

CS 103 Autumn 2022: Mid-semester exam (60 marks, 25% grade)

Name: _____ Roll number: _____

All questions carry one mark each. No partial marks for partially correct answers.

1. Which topic(s) covered in the course so far did you enjoy the most, and why?
2. Which topic(s) covered in the course so far did you enjoy the least, and why?

Instructions: Questions 3–17 contain some general statements about how science and technology develop. For each statement below, give a specific example of a scientific/technological innovation/milestone that illustrates the point being made in the statement. You can either use examples discussed in class or those you have read elsewhere.

There are many possible answers. One example is provided below but we have given marks to other correct examples as well.

3. The availability of suitable technology and equipment accelerates the progress of science.

Answer: Telescope and astronomy.

4. Technology developed for military use during periods of war is often put to good use later on for civilian (non-military) needs.

Answer: Radar, modern computing.

5. Relying on empirical observations instead of on authority greatly improves the correctness of scientific theories.

Answer: Theories about the human anatomy.

6. Many technologies developed during the industrial revolution are a result of the working together of craftsmen and scientists.

Answer: Invention of the steam engine involved knowledge of metal working as well as science.

7. The ecosystem of existing market players can sometimes hinder the development of a new disruptive technology.

Answer: The opposition to the electric car from the oil industry.

8. People during pre-modern times developed reasonably useful technologies, but did not fully understand the science behind why/how they worked.

Answer: Predicting eclipses without having an accurate model of the solar system.

9. Historical or political events unrelated to science sometimes have a large impact on the direction of progress of science or technology.

Answer: Impact of world war 2 on modern science and technology.

10. A scientific theory that is assumed to be true for a long period of time can be proved false in the future because it cannot explain data from new observations and experiments.

Answer: Heliocentric model of the solar system replacing the geocentric model.

11. Access to a large market where the technology can be commercialized profitably is critical to the development of new technologies.

Answer: Access to markets in colonies accelerated the development of steam powered textile mills.

12. The presence of a “killer app” or a compelling use case is critical to the development and widespread deployment of new technologies.

Answer: The Altair console for personal computing.

13. Predictions about how technology will evolve in the future sometimes turn out to be wildly inaccurate.

Answer: Predictions around how little use there would be for general purpose computers.

14. Restricting imports of products can sometimes lead to a strengthening of the domestic industry and indigenous technologies.

Answer: Calico acts and development of the British textile industry.

15. Availability of the right resources, either human and natural, has caused an accelerated development of science and technology in certain places and times.

Answer: Fall of Constantinople and the Renaissance.

16. Designing successful products for commercial use requires performing “engineering” tweaks to adapt scientific ideas to the scale and scope of real life use.

Answer: Edison’s invention of the light bulb.

17. Not having appropriate background knowledge or equipment can lead to faulty scientific observations.

Answer: Misunderstanding fractional atomic weights due to isotopes.

Instructions: Questions 18–42 below contain simple arguments. For each argument, evaluate whether the argument presents cogent reasoning or not. If the argument is cogent, state so. If the argument is fallacious, describe the flaw in reasoning in one or two sentences. (It is not necessary to remember the technical name of the fallacy as long as you can describe it.)

We have given marks for all reasonable answers, even those that differ from the key below. We did not look for the technical terms or names of fallacies, but only for correct explanations.

18. “France recently moved to using only rail services for domestic travel within the country, instead of domestic flights, in order to reduce greenhouse gas emissions. India should do the same too.”

Answer: False equivalence. France and India are not comparable in terms of size or maturity of rail infrastructure, and it is much harder to avoid domestic flights in India.

19. “If I buy a pack of potato chips, I will eat it all in one day. And if I do that, I will surely get sick. I have just bought a pack of potato chips. Therefore, I expect to get sick soon.”

Answer: Cogent. A implies B and B implies C, so A implies C.

20. “Some think that government surveillance and spying of phones is a threat to privacy. But such surveillance is necessary for the security of the country. Would you rather have terrorist attacks in the country every other day?”

Answer: Either-or fallacy or false dilemma. There can exist a middle ground between frequent terrorist attacks and spying of phones.

21. “There have been reports of violence during the recent elections. However, these incidents do not indicate misgovernance or administrative failure on the part of the government, because elections have always seen violence in the past few decades and this is nothing new.”

Answer: Justifying one wrong action with another.

22. “XYZ has been recently elected prime minister of the country. He comes from an illustrious family of academics, but he always wanted to be a politician from a very young age. Therefore, he will make a terrific leader.”

Answer: Irrelevant premises. No relevant reason provided for why XYZ will be a good leader.

23. “The population of prisoners in jails has significantly increased in our country, from around 2 lakhs in 1974 to about 5 lakhs today. This points to a decay of moral values in modern society.”

Answer: Incorrect usage of statistics, missing normalization. The population would have also increased significantly in this period, so there will be an increase in prisoners. This does not necessarily imply moral decay.

