## FINAL-EIN 13 – Electrical Installer Theory Examination Marking Schedule

Notes: 1. (1 mark) means that the preceding statement/answer earns 1 mark.

2. This schedule sets out the accepted answers to the examination questions. A marker can exercise their discretion and decide on the overall accuracy of any answer that is presented in the candidate's own words.

3. Symbols and terms - alternatives

| | |
|---|---|
| Power | W or P |
| Voltage | V or E or U |
| Phase | Active |

| **Question 1** | *Reference Marks* | *Marking notes* |
|---|---|---|
| | | |
| (a) $R_2 = \frac{R_1 \times L_1}{L_2}$ | (½ mark) | |
| $= \frac{100 \times 100}{300}$ | (½ mark) | |
| $= 33.33\ M\Omega$ | (1 mark) | |
| | | |
| (b) This test voltage is used to avoid destroying or damaging the semi-conductor components. | (2 marks) | |
| | | |
| (c) $pf = \frac{P}{\sqrt{3} \times V \times I}$ | (½ mark) | |
| $= \frac{40000}{\sqrt{3} \times 405 \times 63.5}$ | (½ mark) | |
| $= 0.898$ lag | (1 mark) | |
| | | |
| (d) • It ensures that the voltage never rises above 230 V under fault conditions. | (1 mark) | |
| • It ensures that the potential difference between neutral and the general mass of earth will always be about 0V. | (1 mark) | |
| | | |
| (e) (i) 1MΩ | (1 mark) | |
| (ii) 0.01MΩ | (1 mark) | |
| | | |
| (f) There is an internal volt drop due to the impedance of the windings. | (2 marks) | |
| | | |
| (g) Better mechanical protection. | (2 marks) | |
| | | |
| (h) To ensure that the minimum sized mains cable can be selected. | (2 marks) | |
| | | |

| **Question 1** | *Reference Marks* | *Marking notes* |
|---|---|---|
| | | |
| (i) The protective device must be capable of safely clearing that level of prospective short-circuit current without damage. | (2 marks) | |
| | | |
| (j) The power output of the heater will drop. | (2 marks) | |

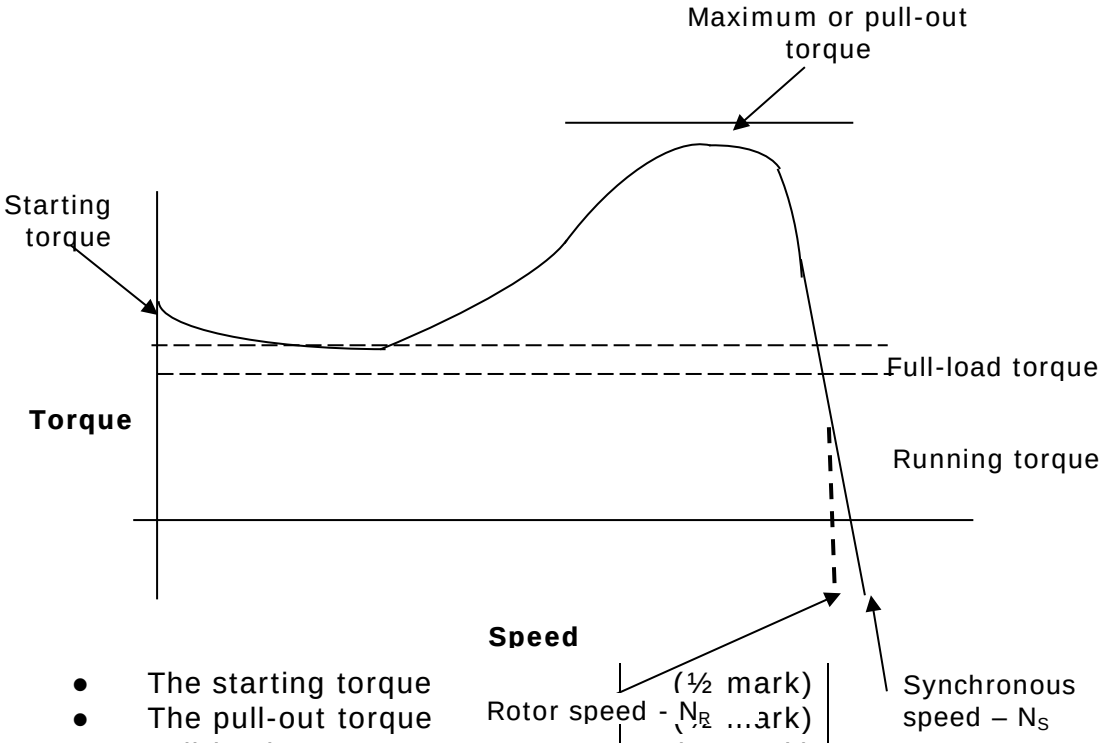
| **Question 2** | | | *Marks* | *Reference* | *Marking notes* |
|---|---|---|---|---|---|
| | | | | | |
| (a) | (i) | To provide a warning where turning on the point of isolation would cause personal danger. | (1 mark) | | |
| | (ii) | A danger tag is attached to a point of isolation of electrical equipment being worked on. | (1 mark) | | |
| | (iii) | Any THREE of:<br>● Ensure the correct isolating switch is selected.<br>● Ensure the isolating switch is in the OFF position.<br>● Each person concerned must fasten a tag to the isolation switch.<br>● Danger tags must be securely fastened. | (3 marks) | | |
| | (iv) | ● Where each electrical installer has finished work.<br>● Where an authorised person is satisfied that it is safe to remove the tags. | (2 marks) | | |
| | | | | | |
| (b) | | ● An out-of-service tag is attached to faulty or damaged electrical equipment.<br>● To warn against reconnection where use of the equipment would cause more damage or could cause injury. | (1 mark)<br>(1 mark) | | |
| | | | | | |
| (c) | | Any ONE of:<br>● Test between each phase and earth.<br>● Test between each phase and neutral. | (1 mark) | | |

