Assignment 1

3.

SAM4S8B (64LQFP package)	ESP32 (WROOM-32E module)	OV2640
VDDIN: 1.62V to 3.6V VDDIO: 1.62V to 3.6V VDDCORE: 1.08V to 1.32V VDDPLL: 1.08V to 1.32V	3.0~3.6V	Core: 1.2VDC Analog: 2.5~3.0VDC I/O: 1.7V to 3.3V

The minimum number of voltage levels:
Core: for SAM4S8B and OV2640, (1.08+1.2)max=1.2V; for ESP32, 3.0V
Analog: (1.62+3.0+2.5)max=3.0V
I/O: (1.62+3.0+1.7)max=3.0V

4.

Form datasheet: we need,
Frequency: 12 MHz
CL: 9.5 pF.
ESR: Lower ESR is preferred for stability.
Voltage Rating: VDDIO 1.62V to 3.6V.
Temperature Stability: -40°C < Temp < +105°C
Overall: DigiKey XC63M4-12.000-F09NJDTK is the best choose, because
Frequency: 12 MHz
Frequency Stability: ±30ppm
Frequency Tolerance: ±10ppm
Load Capacitance: 9pF
ESR (Equivalent Series Resistance): 45 Ohms
Operating Temperature: -40°C ~ 85°C
XC63M4-12.000-F09NJDTK Suzhou Hangjing Elec&Tech Co.,Ltd | Crystals, Oscillators, Resonators | DigiKey Marketplace

5.

The minimum number of standalone voltage regulators is 2
According to Dual Power Supply Strategy in the checklist and problem 3,
We need a standalone voltage regulator (5 to 3V) as Main supply and ADC, DAC, Analog comparator supply for SAM4S8B, ESP32, and OV2640.
Another standalone voltage regulator (5 to 1.2V) for the OV2640 core and SAM4S8B VDDCORE.

6.

Both regulators should operate from the 5V input power supply.
For 3V voltage regulator:
SAM4S8B, in Normal mode, the voltage regulator consumes less than 500 µA static current and

draws 80 mA of output current.
ESP32, peak current is 379 mA
OV2640, Power consumption: 125 mW at 15 fps in UXGA mode. Current requirement: I=P/V =125mW/1.2V ≈104.2mA
Total peck current: 80+379+104.2=563.2mA
So, DigiKey ADM7154ACPZ-3.0-R7 is the best choose, because
Voltage - Input (Max): 5.5V
Voltage - Output (Min/Fixed): 3V
Current – Output: 600mA
Current - Quiescent (Iq): 7 mA
Current - Supply (Max): 10 mA
Operating Temperature: -40°C ~ 125°C
ADM7154ACPZ-3.0-R7 Analog Devices Inc. | Integrated Circuits (ICs) | DigiKey

For 1.2V voltage regulator:
SAM4S8B, in Normal mode, the voltage regulator consumes less than 500 µA static current.
OV2640, peak current is 40 mA
So, DigiKey TLV77012PDBVR is the best choose, because
Voltage - Input (Max): 5.5V
Voltage - Output (Min/Fixed): 1.2V
Current – Output: 50mA
Current - Quiescent (Iq): 120 µA
Operating Temperature: -40°C ~ 125°C
TLV77012PDBVR Texas Instruments | Integrated Circuits (ICs) | DigiKey

7(a). 1 unit
Crystal: $0.46800
3V voltage regulator: $8.41000
1.2V voltage regulator: $0.10000
SAM4S8B: $6.00000
ESP32-WROOM-32E: $2.68000
OV2640: $0.99
Total: $18.648

7(b). 5000 unit
Crystal: $ $0.36800
3V voltage regulator: $3.62500
1.2V voltage regulator: $0.02001
SAM4S8B: $4.94000
ESP32-WROOM-32E: $2.68002
OV2640: $0.99
Total: $12.623

8(a). Awake and active
OV2640: Core (1.2V): 125 mA. Analog (3.3V): 60mA.
ESP32: Wi-Fi transmission (3.3V): 240mA.
SAM4S8B: Typical operation (3.3V): 36mA.
Total current draw:
125mA (core)+60mA (analog)+240mA (ESP32)+36mA (SAM4S8B)=461mA.
Battery Runtime=500mAh/461mA≈1.08hours.

8(b). Lowest power sleep mode
OV2640: Standby current: 600 μA=0.6 mA.
ESP32: Deep sleep current: 10 μA=0.01 mA
SAM4S8B: Backup mode: 1 μA=0.001 mA.
Total current draw:
0.6mA+0.01mA+0.001mA≈0.611mA.
Battery Runtime=500mAh/0.611mA≈818hours.

8(c). Sleep mode with periodic wake-ups
Awake current draw: 461mA for 5 seconds.
Sleep current draw: 0.611mA for 55 seconds.
Average current=[(461mA×5)+(0.611mA×55)]/60≈39.63mA.
Battery Runtime=39.63mA500mAh≈12.61hours.