GEORGE - EMMI/01643/2017.

POWER ELECTRONICS CAT. 26-11-2020

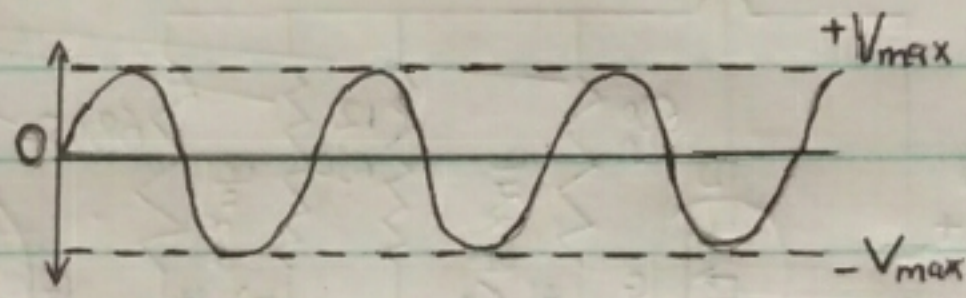
(a) Explain the difference between controlled and uncontrolled rectification.

- Rectification is the use of rectifiers in a converter circuit which converts AC to DC.
- Rectifier circuits using diodes only are called uncontrolled rectifier circuits. Diodes are used to block current flow in one direction (cannot allow flow in one direction). When thyristors (SCR) are used, output voltage can be controlled. Unlike diodes, SCR can be triggered by means of a gate pulse to conduct flow in both directions ie can be turned ON and OFF.

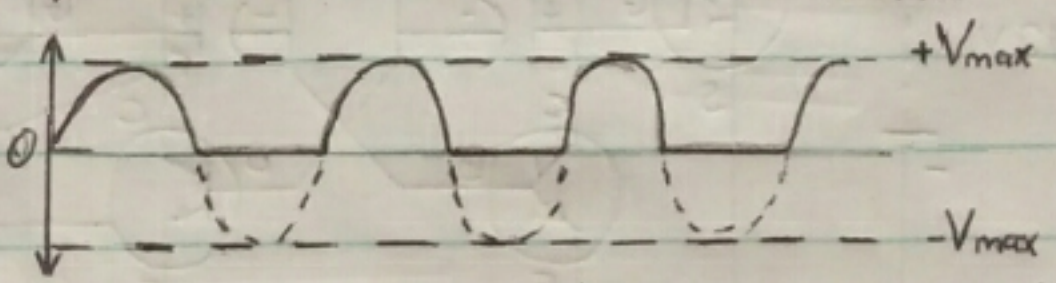
(b) With simple circuit diagrams of input and output waveforms, explain the control characteristics of:

(i) Power diodes.

Input signal:



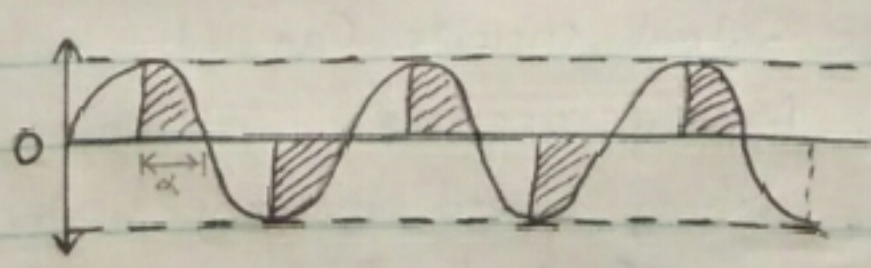
Output signal:



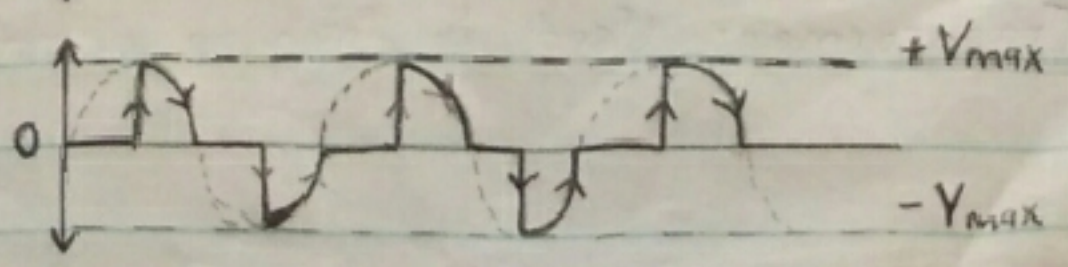
- After rectification i.e introduction of diode in the circuit, ~~AC is converted to DC and~~ signal flows in one direction only.

