:

   MOV AX, 0165H
   ADD AL, 32H
   MOV CX, 50H
   L1:   DEC AL
         LOOP L1
   OUT 9, AL

12) Calculate the value of CX to obtain a 25ms delay in the following program:

   MOV CX, ?
   L2:   LOOP L2

   Assuming a frequency of 4 MHz.

13) Hand assemble the following program:

   IN AL, 50H
   MOV CL, AL
   MOV BL, 45H
   ADD BL, CL
   INC AL
   MUL AL, BL
   OUT 45H, AL
   MOV AL, AH
   OUT 46H, AL

14) Describe the I/O read and I/O write cycle timing of a parallel port.

Dr Ing. Carl James Debono
15) Describe the hardware required for a parallel output port.

16) Describe the hardware required for a parallel input port.

17) Explain the technique for asynchronous serial communication.

18) Describe the requirement of a UART.

19) Compare the asynchronous to synchronous serial communications.

20) Synchronous serial communications can use two protocols, discuss.

21) Describe interrupt driven I/O.

22) By the use of block diagrams, describe the function of the 8255 PPI chip.

23) The 8255 has to be programmed for the desired operating mode and I/O configuration, indicate how the different control words will program this chip.

24) What are the functions of the 8255 programmed in Mode 0.

25) What are the functions of the 8255 programmed in Mode 1, indicating also the timing required.

26) What are the functions of the 8255 programmed in Mode 2.

27) By the use of block diagrams, describe the function of the 8259 PIC chip.

28) Describe the four 8259 initialization control words.

29) Describe the three 8259 operation control words.