

Q2

To draw the consumer's indifference map based on the given information, we need to understand the utility function $U = F(X, Z)$ and the properties of marginal utilities for goods X and Z .

1. Marginal Utilities (MU_x and MU_z):

- $M \cdot U_x \geq 0$: This implies that the marginal utility of X is non-negative, suggesting that X is a normal good. As more X is consumed, the consumer's utility does not decrease.
- $M \cdot U_z \leq 0$: This indicates that the marginal utility of Z is non-positive, implying that Z is a "bad" or negative utility commodity. Consuming more of Z decreases the consumer's utility.

2. Indifference Curves:

- Indifference curves represent combinations of goods X and Z that give the consumer the same level of utility (indifference).
- Since Z is a "bad" commodity (with negative marginal utility), the indifference curves will exhibit a characteristic feature:
 - They will be bowed inward towards the origin (concave to the origin).
 - This concavity arises because the consumer requires increasing amounts of X to

compensate for decreases in Z to maintain the same level of utility.

3. Indifference Map:

- Start by plotting indifference curves on a graph where the axes represent X and Z .
- Given $M \cdot U_x \geq 0$ and $M \cdot U_z \leq 0$, the indifference curves will slope downwards (due to diminishing marginal rate of substitution between X and Z) and will be concave to the origin.
- Indifference curves further from the origin (higher utility levels) will require more X and less Z compared to indifference curves closer to the origin.
- The degree of concavity depends on the specific form of $F(X, Z)$ (the utility function), but generally, they will not be straight lines nor convex towards the origin.
- The concave shape of indifference curves indicates that as the consumer gives up Z (a "bad" commodity), they require increasing amounts of X (a normal commodity) to maintain constant utility.
- This reflects the diminishing marginal rate of substitution between X and Z .

