

Gareth Hill Exam Answers

by Gareth Hill

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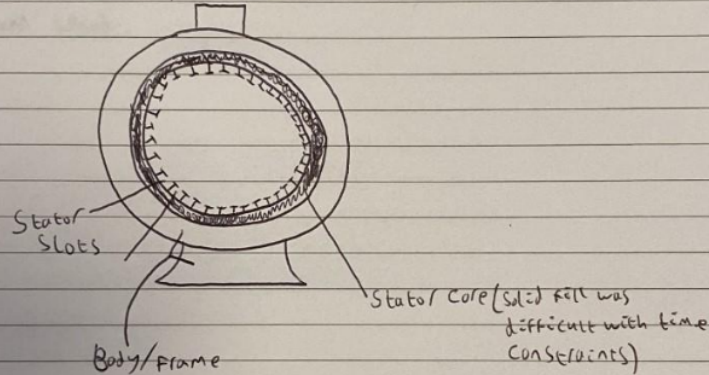
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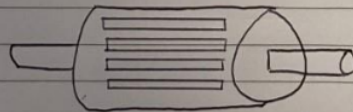
Gareth Hill exam answers May 2022. This is the 20 word minimum for the paper to be accepted on turn it in.

Question 1

- ① An induction motor consists of 2 main parts, a stator and rotor. The stator is stationary and houses the rotor which is the moving part. The construction of the stator are stacks of thin-slotted, permeable steel laminations, inside a steel frame. The arrangement of the laminations can be seen in the diagram below. Winding passes through the steel slots of the stator.



The rotor sits inside the stator. There is a small gap between the rotor and stator known as the 'air-gap'. This can vary from 0.5mm-2mm. Rotor construction can be seen below.



① When 3-Phase AC current passes through the windings it produces a rotating magnetic field. As this happens, current is induced into the bars of the Squirrel cage and it starts to rotate. Electricity is ~~inducted into~~ induced into the rotor by magnetic induction rather than direct electric connection. The speed of the induction motor is dependant on load. Induction motors rely on slip and do not run at fixed speed.

Question 2

② MPPT is a technique that grid connected inverters and similar devices, use to get the maximum possible power from photovoltaic devices. They convert higher voltage DC output from solar panels.

The central problem addressed by MPPT is that the efficiency of power transfer from the solar cell depends on the amount of available sunlight, shading, and the load's electrical characteristics.

When directly connecting a load to cell, the operating point of the panel is rarely at peak power. Changing the duty ratio of the DC-DC converter changes the impedance seen in the cell.

Methods:

Perturb + Observe

In this method the controller adjusts the voltage from the array by a small amount and measures power. If the power increases, further adjustments in that direction are tried until power no longer increases.

Incremental conductance

This method the controller measures incremental current and voltage changes to predict the effect of voltage change. This method requires more computation in the controller, but can track changing conditions more rapidly.

Current Sweep

The current sweep method uses a sweep waveform for the array current such that the I-V characteristics of the PV array is obtained and updated at fixed time intervals. MPP voltage can then be computed from the characteristic curve at the same intervals.

Question 3

③

$$P = V \times I$$

$$= 6 \text{ kV} \times 250 \text{ kVA}$$

$$= 1500 \text{ kW}$$

$$f = \frac{\omega P}{60} \quad \omega = \text{rpm} \quad P = \text{Pole Pairs}$$

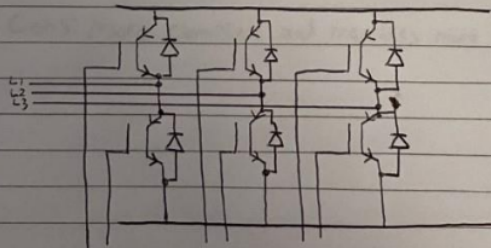
$$f_{\min} = \frac{0 \times 12}{60} = 0 \text{ Hz}$$

$$f_{\max} = \frac{1000 \times 12}{60} = 200 \text{ Hz}$$

$$V = 6 \text{ kV} \quad I = 250 \text{ kVA} \quad f = 0 \text{ to } 200 \text{ Hz}$$

20 Pulses per cycle means that Switching Frequency of the transistors is between zero and 4 kHz

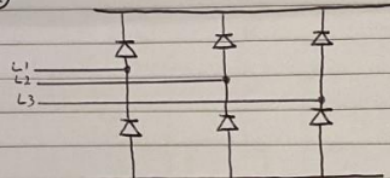
The most suitable transistor for this application would be an IGBT. This is due to the system voltage being so high (6kV) as a Power bipolar and MOSFET will only handle voltages up to 1kV. Power bipolar also won't be able to handle the current used as it has a max of around 500A. An IGBT can also switch at the desired frequency.



Question 4

(4)

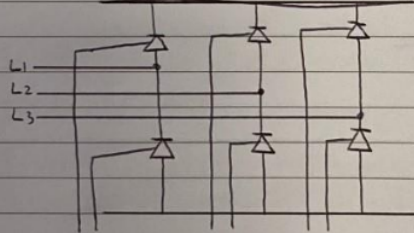
Diode rectification



Pros: Cheap to buy and simple circuitry

Cons: Can't be used to control anything

Thyristor rectification

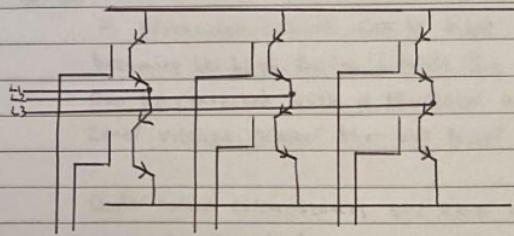


Pros: Can control voltage ~~and operate both directions~~

Cons: More complex and requires more circuitry

(4)

IGBT



Pros: Bi directional current flow

Cons: Limited by switching speed and very costly. Complicated to drive.

Diode rectification is good for simple operations as it is cheap and not complex to use. Its simplicity is also its limiting factor as it can't control anything.

Thyristor rectification has a voltage that is proportional to angle of phase/firing angle. Variable angle & timing can change average voltage

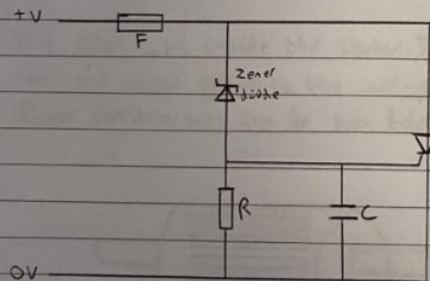
IGBT can be used for rectification, and voltage control. It can also feedback and recover energy back to the supply.

Question 5

⑤

A protection circuit can be used to prevent the output voltage becoming too high during a fault. In order to do this, a Zener diode can be connected with a thyristor as the Zener diode has a Zener voltage greater than the power supply output voltage.

Under normal circumstances the Zener will not conduct. Effectively there is an open circuit between the anode and cathode of the thyristor. If the output voltage exceeds the max value, the Zener will conduct and activate the thyristor. When the thyristor conducts, the current becomes big enough to blow the fuse.



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GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

78/100

Instructor

Q1 - 10/15

Q2 - 20/25

Q3 - 18/25

Q4 - 18/20

Q5 - 12/15

total 78/100

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Comment 1

Incorrect power calculation.

$$I = P/V$$

$$I = 250,000 / 6,000 = 41.67 \text{ A}$$

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