| **Question 3** | | | *Marks* | *Reference* | *Marking notes* |
|---|---|---|---|---|---|
| | | | | | |
| (a) | (i) | • It shows that the higher the fault current | (1 mark) | | |
| | | • The lower the time it takes the fuse to trip. | (1 mark) | | |
| | (ii) | • With a 50A fault current flowing in the 16A fuse will blow in 2.8 s. | (1 mark) | | |
| | | • With a 100A fault current flowing in the 16A fuse will blow in 0.1 s. | (1 mark) | | |
| | (iii) | 20 x 1.5 | (½ mark) | | |
| | | = 30A | (½ mark) | | |
| | (iv) | 95A | (1 mark) | | |
| | | | | | |
| (b) | Correct discrimination occurs when only the protective device protecting the final subcircuit operates. | | (2 marks) | | |
| | | | | | |
| (c) | • To provide short-circuit protection for the circuit and motor. | | (1 mark) | | |
| | • Because the thermal overloads are not designed for this type of protection. | | (1 mark) | | |

| **Question 4** | | | | *Marks* | *Reference* | *Marking notes* |
|---|---|---|---|---|---|---|
| | | | | | | |
| (a) | (i) | $I_{PH}$ = | $\frac{V_{PH}}{R_{PH}}$ | (½ mark) | | |
| | | = | $\frac{230}{26.45}$ | (½ mark) | | |
| | | $I_{PH}$ ($I_L$) = | 8.7A | (1 mark) | | |
| | (ii) | P = | $\sqrt{3} \times V_L \times I_L \times pf$ | (½ mark) | | |
| | | = | $\sqrt{3} \times 400 \times 8.7 \times 1$ | (½ mark) | | |
| | | = | 6027.36 W | (1 mark) | | |
| | (iii) | 1.5 $mm^2$ | | (½ mark) | | |
| | (iv) | 10A | | (½ mark) | | |
| | | | | | | |
| (b) | (i) | $I_{PH}$ = | $\frac{V_{PH}}{R_{PH}}$ | | | |
| | | = | $\frac{400}{26.45}$ | (½ mark) | | |
| | | = | 15.12A | (1 mark) | | |
| | | $I_L$ = | $I_{PH} \times \sqrt{3}$ | (½ mark) | | |
| | | = | $15.12 \times \sqrt{3}$ | (½ mark) | | |
| | | = | 26.2A | (1 mark) | | |
| | (ii) | P = | $\sqrt{3} \times V_L \times I_L \times pf$ | | | |
| | | = | $\sqrt{3} \times 400 \times 26.2 \times 1$ | (½ mark) | | |
| | | = | 18151.36W | (1 mark) | | |

| **Question 5** | *Marks* | *Reference* | *Marking notes* |
|---|---|---|---|
| | | | |

