Correct answers are made bold and underlined. For some questions, multiple correct answers were accepted.

1. Which of the following is true about interrupts:
   a. I/O devices must send clock synchronised interrupt requests to the processor.
   b. The Interrupt Service Routine is the routine that services interrupt initialization, it runs at startup to enable interrupts and mask unused interrupts.
   c. It is good practice to use infinite loops inside of interrupt service routines.
   d. **None of the above**
   e. All of the above

2. Select the item that best describes the reason why one cannot use an interrupt-based delay function inside an interrupt service routine (ISR), after entering the interrupt and masking all interrupts:
   a. **The interrupt that tells us that the delay is done never arrives and the program can freeze/deadlock.**
   b. The code used to create ISRs can only include a specific set of libraries, none of which contain delay functions.
   c. Delay functions are not available at all for microcontrollers.
   d. This is not an issue, in fact interrupt-based delays are used all the time in ISR functions.

3. In Lab 1 you used a numbered keypad. Considering a similar keypad, what would happen if you set more than one row of the keypad HIGH simultaneously and press a button in one of those rows?
   a. A button press would engage the pull-down resistor, but because multiple rows are HIGH the column would not successfully pull to LOW, and the interrupt would not trigger.
   b. A button press would trigger the interrupt, but the interrupt handler would return the first row that was set HIGH.
   c. **A button press would trigger the interrupt, but we wouldn't know what row it belongs to.**
   d. A button press would trigger the interrupt and the interrupt handler would return the correct row, but it would take longer than if rows were set HIGH sequentially.

4. Internal interrupts are _____ and external interrupts are _____ to the program.
   a. **Synchronous, asynchronous**
   b. **Asynchronous, asynchronous**
   c. Asynchronous, synchronous
   d. Synchronous, synchronous

5. How can the processor ignore other interrupts when it is in the process of servicing one?
   a. By turning off the interrupt request line
   b. If the other interrupts are maskable, by applying a mask to the register which selects the interrupts.
   c. **Both a. and b.**
   d. Neither a. nor b.

6. An interrupt that can be temporarily ignored is called a:
   a. Vectored interrupt
   b. Non-maskable interrupt
   c. **Maskable interrupt**
   d. High priority interrupt

7. Which of the following would reduce quantization error when reading a voltage using an ADC:
    a. Increasing the sampling frequency.
    b. Decreasing the sampling frequency.
    c. **Increasing the number of bits used to represent the voltage sample.**
    d. Increasing the range of voltages the sensor can detect.

8. The code below shows the `while(1)` loop in a platform similar to the one used in the lab. The program reads from the ADC before sending data to the DAC.

```
while (1) {
    HAL_ADC_Start(&hadc3);
    HAL_ADC_PollForConversion(&hadc3, timeout);
    adc_res = HAL_ADC_GetValue(&hadc3);
    sprintf(message, "adc_res=%d\r\n", adc_res);
    print_msg(message);
    HAL_DAC_SetValue(&hdac, DAC_CHANNEL_1, DAC_ALIGN_12B_R, adc_res & mask);
}
```

Which of the following actions would most significantly impact how frequently the output is generated?
    a. Using mask to remove the lowest 8 bits from the sampled signals.
    b. Moving HAL_ADC_Start out of the while loop.
    c. Changing &adc3 to &adc2.
    d. **Removing the print functions.**

9. You are looking to buy an ADC for an application that requires measuring 1000 discrete values between 0 - 3 V. At "*ADCs 'R' Us*" you see 4 ADCs that all have a fixed range from 0 - 4 V but with varying resolution. Which ADC should you buy that has the **minimum** number of bits of resolution to meet your application's needs?
    a. 10 bits
    b. **11 bits**
    c. 12 bits
    d. 13 bits

10. Consider the two's complement signed value 0x1111 1111. What is the decimal value of this number for an 8-bit and a 9-bit representation, respectively?
    a. 1, 255
    b. **-1, -255**
    c. -1, 255
    d. 255, 255

11. You want to use a Look-up Table to create a sine wave. However, memory is very limited, so you want to store the **absolute minimum** number of points needed. You have 8 samples per period. Which of the following allows you to do so, while still being able to produce a correct output?
    a. **Quarter period**
    b. Half a period
    c. Full period
    d. Two periods

12. Suppose you need to add twenty-three numbers together, each of UQ2.14 representation. While you can tolerate loss of precision, you can not have overflow. Which 16-bit numerical representation should you use for the output sum to minimize loss of precision in this case?
    a. UQ7.14
    b. UQ7.9
    c. Q7.8
    d. Q8.7

13. How many bits are needed to represent a Q14.14 format number?
    a. 14
    b. 15
    c. 28
    d. 29

14. Suppose 1111 1100 is expressed in fixed point UQ3.5 format, what is this number in fixed point Q5.3 format including all leading bits?
    a. 1111 1000
    b. 0011 1110
    c. 1 1111 1000
    d. 0 1111 1000
    e. 0 0011 1111

15. Express 5.125 in UQ3.5 format
    a. 1010 0100
    b. 0101 0010
    c. 0101 0101
    d. 1010 0101

16. Which operation casts a fixed point Q3.12 variable f to an integer?
    a. f >> 12
    b. f << 12
    c. (int) f
    d. (uint16_t) f

17. You have 3 variables, $x = 10^{30}$, $y = -10^{30}$, and $z = 1$, that are all represented using IEEE single precision floating point. What does $x + (y + z)$ equal?
    a. 0
    b. 1
    c. $-\infty$
    d. ∞
    e. Undefined

18. Using the same values as x, y & z as the previous question, what does $(x + y) + z$ equal?
    a. 0
    b. 1
    c. $-\infty$
    d. ∞
    e. Undefined

19. Which of the following is false for the I2C bus?
    a. Master is the only device that can initiate data transfer.
    b. Master is not the only device that controls the SDA line.
    c. **The SDA line must not change while SCL is high.**
    d. When two masters attempt to control the SDA line, there will be arbitration. The loser will wait and attempt again.

20. In the I2C bus a master uniquely identifies each slave with:
    a. **A predefined, hardcoded address.**
    b. A unique chip select control line.
    c. An arbiter.
    d. Multiple data channels at high clock frequency.