Polya Robotics Dialogue

General Instructions

- Students can send in their research write-ups in teams of two/three
- The best team which would have submitted the best research shall present during the event.
- If you disagree with any implicit assumptions in the question, please state explicitly.
- All Analysis(QFD) questions are to be answered within 400 words (all answers together)
- All Synthesis(QFD) questions are to be answered within 400 words (all answers together)
- QFD stands for "Question for discussion", the others are helping questions.
- Sciensation is very generous when it comes to awarding points, **describe your thoughts**!
- Interesting wrong answers receive more credits than correct answers.

Selection Criterion

- Originality- The originality of the thought process involved.
- Reasoning- The arguments/assertions need to be justified.
- **Perspectives** - exploring the issues from the point of view of all stake holders.
- Rigor- have you evaluated the arguments critically?
- Creativity- Out of the box solutions to the problems

Analysis Theme1: What is a robot?

Q1. What is technology? Does technology have to be modern? What is a machine? Is technology just about machines? Why did we develop technology? Why do we develop technology (present context)? Can paper be called tech? Can you think of one problem which can be solved using scientific knowledge?

Q2. What is automation? What are the prerequisites for automation? How do we automate a process? How do we identify scope for automation? Are repetitions a hint for designing systems for automation? Can you think of a process which could be automated? How would you design the process?

Q3. What is a machine? Does it have to be physical? What do you mean by a virtual machine? Why do we build machines? Can you think of a machine, what would be the purpose of its design?

Q4. Do all machines have to be automata (self operating)? Can you think of a machine which is an automaton, a machine which is not an automaton? Can you think of three situations, one which requires a self-operating machine, one which requires a machine which is human controlled and a hybrid?

Q5. Most ancient cultures spoke of artificial people, why was this idea so popular? Artificial automata are called robots, but do we have automata which are not artificial? Why do we need a robot?
QFD: Define your own robots and explain why it is needed

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Analysis Theme2: What is a sensor?

Q1. What is a system? Can you think of different systems- both natural and artificial? Why do we need systems? How do systems work?

Q2. How can the working of a system be understood? Can we give different inputs to find out? Does a system have a function which maps inputs to outputs? Does this system have to be deterministic (same output all the time, for a given input)? How can this be represented?

Q3. How do systems get input? How do human beings get input? What is the purpose of sense organs? Can you think of a situation in which only one sense is utilized? Two sense? Three senses? All senses?

Q4. How can an artificial person get an input stream? How can a robot see? How can a robot smell? How can a robot hear? Can you think of an instance where a robot has to smell? Why is this essential?

Q5. What is a sensor? What are the various ways in which a robot can see? Do all animals have similar kind of vision? Should the robot have human (sense organ) eye like sensors or another type of sensors? **QFD:** Define your own sensor and explain how you arrived at it

Analysis Theme3: What is an algorithm?

Q1. What is an instruction? Does a machine require precise instructions? Can machines accept a series of instructions? Can instructions be dependent on the input? How can instructed be represented?

Q2. Do all methods work equally well? Do some methods work better? Why do we use long division method to divide numbers? Why can't we distribute some beads manually, to find the quotient?

Q3. An efficient method of solving problems, is described precisely (with well defined language) within finite amount of space and time. What happens if one or more of these three conditions are dropped? Can you name any two algorithms which you have learnt?

Q4. What do you think "Algorithm Design" means? Can you follow these nine steps to define one algorithm around one problem? 1- Problem definition, 2- Development of a model, 3-Specification of Algorithm, 4-Designing an Algorithm, 5-Checking the correctness of Algorithm, 6-Analysis of Algorithm, 7-Implementation of Algorithm 8-Program testing 9-Documentation Preparation?

Q5. What else would a robot requires besides sensors and algorithms? What do you understand by the term functionality? Would you want one person to develop a robot or would you want multiple people to contribute? What about evolutionary robotics?
QFD: Design a robot and an algorithm which can solve an interesting problem defined by you.

Synthesis Theme1: Self-driving cars

Q1- What do you understand by auto-pilot? Is it a good idea to replace drivers with robots? What are the pros and cons of having drivers? What about robots?

Q2- What kind of input would a self drive car require? What kind of sensory input does a driver use? What kind of sensors would be required to bring such input?

Q3- What kind of choices does a driver make while driving? What kind of algorithms can be programmed into the car to enable the car to engage in similar kind of decision making?

Q4- Can we have cars which work with a driver and a robot driving it at the same time? There are various levels of automation, what do you think these words mean – Warnings only, Hands on, Hands off, Eyes on, Eyes off, Mind off, No human intervention. What would be the difference between hands on and hands off? What would be the difference between mind and eyes?

Q5- Should self-drive cars be taken off roads as accidents are being reported? Wouldn't drivers commit accidents? Who should be punished for the accidents? Should somebody be punished? What would be the consequences if nobody is punished? What kind of programming can reduce the risk of accidents?
QFD: Design your own model of a self-drive car and explain its functionalities and algorithms

Synthesis Theme2: Humanoid Robots

Q1- What do you understand by humanoid or a robot with body shape resembling human body? What do you understand by android or a robot with "aesthetic" resemblance of the body shape?

Q2- What are the various mechanical tasks performed by human beings? Can you think of machines which can perform those tasks? Can robots play soccer, can they score more goals?

Q3- Can machines modify or replace human body parts? Can robots be used to treat diseases? Why do you think this was the early motivation for humanoid research? Can you think of other use-cases?

Q4- Can study of human morphology is useful in humanoid research? For instance, we have a fluid near of neck, which acts like a gyro sensor, it helps in balancing, we experience pain near our neck when we go astray. Can this be imitated in a humanoid? How can we get a humanoid to balance itself?

Q5- What kind of ideas would be useful in humanoid research? Would biology be relevant? How about chemistry or physics or mathematics? How about Economics, Sociology and Psychology? Can you think of application of ideas from three different subjects, into your robot?
QFD: Design your own humanoid robot and explain its functionalities

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