Hardware

Mother	Supply	V-Amp	Sensor	u-Cont	Description	Example
					Circuit Design	
1	1	1	1	1	RCG	Complete, brief, relevant, meaningful
				5	Selection	Choose commercial board
2	5	5	3		Circuit	Design
	1	1	1		Protection	Fuses, opto-isolation
	2	2	2		Simulation	Relevant properties (power, transient repsonse, logic)
					PCB	
1	1	1	1	1	RCG	Complete, brief, relevant, meaningful
1	1	1	1		Organization	Grouping, alignment, easy to stuff
1	1	1	1		Area	Neither wasteful nor crowded, optimized
1	1	1	1		Silk screen	Clear, meaningful, complete
1	1	1	1		Cables & connectors	Choice, integration, orientation, cable interference
1	1	1	1		Mounting features	Stand-offs, mounting screws
1	1	1	1		Debug features	Test points, switches for simulation, trimmers
1	1	1	1		Traces	Widths, gaps, teardrops, ground planes
	1	1	1		Component packages	Justify choices, heat sinks,
11	18	18	16	7	**Sub-Total**	
		5			**Discretionary**	
		75			**Total**	

Glossary

Mother	Mother-board which integrates all cable connections and daughter boards. Physically mounted to mechanism.
Supply	AC/DC converter. Input = 120V AC. Output = DC voltages required by all daughter boards.
V-Amp	High I/P Z, low O/P Z, DC/DC converter. Input = Analog or PWM from u-Cont. Output = motor terminals.
Sensor	Digital state machine. Input = pulse train + control signals. Output = serial or parallel digital count.
u-Cont	Commercial micro-controller board. Ideally mounts as daughter board but may use ribbon cables.

Software

Joint 1	Joint 2	Amp	Motor	Mech	Sensor	u-Cont	Description	Example
							Controller Design	
1	1					1	RCG	Complete, brief, relevant, meaningful
		3	3	3	1	5	System Models	O2 Amp, Motor, Mechanism, Sensor, u-Controller & CF
1	1						Sensor Filter	Evaluation & Design
2	2						Derivative Filter	Evaluation & Design
5	5						10-Step Process	Using Matlab / Simulink
2	2						Heuristic Tuning	Using Simulink / SimulationX Co-Simulation
							Actuator Design	
1	1						RCG	Complete, brief, relevant, meaningful
2	2						Motor	Criteria for selection from Maxon Catalog
2	2						Gear Rato	Ratio, OTS Planetary, Custom Parallel-Axis
1	1						Sensor	Resolution
							C-Code	
						2	Homing Logic	Initialization using homing sensor
						2	Sensor Logic	Reading count from digital circuit each control cycle
1	1					2	Kinematics	Direct & Inverse
						3	Path Planning	Desing & evaluation
						4	Self-Documentation	C-Code structure & comments
						5	Testing	Evaluation & results
18	18	3	3	3	1	24	**Sub-Total**	
			5				**Discretionary**	
			75				**Total**	

Glossary

Joint 1	Shoulder joint of SCARA robot, & all associated components.
Joint 2	Elbow joint of SCARA robot, & all associated components.
Amp	V/V Amplifier circuit designed by hardware team.
Motor	Maxon Motor & Gear
Mech	Mechanism connected to output shaft of motor or gear
Sensor	Optical Encoder connected to motor
u-Cont	System-level code and specifications related to micro-controller performance

System

Base	Up-Arm	4-Arm	System	Description	Example
				Mech Design	
1	1	1	1	RCG	Complete, brief, relevant, meaningful
2	2	2		Structural	Support structure for shoulder joint
1	1	1		Covers	Base and arms, professional appearance
1	1	1		Interfaces	Shaft connections, parts, robot mount
1	1	1		Components	Appropriate choices, integrated into SW Assemblies
2	2	2		Stress & Strain	Optimized geometry to satisfy RCGs
			3	Cable Routing	Features for mounting PCBs & cable routing
			5	Assembly	Explosions & Animations
				SimulationX	
			2	RCG	Complete, brief, relevant, meaningful
			5	Complete	All inertias, frictions, acurate parts, materials
			5	Organization	Clear layout, visual adjustements.
			5	Adjustability	External parameters, references
			5	Results	Simulation outputs, verify RCGs, saturation & non-lin avoided
			5	Sensitivity	Effect of bearing wear & damage on performance
				Application	
			1	RCG	Complete, brief, relevant, meaningful
			3	Special features	Application-specific physical features implemented
			3	Efficacy	Ability to satisfy RCGs based on demonstrated performance
			3	Cost	Trade-offs, materials, components
8	8	8	46	**Sub-Total**	
		5		**Discretionary**	
		75		**Total**	

Glossary

Base	Support structure for shoulder joint
Up-Arm	Arm connecting shoulder and elbow
4-Arm	Arm connecting elbow and wrist
System	Entire mechanism