DC motors:

- Assumptions
- Worst-case rover mass m=80 kg
- Gravity g=9.81 m/s2
- Minimum 4 wheels in contact and sharing load (so per-wheel share = total / 4).
- Wheel diameter assumed D=0.14 m
- Coefficient of rolling resistance for rough terrain, Crr=0.10 (conservative).
- Uphill slope to handle: 20% grade (0.2).
- Gearbox efficiency ≈ 85% (0.85).
- Safety/roughness margin: ×2 on torque and power.

If any of those should change (wheel diameter, desired top speed, slope), all calculation would change

Rolling resistance:

Frr = Crr m g = 78.48 N

Grade (climb) force:

Fgrade = 0.2 mg = 156.2

Total traction force needed:

Ftotal = 98.1+196.2=235.3 N

Force per wheel and torque for a wheel:

Fwheel = Ftotal / 4 = 58.3 N

Torque = 76.3 X 0.07 = 4.141

Speed & wheel RPM:

Assuming velocity of rover to be 1.2 m/s

Rpm for rover = 164 rpm

Power requirement:

- Torque required: ~5 N·m continuous
- Speed:164 rpm
- Power per wheel:

    P = torque X rpm

    P = 70.7 W

So 75 W per wheel.

For 6 wheels → 450 W total.

Final Motor specs:

Voltage: 24 V (best balance for robotics, ROS ecosystem).

Power: 150 W continuous.

Torque: ≥5 N·m continuous

Encoder: Integrated quadrature encoder (≥500 CPR). Essential for ROS odometry.

Type: Brushed DC or BLDC. BLDC + encoder preferred for efficiency, brushed + encoder is cheaper but less efficient.

Ingress protection: IP54+ recommended (dust protection for rough terrain).

Final Motor Driver specs:

1. Voltage rating

- Must match motor voltage → 24 V nominal,
- Safe margin → support up to 30 V.

2. Current rating

- Continuous: ≥4 A
- Peak (short-time): ≥10 A (for acceleration & slope climbing).
- Must be *per motor channel*.

3. Number of channels

- You have 6 DC motors.
- Options:
    - Single-channel drivers (6 boards) – one per motor.
    - Dual-channel drivers (3 boards) – better wiring & compact.

4. Control interface

- PWM + direction pins if Arduino is main controller.
- Or serial / CAN bus if you want fewer control pins and ROS-friendly communication.
- Encoder feedback support is a must for ROS odometry.

5. ROS compatibility

- Prefer drivers with existing ROS support:
    - RoboClaw: Dual channel, up to 2×30A, encoder feedback, ROS packages available.
    - ODrive (for BLDC motors): High performance, encoder feedback, ROS drivers exist.
    - Sabertooth 2×25 or 2×32: Simple, reliable, ROS nodes exist (serial control).

6. Protections required

- Over-current shutdown
- Thermal protection
- Reverse polarity protection
- Regenerative braking (optional but useful)

7. Power efficiency

- Must be high (>90%), otherwise heat buildup will be a problem in a sealed rover chassis.
- Include heatsink or cooling fan if operating at continuous high current.

Servo Motors:

1. Mechanical Requirement

- Wheel diameter: 26 cm (radius = 0.13 m).
- When stationary on rough terrain, friction resists turning.
- The servo is not rotating the wheel, but rotating the wheel + hub + suspension arm around a vertical axis.
- Resistance torque depends on:
    - Wheel load (rover weight per wheel).
    - Ground surface (rough terrain = high resistance).
    - Steering linkage geometry (lever arm length).

2. Load Estimation per Steering Wheel

- Rover mass = 100 kg (worst-case).
- Assume even load: ~25 kg per steering wheel (if all 4 take equal load).
- Vertical force per wheel: **25 × 9.81 ≈ 245 N**.
- Static friction coefficient for rough ground ≈ 0.6.
- Lateral resisting force while steering:
  F ≈ μ × Normal ≈ 0.6 × 245 ≈ 147 N

Now, assume steering pivot offset (lever arm) = 5 cm = 0.05 m.

Resisting torque at pivot:
T = F × r = 147 × 0.05 ≈ 7.35 N·m

With x2 safer servo torque required is 15 Nm

Servo speed is not much need so 0.2sec/60deg works

Final Servo Specs:

Torque: ≥15 N·m (150 kg·cm)

Voltage: 7.4–12 V

Speed: ~0.2 sec/60° or faster

Control: PWM (standard RC), or RS-485/CAN (for industrial servo)

Protection: Metal gears, waterproof casing (IP65+), ball bearings

Power: Separate UBEC 5–10 A supply for all 4 servos

Microcontrollers:

- Raspberry Pi5 8 GB
- Arduino Mega 2560

Controll Flow:

Ros Laptop —---------> Ros Raspberry —------> Aurduino —> Motor driver (to Dc Mortor)

|

Servo

Battery:

For the main rover

Li-ion (18650/21700 cells) or LiPo

Voltage: 24 V nominal (6S or 7S)

Capacity: 35–40 Ah

Energy: 850–950 Wh
Continuous discharge: ≥80 A

Peak discharge: ≥160 A

With BMS protection (overcurrent, undervoltage, temp).

Separate buck converters:

- 7.4 V @ 10 A for servos

- 5 V @ 2–3 A for Arduino

For Raspberry:

Needs 5 V, 3–5 A.
Options:

- USB-C PD power bank (20,000 mAh, 100 Wh).
- Or a small 3S Li-ion pack + 5V buck converter.

For Servo:

https://robokits.co.in/automation-control-cnc/integrated-dc-servo-motors/nema23-high-torque-encoder-dc-servo-motor-10rpm-with-step-dir-drive X 4

Needs 12 V , 7.5 A max

4 servos - needs around 15000mah battery (runtime 30 mins)

Battery -
https://robokits.co.in/batteries-chargers/drone-batteries/solid-state-batteries/genx-pro-solid-state-44.4v/genx-pro-solid-state-44.4v-12s-16000mah-premium-li-ion-battery

For Arduino, Raspberry and Cameras , we need max - 10000mAh power bank

https://www.amazon.in/boAt-Energyshroom-PB300-Protection-Indicators/dp/B0C7C7Z2VX?source=ps-sl-shoppingads-lpcontext&ref_=fplfs&smid=A1WYWER0W24N8S

Camera

https://robu.in/product/raspberry-pi-hq-camera/?gad_campaignid=19974686076 X 2

Communication - we will use ubiquiti nanostation loco m5

https://www.amazon.in/Ubiquiti-Nanostation-LOCO-Outdoor-802-11n/dp/B004EHSV4W
X2

We need around 2500 mAh

Battery -
https://robu.in/product/orange-5200mah-6s-35c-22-2-v-lithium-polymer-battery-pack-li-po-copy/

For motors - 40000mAh 24 V

https://ashvavolt.com/product/ashvavolt-24v-40ah-lithium-ion-rechargeable-battery-pack-for-electric-cycle-solar-others-ev-24-volt-40000mah/