Expanded Mark Scheme – Motors & Encoders

Q	Expanded Answer Guidance	Marks
1a	Any 2 AC motors: • Induction motor – simple, robust, low maintenance • Synchronous motor – constant speed • Single-phase motor – used in domestic applications Accept any valid + characteristic	4
1b	• Three-phase supply produces 3 currents 120° apart • Each creates a magnetic field • Fields combine to form rotating magnetic field • This induces current in rotor causing motion Accept diagrams/explanations	4
1c	Effects of higher frequency (60 Hz): • Increased speed (Ns proportional to frequency) • Possible overheating • Reduced torque • Mechanical stress Accept: • Any valid performance impact	4
2a	Any 5 parts: • Armature • Commutator • Brushes • Field coils/magnets • Power Source Accept equivalents	5
2b	• Reverses current direction in armature • Maintains continuous rotation • Ensures torque stays in same direction	2

2c	Shunt: • Parallel winding • Constant speed Series: • Series winding • High starting torque Accept comparisons	3
3a	• Provide movement at joints • Convert electrical energy into mechanical motion • Enable positioning of arm	2
3b	• Measure position/rotation of joints • Provide feedback to controller • Enable accurate positioning Accept: • Speed/position feedback	3
3c	Incremental: • Provides relative position • Needs reference point Absolute: • Provides exact position • No reference needed Appropriate: • Absolute encoder (better for robotics) Accept justification	3
3d	• Dust blocks light paths • Reduces accuracy • Causes signal errors Accept: • Reliability issues in dirty environments	3

3e	Better option: • Magnetic encoder • Inductive encoder Justification: • Resistant to dust • More robust in harsh environments Accept equivalents	3