24. “India and China both have similar working age populations of approximately a billion each. If suitable industrial employment opportunities and training are provided to the labor force in India, we can match China in terms of industrial output.”

Answer: Cogent.

25. “The female labor participation rate in India (i.e., the fraction of females employed in jobs outside the home) is only 20%, while it is 60% in the UK. This explains why I know so few working women in India as compared to the UK.”

Answer: Incorrect usage of statistics. Even with different female labor participation rates, the number of working women in India will be significantly higher due to a much higher population. Not knowing enough working women could be due to other reasons.

26. “It is high time I buy a car. All my friends have one, and I feel insulted being the only person without a car.”

Answer: Appeal to emotion. No logical reason provided for buying a car.

27. “I always see this stray cat near my table every time I go to eat at Gulmohar. I think this cat likes me a lot.”

Answer: Sampling bias. Maybe the cat likes to sit at that table at other times too.

28. “When it rains, the ground gets wet. The ground in front of my house is dry today morning, therefore it surely would not have rained last night.”

Answer: Cogent. A implies B, so not B implies not A.

29. “I have interviewed a large number of people who have been infected with, and fully recovered from, Covid during the past 2 years. None of them has any lingering effects of Covid. Therefore, the Covid virus does not cause any long term health issues.”

Answer: Many possible fallacies. The ones with serious Covid and long term health issues may not have survived (survivorship bias). Also, 2 years is too short a time period to evaluate long term effects.

30. “I asked the students in my CS103 class whether JEE preparation is easy or hard, and all of them answered that it is super easy. I do not know why some kids complain about JEE preparation being too hard or stressful, as it does not seem to be the case at all.”

Answer: Biased sample of only JEE toppers to conclude how hard JEE is for all students.

31. “The clinical trials of this vaccine on humans seem to have been done in a hasty manner. All scientists treat patients like guinea pigs for their experiments. This is not acceptable, and all vaccine trials should be stopped.”

Answer: Strawman argument. Oversimplification to say scientists treat patients like guinea pigs.

32. “It is a terrible idea to elect XYZ as the chief minister. She was a movie actress for a brief period before she became a full-time politician. We all know how movie actresses have loose moral values.”

Answer: Ad hominem attack. Hasty generalization.

33. “There was a riot between groups X and Y yesterday in which one person was killed. At this rate, I think the country will soon see a genocide where one of the two groups will completely wipe out the other.”

Answer: Slippery slope. Extrapolating too much.

34. “People who hate each other do not mingle. My friends X and Y do not mingle with each other at all. I think they hate each other”

Answer: Invalid deduction. A implies B, but B does not imply A.

35. “When the government has a good economic policy, the country sees periods of high growth. The past decade saw very high growth rates. Therefore, the government during that period must have implemented a very good economic policy.”

Answer: Invalid deduction. A implies B, but B does not imply A.

36. (Judy Hopps, a bunny rabbit character from the movie Zootopia thinks:) “I was bullied by Gideon Grey, a fox, when I was a child. I think foxes are not trustworthy in general.”

Answer: Hasty generalization.

37. “The use of pesticides in agriculture causes cancer. We eat only organic food that is free of all pesticides, so there is a very low probability of us having cancer.”

Answer: Invalid deduction. A implies B, but not A does not imply not B.

38. “I participated in a large scale cancer screening test conducted on campus. The test indicated something suspicious in my reports. I googled about the test online and found that the test detects

over 90% of all cancer cases correctly, with a reasonably low false positive and false negative rate. I am now terrified because I think I have a 90% probability of having cancer.”

Answer: Incorrect understanding of conditional probability.

39. “Because of the disruptions caused by the Ukraine-Russia war, 25% of all food grain exports are blocked at war-affected ports. This means that a country like India which has a large population to feed will suffer from a severe famine.”

Answer: Incorrect understanding of statistics. Misleading premises. India is not dependent on grain imports from the war-affected areas.

40. “My very wealthy uncle often says that money doesn’t buy you happiness, and not all rich people are happy in life. Therefore, I have decided to shun all wealth and remain poor all my life, so that I can at least be guaranteed happiness.”

Answer: Fallacious. Not all rich people are happy but this does not mean that being poor will give you happiness.

41. “I conducted a survey asking people which was the sweetest sounding Indian language they had heard. I collected responses from a large random sample across the entire country. The language Hindi received the highest votes amongst all the languages in the survey. Therefore, I think Hindi is the sweetest sounding Indian language.”

Answer: Sampling bias. Given that Hindi is the most widely spoken language in India, a random sample across the country will likely have many more Hindi speakers than speakers of other languages. It is also very likely that people will vote for a language they are familiar with.

