

Joshua Hunt

by Joshua Lee Hunt

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LOCATION: SWANSEA

LLEOLIAD: ABERTAWE

LEVEL 6

LEFEL 6

EXAMINATION PERIOD

CYFNOD ARHOLIADAU

MAY 2022

MAI 2022

MODULE CODE: ACDA6004

Power Electronics & Drives

TIME: 2 HOURS

ANSWER ALL QUESTIONS

Equipment or materials required – Calculator

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Sem 2 Exam MAY 2021-2022

① Induction Motor

* Constructed from two main parts; Rotor and Stator.

Stator - is a Stationary part of the induction motor. A stator winding is placed in the stator of induction motor and the three phase supply is given to it.

Rotor - The rotor is the rotating part, connected to the mechanical load through the shaft.

* The rotor are further classified as Squirrel cage and Slip ring/Wound/Phase wound rotor.

* Induction Motors pass an AC current through coils in the stator which produces a magnetic field, and the oscillating frequency of the AC supply will cause this magnetic field to rotate. This rotating magnetic field will then induce opposing magnetic field in the rotor, the free moving armature attached to the output shaft - causing rotation.

* These are also known as asynchronous motors, as the frequency of their AC current doesn't match the number of rotations.

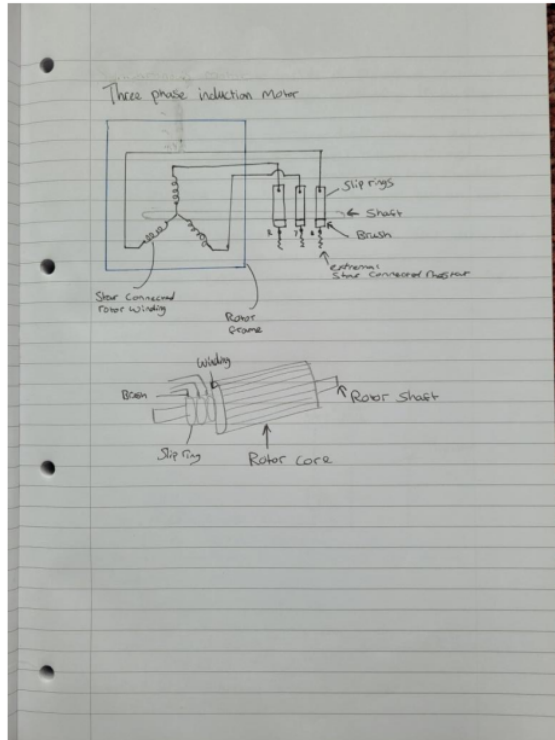
* This is known as "slip" and happens because the rotor is always trying to catch up with the RMF

* Precise timing is difficult with induction motors

* These devices can be found in household appliances, electric vehicles and large industrial equipment.

* Voltage induced in Squirrel cage will go down as speed of motor goes up.

1.



2) *Maximum power point tracking (MPPT) is a technique that grid connected inverters, solar battery chargers and similar devices use to get the maximum possible power from one or more photovoltaic devices, typically solar panels.

* Solar cells have a complex relationship between solar irradiation, temperature and total resistance that produces a non-linear output efficiency which can be analysed based on the I-V curve

* Heat causes solar panels to be less efficient

* MPPT allows a solar PV inverter to adjust its input resistance in response to solar panel performance to maintain MPPT.

how? - * This is done by measuring the current and voltage produced by the panel and using this information to modify the input resistance of the inverter to match the output resistance of the solar panel ensuring MPPT.

* Algorithms are then employed to determine the best way of adjusting the resistors

- Strategies to optimize the power output:

* Perturb and Observe - Adjusts the voltage from the array by a small amount and measures the power. It's the most common and simple but can produce oscillations to power output

* Incremental Conductance - This method measures the changes in array current + voltage to predict the onset of voltage change. It's more complicated but faster.

* Current Sweep Method - Uses a sweep waveform for the PV array current so that the I and V is obtained and input/output power is calculated

* Constant Voltage - The power is delivered to the load is briefly interrupted and the open-circuit current with OV is measured.