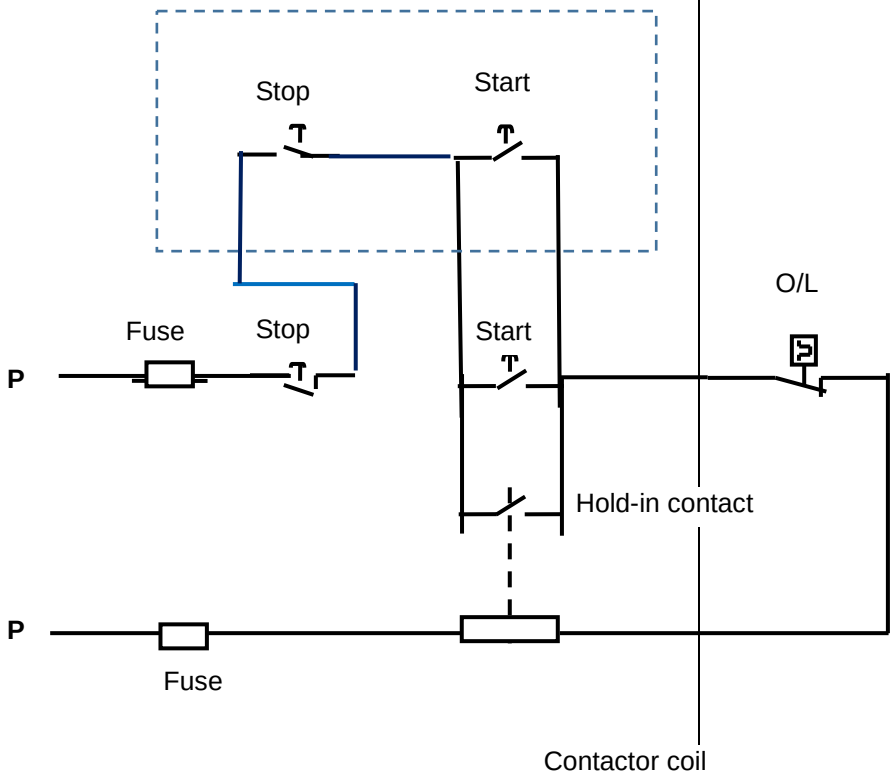
(a)




- The starting torque (½ mark)
- The pull-out torque (½ mark)
- Full-load torque (½ mark)
- Running torque (½ mark)
- Rotor speed – $N_R$ (½ mark)
- Synchronous speed $N_S$. (½ mark)

| Question 5 | Marks | Reference | Marking notes |
|---|---|---|---|

(b)




| | | | |
|---|---|---|---|
| (i) | • | Correctly connected fuses | (1 mark) |
| | • | Correctly connected start button | (½ mark) |
| | • | Correctly connected stop button | (½ mark) |
| | • | Correctly connected hold-in contact | (½ mark) |
| | • | Correctly connected coil | (½ mark) |
| | • | Correctly connected thermal overload | (½ mark) |
| | • | Working circuit | (½ mark) |
| (ii) | • | The remote stop is in series with the local stop button | (1 mark) |
| | • | The remote start in parallel with the local start button | (1 mark) |
| | • | There is no link between the stop and the start buttons in the starter | (1 mark) |