42. (From an article 200 years in the future:) “USA was inhabited primarily by people of European ancestry in the 18th and 19th centuries. Around the middle of the 20th century, a large number of people of Indian and Chinese ancestry began to migrate into the country. Soon after, USA became the predominant economic force throughout the late 20th and all of the 21st century. The most probable cause of this greatness of USA is the smart genes, languages, culture and traditions brought into the country by those Asian immigrants.”

Answer: Incorrectly implying causation. Post hoc ergo propter hoc.

Instructions: Questions 43–50 contain several statements/theories. For each, identify whether it is falsifiable or not. If you answer falsifiable, also describe a method (that is reasonable and feasible by today’s standards) by which you could possibly attempt to falsify the theory. If you think it is not falsifiable, justify why that is so in one or two sentences.

We have given marks only if proper justification was provided along with the correct answer of falsifiable/not falsifiable. Many of you have given reasons why a statement is true or false, but we are looking for reasons why it is falsifiable. Please understand the difference.

43. “All swans are white.”

Answer: Falsifiable by finding a non-white swan.

44. “Moore’s law: the number of transistors on an integrated circuit will double approximately every 18 months.”

Answer: Falsifiable by finding an 18-month duration where the count did not double.

45. "The sun will rise in the west tomorrow."

Answer: Falsifiable by finding a day where the sun did not rise in the west.

46. "She is very cunning. She only tells undetectable lies."

Answer: Not falsifiable, because one can always claim that undetectable lies are being spoken all the time, even when the person's statements appear to be true. Therefore it is hard to convince the speaker that the person being discussed is not cunning.

47. "When we die, we all go to heaven or hell depending on how good or bad we have been in this life."

Answer: Not falsifiable, as no one knows what happens after death.

48. "No one may realize it, but your job is the best possible one you can get for your qualifications."

Answer: Not falsifiable. Even if you think some other job is good, the speaker can argue that you do not realize what is good for you.

49. "The government is quite corrupt. But we never hear of their scams because anyone who tries to expose them disappears without a trace."

Answer: Not falsifiable. It is hard to convince the speaker that the government is not corrupt. If you attempt to falsify this statement by showing that the government is clean because no scam has been exposed, the speaker can always say that those who would have exposed scams have been eliminated.

50. "Using masks reduces the risk of catching air-borne infectious diseases."

Answer: Falsifiable by conducting a statistical study measuring risk of disease spread with and without masks.

Instructions: Read a summary of this scientific study and answer questions 51–55 based on it. "Researchers conducted a study to understand the relationship between the malnutrition status of pregnant women and the IQ level of their future kids. Researchers measured the nutrition status of a large number of pregnant women and noted down the extent of their malnutrition, as indicated by their height and weight parameters. The women were randomly chosen from those who consulted at a government hospital of a large city over a period of one year. Five years later, researchers tracked down the children of these women, and measured their IQ scores. The researchers found that children born to malnourished mothers scored, on average, 10 points lower on the IQ test, than children born to well nourished mothers. The researchers concluded that malnourishment in the would-be mother increases the risk of lower IQ in future children."

51. Is this an active experimental study or a passive observational study?

Answer: This is a passive observational study.

52. Is the conclusion of the study falsifiable or not? Answer with suitable justification.

Answer: It is falsifiable by finding a sample of malnourished women whose children have high IQ.

53. The study attributes low IQ only to malnourishment. Can you think of any other confounding factor not accounted for in the study, that could be impacting the conclusion of the study? That is, can you find another reason, besides malnourishment, to explain the difference in IQ scores?

Answer: Many other reasons can impact IQ, including the educational status of the women.

54. Does the study show/prove causality between malnourishment in the mother and low IQ in the child? Answer with suitable justification.

Answer: The study does not show causality, but only correlation between mother's malnourishment and child's IQ.

55. Is the conclusion of the study impacted by a bias due to placebo effect in any way? Answer with suitable justification.

Answer: There is no placebo given to the participants, so there is no placebo effect here.

Instructions: Answer the following questions.

56. Identify the premises and conclusions in the following argument. "The use of genetically modified plants in India is questionable. There is no information on the long term usage of these plants. There is also the problem of cross contamination if these plants spread to other areas."

Answer: The first sentence is the conclusion and the rest are premises.

57. Assuming the following argument is cogent, identify the implied premise. "If we are to find a cure for diabetes, cancer, and other such diseases, we need to use the latest research available to us. Stem cell research is the way to go."

Answer: Stem cell research is the latest research for these diseases.

58. Give one reason why scientific temper spread to the masses only after the industrial revolution began in the 19th century, and not soon after the scientific revolution began in the 16th century?

Answer: Because the masses realized the importance of science only after it started materially impacting them and making their lives better.

59. Describe one advantage of the von Neumann architecture over the design of previous generation computers like ENIAC.

Answer: Easier to reprogram for a different task.

60. Describe one idea that contributed to computers evolving to doing real-time processing of data instead of batch processing.

Answer: Faster data transfer from I/O devices to memory.