(ii) SCR / Thyristor.

Input signal:

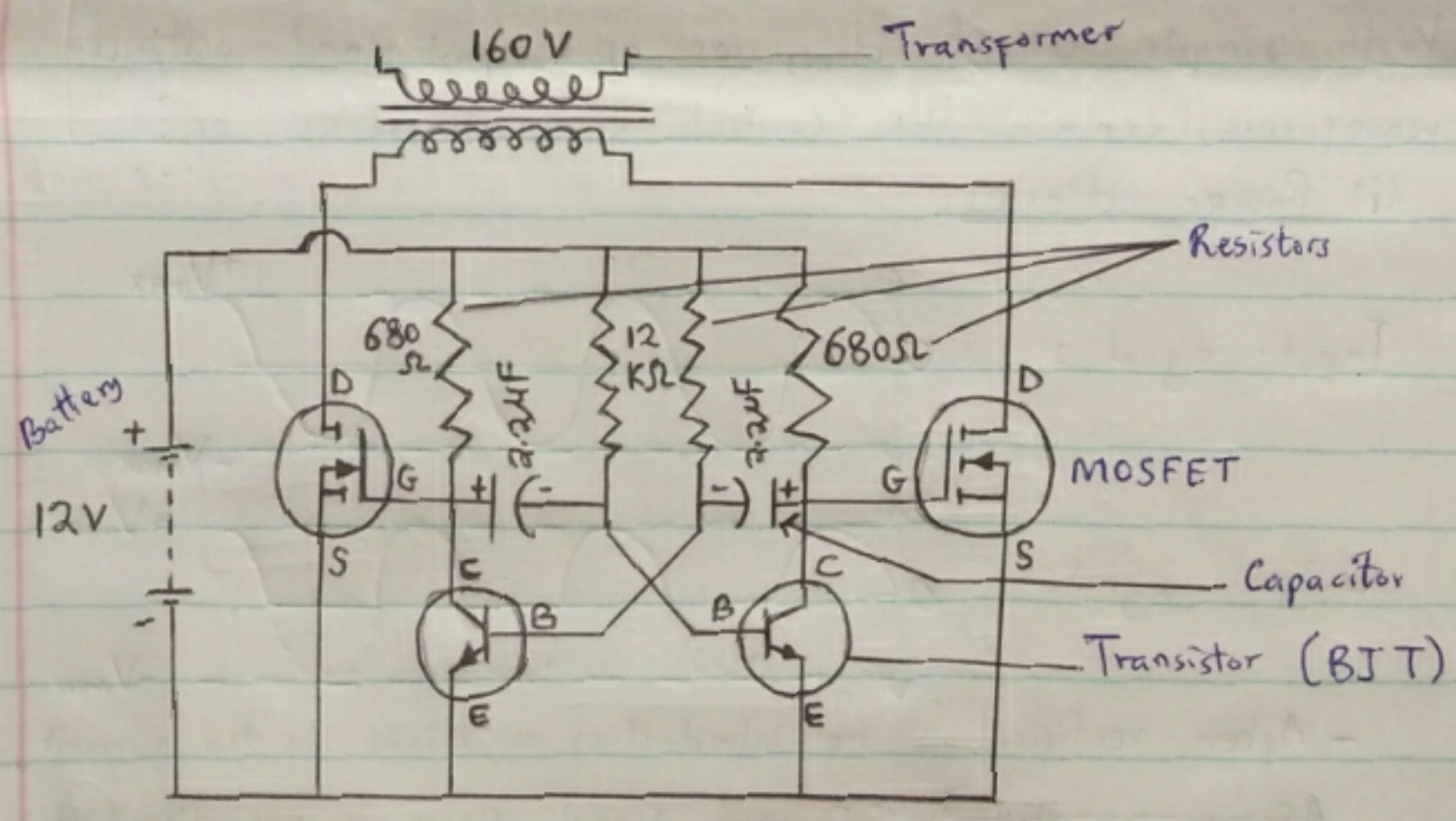


Output signal:



(iii) IGBT

(c) Sketch and explain a simple inverter circuit, explaining the functions of the common power electronic devices.