| **Question 6** | *Reference Marks* | *Marking notes* |
|---|---|---|
| | | |
| (a) pf = cosΦ | (½ mark) | |
| = cos $35^0$ | | |
| = 0.8191 lag | (½ mark) | |
| | | |
| (b) Input power = $\frac{\text{Output power}}{\text{Efficiency}}$ | (½ mark) | |
| = $\frac{4000}{0.83}$ | (½ mark) | |
| = 4819.27 W | (1 mark) | |
| | | |
| (c) $I_L$ = $\frac{P_{Input}}{\sqrt{3} \times V_L \times pf}$ | (½ mark) | |
| = $\frac{4819.27}{\sqrt{3} \times 400 \times 0.8191}$ | (½ mark) | |
| = 8.5A | (1 mark) | |
| | | |
| (d) (i) N = $\frac{60f}{P}$ | (½ mark) | |
| = $\frac{60 \times 60}{2}$ | (½ mark) | |
| = 1800 rpm | (½ mark) | |
| Slip speed = N x slip | (½ mark) | |
| = 1800 x 4% | (½ mark) | |
| = 72 rpm | (½ mark) | |
| (ii) Rotor speed = N – slip speed | (½ mark) | |
| = 1800 - 72 | (½ mark) | |
| = 1728 rpm | (1 mark) | |

| **Question 7** | *Marks* | *Reference* | *Marking notes* |
|---|---|---|---|
| | | | |
| (a) Any THREE of:<br>● The trip mechanism is operational.<br>● The PRCD trips at its rated residual current in the required time.<br>● The PRCD trips when voltage ceases to be supplied.<br>● The PRCD remains tripped when electricity supply is restored. | (3 marks) | | |
| | | | |
| (b) Any TWO of:<br>● Install RCD at the switchboard at the origin of the final subcircuit.<br>● Install an SRCD on the bathroom socket outlet.<br>● Install an SRCD on a socket outlet upstream from the new socket outlet in the bathroom. | (2 marks) | | |
| | | | |
| (c) ● Overcurrent<br>● Short circuit<br>● Earth leakage | (½ mark)<br>(½ mark)<br>(½ mark) | | |
| | | | |
| (d) (i) 30 milliamps.<br>(ii) 10 milliamps<br>(iii) 300 milliamps. | (½ mark)<br>(½ mark)<br>(½ mark) | | |
| | | | |
| (e) ● No.<br>● It does not operate on residual pulsating direct current. | (1 mark)<br>(1 mark) | | |

| **Question 8** | *Reference Marks* | *Marking notes* |
|---|---|---|
| | | |
| (a) ● Voltage<br>● Frequency | (1 mark)<br>(1 mark) | |
| | | |
| (b) A Rectifier<br>B Smoothing circuit (d.c. link)<br>C Any ONE of:<br>● Inverter<br>● d.c. to a.c. Converter<br>D Control unit | (½ mark)<br>(½ mark)<br>(½ mark)<br><br><br><br>(½ mark) | |
| | | |
| (c) Changes the three-phase a.c. supply to a d.c. supply. | (1 mark) | |
| | | |
| (d) Changes the d.c. supply back to a three-phase a.c. supply | (1 mark) | |
| | | |
| (e) ● The motor would overheat.<br>● As there would be minimal fan cooling at low speed. | (1 mark)<br>(1 mark) | |
| | | |
| (f) Any TWO of:<br>● Easier to control the starting current<br>● Easier to control the starting torque<br>● Multiple variations of the time it takes from rest to full speed (or full-load torque).<br>● Reduces mechanical shock to equipment<br>● More even torque<br>● Reduces disruption to supply voltage | (2 marks) | |

| **Question 9** | | | *Reference Marks* | *Marking notes* |
|---|---|---|---|---|
| | | | | |
| (a) | A | Main winding | (½ mark) | |
| | B | Centrifugal switch | (½ mark) | |
| | C | Start capacitor | (½ mark) | |
| | D | Rotor | (½ mark) | |
| | E | Run capacitor | (½ mark) | |
| | F | Auxiliary winding | (½ mark) | |
| | | | | |
| (b) | (i) | By an external current relay | (1 mark) | |
| | (ii) | 60% to 80% of full-load speed | (1 mark) | |
| | | | | |
| (c) | Any ONE of:<br>● It runs a lot quieter<br>● It develops a higher running torque<br>● It develops a higher starting torque | | (2 marks) | |
| | | | | |
| (d) | VA = 235 x 14.7 | | (½ mark) | |
| | = 3454.5 VA | | (½ mark) | |
| | Pf = $\frac{W}{VA}$ | | (½ mark) | |
| | = $\frac{3000}{3454.5}$ | | (½ mark) | |
| | = 0.87 | | (1 mark) | |