Not strictly a MPPT technique but does have advantages when the MPPT fails

③ Apparent power = 250 KVA
Voltage = 6 KV
12 pole pairs = 24 Poles
Standstill to 1000 rpm
Switching Speed 20 pulses per cycle

$$I = \frac{P}{V} = \frac{250,000}{6000} = \underline{41.66 \text{ A}}$$

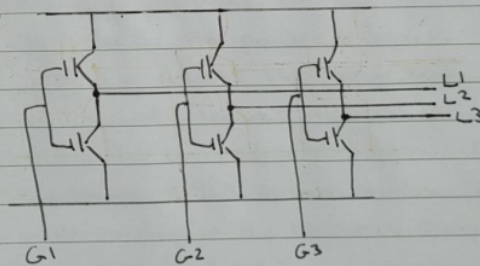
$$f = \frac{\omega}{60} = \frac{1000}{60} = 16.66 \text{ Hz}$$

$$\text{Gate Switching frequency} = 20 \times 16.66 \\ = \underline{333.2 \text{ KHz}}$$

Due to the Characteristics shown above and referencing the IGBT comparison table, the transistor technology that would be most suitable for this application would be the IGBT due to the following reasons:

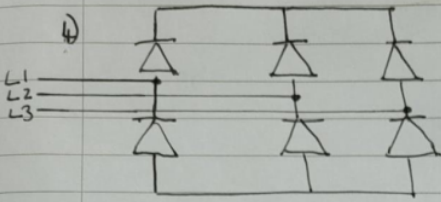
(Turn over)

- * it has a high Voltage capability
- * low ON resistance
- * ease of drive
- * Relatively fast Switching Speed
- * Combined with Zero gate drive current makes it a good choice for moderate Speed, high voltage applications such as in pulse-width Modulated (PWM), Variable Speed Control, Switch-mode power Supplies or Solar powered DC-AC inverter and frequency Converter applications operating in the hundreds of Kilohertz range.



- * IGBTs are used in half bridge Configuration for each phase of the three-phase inverters.
- * The gate drives for the transistors would be derived from a Sinusoidal waveform encoded as PWM
- * The top transistors Pulse on when associated phase output is positive, bottom Pulse on when phase output is Negative
- * The diodes fitted across the collector and emitter of the transistor protects transistors from back emf produced when coils of the motor are energised.

④

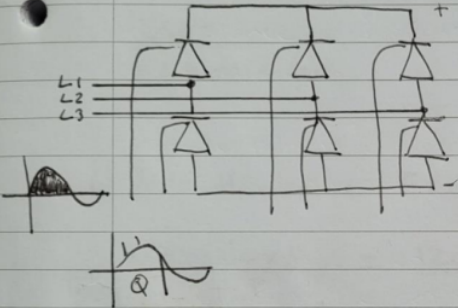


Diodes

- * Rectification only
- * Uncontrolled rectifying devices (as triggering pulse is not required)

Pro	Con
Cheap & Simple	Restricted Control

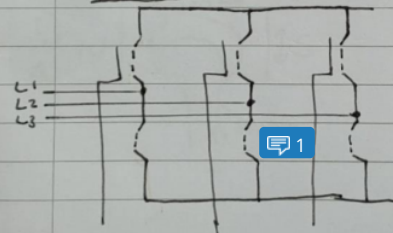
SCRs (Thyristor)



- * Can Switch on
- * Controlled turn-on device (as triggering pulse is needed)
- * Rectification + Voltage Control (Firing α)

Pro	Con
- Can Control Voltage	- Complicated, more Circuitry to control

IGBT



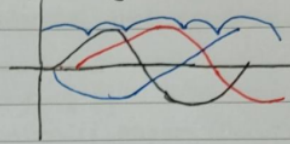
- * Can Switch transistors on/off
- * Control how long switch transistors on
- * Another circuit down other end driving motor so can operate in both directions
- * Can use motor to re-energise mains
- * Rectification + Voltage control + return power to supply (regenerative braking)

Pro	Con
Bi-directional current flow	Expensive, Complicated to drive

Diodes

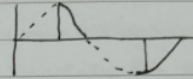
* Ripple

Harmonics and noise by each



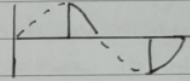
SCR

* Sharp edges



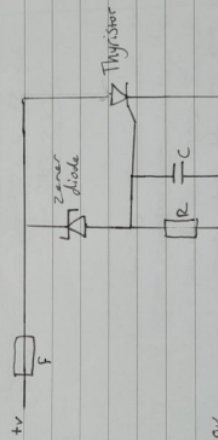
IGBT

* Sharp edges



⑤ A power supply can include a protection circuit to prevent the output voltage exceeding its rated voltage.

- * This is done using a Zener diode with a Zener voltage greater than the power supply output voltage.
- * Under normal conditions, the Zener will not conduct.
- * The anode and cathode of the thyristor has an open circuit between them.
- * If the output voltage goes over the max value then the Zener will turn the thyristor on.
- * When the thyristor conducts, the current is large enough to blow the fuse.
- * This prevents damage.



FINAL GRADE

GENERAL COMMENTS

92/100

Instructor

Q1 - 8/15

Q2 - 25/25

Q3 - 25/25

Q4 - 16/20

Q5 - 18/20

total 92/100

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Comment 1

Only half your transistors have gate connections?

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