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(2) Question 1. Add more {energy, power, current, voltage} to get more bandwidth.

(6) Question 2. This system has a read-modify-write critical section in main.
(4) Part a) H) Remove the line `PTP ^= 0x40;`
(2) Part b) E) Minimally intrusive

(4) Question 3. A,B,CCR,X,Y,PC is 9 bytes.
(4) Question 4. A data flow problem where data is produced twice as fast as it is consumed.
D) The system does not work, but could be corrected by increasing baud rate
(4) Question 5. The capacitor behaves like I = CdV/dt
F) The dV/dt at 100ns will be about 5V/(**RC**)
(4) Question 6. Binary fixed-point is faster/easier for calculations
E) Signed 16-bit binary fixed-point with 2^{-8} resolution
(6) Question 7. output of one digital circuit is connected to the input of another digital circuit.
(2) Part a) Current sinks into the output when low
A) Right to left
(2) Part b) Current sources out of an output when high
B) Left to right
(2) Part c) Capacitance slows down digital signals. It takes longer to send each bit
B) The bandwidth decreases

(4) Question 8. The following waveform was measured on the PS1 output
(2) Part a) Bit time is 2ms, baud rate is 500 bits/sec.
(2) Part b) start,1,0,0,1,1,1,0,1,stop. $B9

(8) Question 9. There are three decimal fixed point numbers: **X** = **I**$*10^{-1}$, **Y** = **J**$*10^{-2}$, **Z** = **K**$*10^{-2}$.
(4) Part a) **Z**=**X***Y**. Substitute **K**$*10^{-2}$= **I**$*10^{-1}$ * **J**$*10^{-2}$.
D) K = (I*J)/10
(4) Part b) **Z**=**X**+**Y** Substitute **K**$*10^{-2}$= **I**$*10^{-1}$ + **J**$*10^{-2}$.
B) K = (10*I)+J

(4) Question 10. State the DAC parameter determined by each.
Part a) Resolution **Part b)** Precision **Part c)** Accuracy **Part d)** Monotonic

(4) Question 11. Get permission from the author and retain or add references to the author. If you cannot get permission, you can search for patent protection. If the theory is not protected by IP, then you could create your own implementation based on the theory.

(4) Question 12. $\delta V = \Delta V/\Delta t * \delta t$, where δV is the voltage error, $\Delta V/\Delta t$ is the slew rate of the input, and δt is the sampling jitter.

(4) Question 13. T_{life} = E/I, where T_{life} is the operating life of the product in hours. E is energy stored in the battery in amp-hr, and I is the average current used by the device in amps.

(2) Question 14. C0G X7R and Z5U refer to ceramic capacitor types. C0G is best.
(5) Question 15. Solve for noise, $40 = 20 \log_{10}(5V/\textbf{noise})$, $2 = \log_{10}(5V/\textbf{noise})$, $100 = 5V/\textbf{noise}$, thus **noise** = 50mV. 7 bits is enough. A 7-bit ADC has a resolution of 5V/128 = 40 mV.

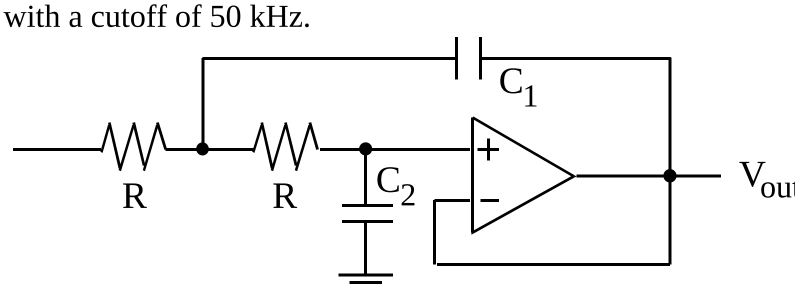
(5) Question 16. L293 or TPIC9197B are the two possibilities from the book.
(5) Question 17. Two bytes are transferred every 1 ms, one byte in each direction. 2000 bytes/sec.
(10) Question 18. There is a negative logic push-button interfaced to PP0.
(4) Part a) Show the ritual used to initialize the system, including interrupt enable.

```
void Key_Init(void){
  Count = 0;
  DDRP &= ~0x01;  // PP0 is input
  PPSP &= ~0x01;  // falling edge active
  PIEP |= 0x01;   // arm PP0
  PIFP = 0x01;    // clear flag
asm cli           // enable interrupts
}
```

(4) Part b) Show the Port P key wakeup ISR.

```
interrupt 56 void Keyhandler(void){
  PIFP = 0x01;    // clear flag
  Count++;        // key touch
}
```

(2) Part c) It takes about 1µs to execute the ISR once. The exact answer is 9 cycles to suspend main and launch ISR, 3 cycles for `PIFP=0x01`, 7 cycles for `Count++` assuming `Count` is 16 bits, and 8 cycles for RTI. This is a total of 27 cycles, which is about 1µs.
(10) Question 19. Design an analog LPF filter with a cutoff of 50 kHz.



2 pole Butterworth analog filter, R = 10 kΩ

1) select the cutoff frequency, f_c=100 kHz
2) divide the two capacitors by $2\pi f_c$
   $C_{1A} = 141.4\mu F/2\pi f_c =$
   $141.4\mu F/2\pi 40000 = 450$ pF
   $C_{2A} = 70.7\mu F/2\pi f_c = 225$ pF
3) Choose C_{1B} = 200 pF and C_{2B} = 100 pF
   let C_{1B}, C_{2B} be these standard value capacitors, let x be this factor
   $C_{1B} = C_{1A}/x$, x = 450/200
   $C_{2B} = C_{2A}/x$
4) adjust the resistors to maintain the cutoff frequency
   $R = 10k\Omega \bullet x = 22.5\ k\Omega$

(5) Question 20. This is a great FIFO. I found it as part of the Keil example files for the Arm. It is easy to change. It runs a little slower than the one in the book.
(2) Part a) “Yes it works”
(2) Part b) “There are NO critical sections”
(1) Part c) “Yes it works”