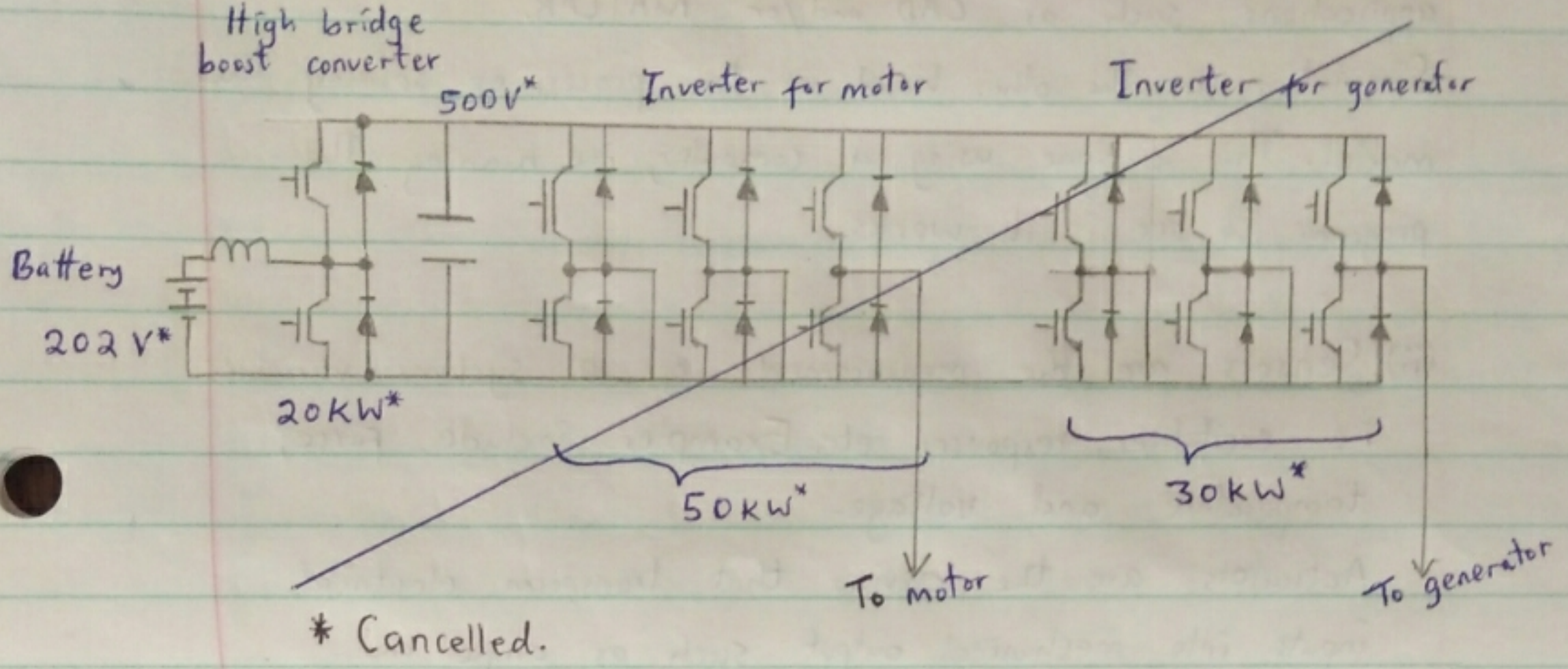
~~Transformer~~: ① Battery: Producer the reserve energy required by the system during abnormal power conditions.

② BJT: Used to amplify small input currents into larger controllable output currents. Can also be used as a switch.

③ MOSFET: Mainly used for switching of electric signals as its switching speed is very high.

④ Transformer: Used to step up or step down voltage.

(d) Block diagram of a power converter system for a hybrid electrical vehicle.



(e) Using an example, describe a mechatronic system.

This is a system that intergrates and cordinates mechanical, electrical, electronic and computer systems to generate simple, reliable and more economic systems.

Example: A robot / robotic system. Robots use electric power and ~~electrical~~ electronic ~~components~~ devices e.g IC's together with artificial intelligence (computing) to mimick human operations which are mechanical in nature - work.

