

IIT JODHPUR

Minor-2 Examination: EEL3090 Embedded System (Mar'24)

Guidelines (Total time: 60 minutes, Maximum Marks: 15):

- Please read the question paper very carefully (both sides of this paper).
 - **NO clarification is required in any question. If you ask the invigilator any question, -5 marks penalty would be awarded.** In case of any doubt, assume whatever you wish to and state that in your answer.
 - Please provide all steps of your answer very clearly.
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1. Suppose that we are designing an embedded application that is to be executed with the help of a hardware timer available on the microcontroller board. We have got the information from the datasheet that the counter for this timer faces overflow when the reload register reaches the value of 1299. Given that the clock period is 50 microseconds, explain what is the value of $5 \times (\text{counting period})$ in ms in this scenario? [1]
2. Assume that students of IITJ are asked to design microcontroller-based alarm system. The students have access to a MCU development board that has a clock driven by 62.5 pF capacitor (C) and 1 Kohms resistor (R). This alarm system should generate an interrupt every T seconds using a specially designed SysTick timer that has a VALUE register of 28 bits. Find the maximum value of T that can be obtained? Hint: The reference clock frequency is given by the reciprocal of multiplication of R and C values in any MCU. [1.5]
3. A servo motor is controlling some critical control-related component in avionics. The motor is basically driven by a PWM signal generated from the timers on the MCU present in the flight system. The MCU has got ARR programmed at some value and the CCR programmed as 0x1F3F. If the duty cycle of the PWM output is 40%, find the content of ARR? [1]
4. For some embedded application, it is targeted to use pins PB2 and PB3 for toggling LEDs. When the LEDs are ON, the contents of GPIOB— >ODR are observed and the lowest four bits are understood as the resolution setting for an ADC to be interfaced on PortE. The input at PE0 is known as 10 V and the ADC output is fed to an alarm (where amplitude of sound output depends on the digital output of ADC). Find out how many different amplitudes of sound that can be created by this alarm? [1.5]
5. Assuming a timer 2 (which is 32-bit timer) channel 1 in input capture mode on an STM32 microcontroller with a clock frequency of 80MHz and a prescaler value (i.e., the division factor) of 4, what is the maximum measurable pulse width of a square wave signal that we are receiving from an enemy radar device with a frequency of 50kHz? If the value of the capture/compare register (CCR) at the rising and falling edge of the signal are respectively known as 0x02E8 and 0x0BB8 in hex, respectively, what is the pulse width of the signal in microseconds? [1 + 1.5]
6. Consider that an alarm-based digital system is designed with digital to analog converter (DAC) to output a cosine wave using SysTick Interrupts and a cosine-wave table. Assume the DAC has 10 bits, the DAC output is connected to a speaker (alarm), the SysTick Interrupt Service Routine (ISR) executes at 32kHz, the cosine table has 1024 elements, and one DAC output occurs at each interrupt. The DAC output range is given as 0 to 5.2V. What is the frequency at which sound is produced (in Hz) by the speaker? [1.5]

7. In a MCU board, an ADC is programmed for converting analog voltages with a sampling time of 50 cycles and the ADC clock is driven by a slow peripheral clock of 6200 KHz (to be divided by a factor of 2). In the same board, a SysTick timer is programmed with 65536 in its LOAD register and is having an input clock of 6400 KHz. This ADC generates an interrupt after every conversion. The MCU board employs a smart interrupt controller that prioritizes the interrupt that arrives first to it and simply drops the other interrupt by putting it in the “pending list” and setting the pendency interval to infinity. With a proper explanation, find the frequency at which this smart interrupt controller is servicing the interrupts in this embedded system? Hint: The conversion time of the ADC is given by adding 12 cycles to the sampling time indicated in the datasheet of the MCU board. [2]
 8. Consider a 32-bit timer with auto-reload register operates in down count mode i.e. it starts counting from the value loaded in ARR register. The input clock frequency is known as 10 MHz and prescaler (PSC) register can be loaded with any of these three values: 3, 7 and 15. Suppose it is needed to produce delay of 04 seconds, explain with calculations, values to be loaded in ARR and chosen prescaler(PSC). [1.5]
 9. Assume that we are providing an analog input of 1.25 V to a specially designed ADC targeted to work for 0 to 2.5 V range and supporting 18 bit output format. Explain with steps the hexadecimal equivalent of output corresponding to this analog input? [1]
 10. Pins of GPIOA of a particular MCU board can change its output voltage from 0 to 500 mV in 10 microseconds. Suppose pin PA0 is sending asynchronous serial data to another peripheral and we observe the bits in the sequence ...1,1,1,0,1,1,0,0,0,1,1,1,1,0,0... respectively at the time-stamps of ...500,520,540,560,580,600,620,640,660,680,700,720,740,760,780.... microseconds. The useful data-item out of this data-stream is getting utilized for programming some pins of GPIOG as this data-item is getting written directly into GPIOG— >MODER register. Please identify which pins of GPIOG can be connected to an ADC for some analog-to-digital data conversion task? [1.5]
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