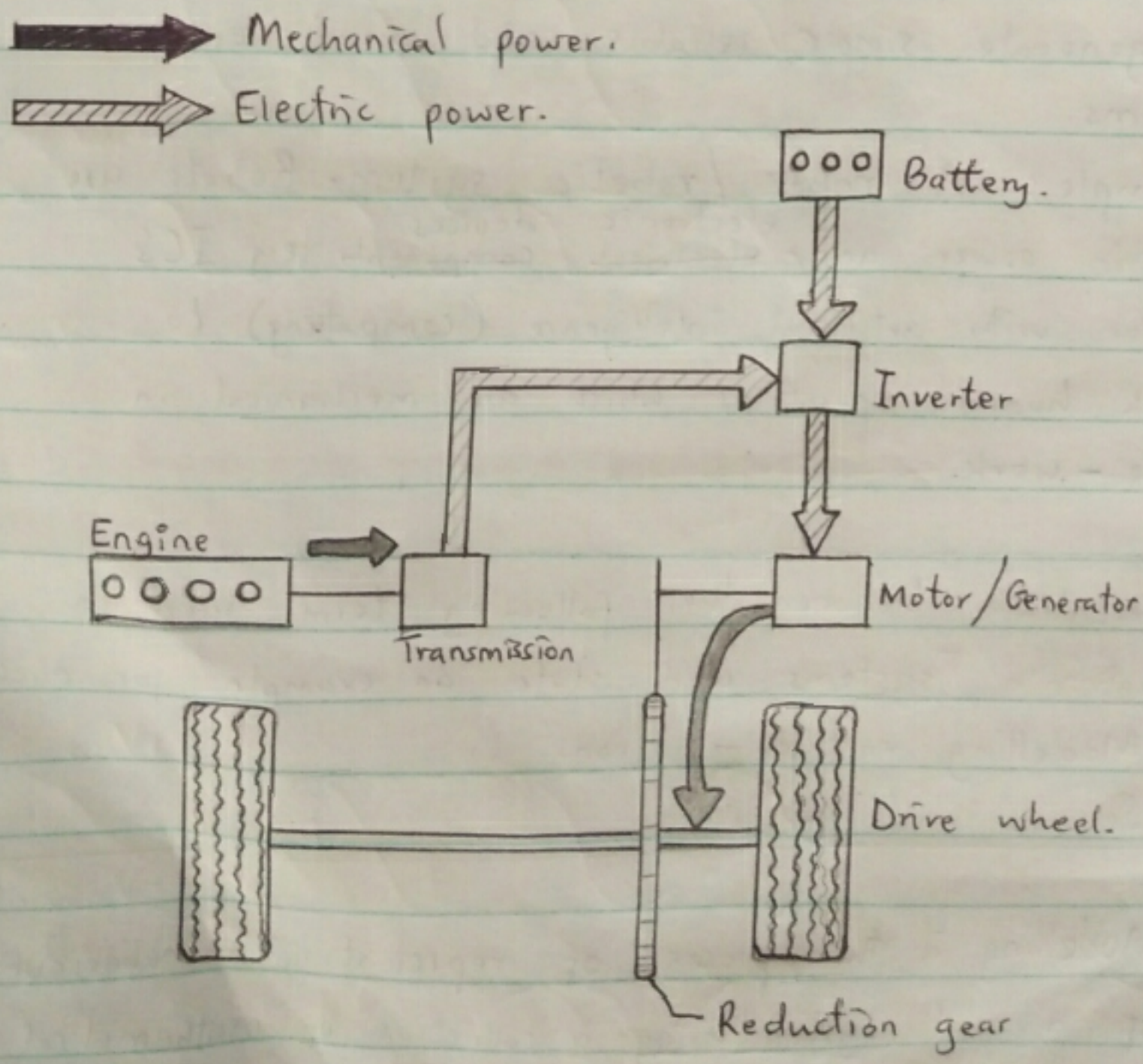
(f) Differentiate between the following terms used in mechatronic systems and state an example for each
(i) Modelling and simulation.
(ii) Sensors and Actuators.

(i) Modelling is the process of representing a behaviour of a real system using a collection of mathematical equations and logic. A model is necessary for simulation

purpose, analysing the ~~design~~ system and designing a controller.
Example of a model is a robot model created using applications such as CAD and/or MATLAB.
Simulation on the other hand is the process of solving the model. This is done using a computer, i.e running the program to see if it works.

(ii) Sensors are the measurements of a systems variables i.e excitations, responses etc. Examples include force, temperature and voltage.
Actuators are the devices that transform electrical inputs into mechanical output such as angle and position. These include hydraulics, DC motors, pumps etc.

(d) Block diagram of a power convertor system.



(j) Explain the principle operation of the mechatronically designed ambulatory rehabilitation walker.

This technology was developed with the sole purpose of assisting in rehabilitation of hospital patients who are learning to walk again after their motor abilities had been affected by either disease or accidents. The main idea behind this is relieving the patients legs a certain percentage of weight (body weight).
The hoist is actively controlled using feedback relays from strain-gauge sensors as the patients walk around in confined room-size gantries. The gantries are motorized in the X- and Y- directions. If the patient were to trip and fall, the hoist system would react and gently counter the fall and in the process remove the full load of the patients body weight/force.