INDIAN STATISTICAL INSTITUTE

Recruitment for posts of Scientific Assistant A (*Specialization: Economics*)

SECTION II

Syllabus for Online and Skill Tests

- **Economics:** Theory of consumer behaviour, Theory of production, Market structure under perfect competition, Monopoly, Price discrimination, Duopoly with Cournot and Bertrand competition, Public goods, Externalities.

- **Mathematics:** *Algebra:* Binomial theorem, AP, GP, Series, Permutations and combinations, Theory of quadratic equations.
  Linear Algebra: Vector spaces, Linear transformations, Matrix representations and elementary operations, Systems of linear equations.
  Calculus: Functions, Limits, Continuity, Differentiation of functions of one or two variables, Unconstrained optimization, Definite and indefinite integrals, Integration by parts and integration by substitution.

- **Elementary Statistics:** Elementary probability theory, Measures of central tendency, Dispersion, Correlation and regression, Probability distributions; Standard distributions: Binomial and Normal, Expectation and variance, Joint, conditional and marginal distributions, Distribution of function of a random variable, Multiple regression model (autocorrelation, multicollinearity, specification bias, exogeneity, and instrumental variables), Time series analysis (stationarity and ARMA model); Estimation, Testing of hypothesis, Sample survey (SRS, stratified, cluster).

Sample Questions for the Online Test

Note: For each of the questions there are four suggested answers, of which only one is correct. You will score

4 marks for each correctly answered question,
0 mark for each incorrectly answered question, and
1 mark for each unattempted question.

1. Consider an economy with two goods X and Y. Let the utility function be given by $u(x, y) = A\sqrt{xy}$ where $A > 0$, $x \geq 0$ is the amount of good X consumed and $y \geq 0$ is the amount of good Y consumed. Suppose that the budget constraint is given by $P_X x + P_Y y \leq M$ where $M > 0$ is the money income of the consumer and P_X and P_Y are the prices of the goods X and Y, respectively. Let $P_X > P_Y > 0$ and let (x^*, y^*) be the equilibrium quantities of this consumer who maximizes utility subject to the budget constraint. Then,

   (a) it must be that $x^* > y^*$.
   (b) it must be that $x^* = y^*$.
   (c) it must be that $x^* < y^*$.
   (d) it must be that $x^* + y^* = \frac{M}{P_Y}$.

2. Let the production function be $Y(L, K) = \min\{L, 2K\}$, where L and K are the labour and capital, respectively. Consider the cost function $C(L, K) = wL + rK$, where $w > 0$ denotes the wage earned by the labourer and $r > 0$ denotes the rent of capital. Suppose that (L^*, K^*) is the value of labour and capital at which the cost is minimized subject to the constraint $Y(L, K) \geq \bar{Y}$. Then,

   (a) $L^* = \bar{Y}$ and $K^* = \bar{Y}/2$.
   (b) $L^* = \bar{Y}/2$ and $K^* = \bar{Y}$.
   (c) $L^* = \bar{Y}$ and $K^* = \bar{Y}$.
   (d) none of the other options is correct.

3. Consider two Ricardian countries (Home and Foreign) which can potentially produce two goods (1 and 2) with consumers having identical preferences given by $u = C_1^{(1/4)} C_2^{(3/4)}$, where C_i is the level of consumption of good i where $i \in \{1, 2\}$. The technological coefficients are as follows:

$$\begin{aligned} a_{L1} &= 2 \\ a_{L2} &= 4 \\ a^*_{L1} &= 10 \\ a^*_{L2} &= 5, \end{aligned}$$

   where a_{L1} and a_{L2} are the labour requirements in the Home country for producing one unit of good 1 and good 2, respectively, and a^*_{L1} and a^*_{L2} are the labour requirements in the Foreign country for producing one unit of good 1 and good 2, respectively. Total labour endowments of the Home and the Foreign country are denoted by L and L^*, respectively, where

$$\begin{aligned} L &= 80 \\ L^* &= 400. \end{aligned}$$

   Let p_i denote the price of good i. If these two countries were allowed to trade freely in goods, then the equilibrium relative price p_1/p_2 is

   (a) 3. (b) 1/4. (c) 5. (d) none of the other options.

4. Suppose that there are two firms 1 and 2 that produce the same good. Let the inverted demand function be $P(q_1, q_2) = 1 - q_1 - q_2$, when firm 1 produces $q_1 \geq 0$ and firm 2 produces $q_2 \geq 0$. Suppose that the cost function of firm $i \in \{1, 2\}$ is given by $c_i(q_i) = \kappa_i q_i$ where $\kappa_i \in (0, \frac{1}{2})$. Note that there is no fixed cost for both the firms. Then, the Cournot equilibrium profit of firm 1 is

(a) $\frac{(1-\kappa_1+\kappa_2)^2}{9}$. (b) $\frac{(1-\kappa_1-\kappa_2)^2}{9}$. (c) $\frac{(1-2\kappa_1+\kappa_2)^2}{9}$. (d) $\frac{(1-2\kappa_2+\kappa_1)^2}{9}$.

5. Let a be an integer. Consider the system of equations:

$$\begin{aligned} \text{ax+y+z} &= 1 \\ \text{x-y+4z} &= 0 \\ \text{x+2y-2z} &= 3 \end{aligned}$$

Suppose that the value of z is 2 in any solution of the above system of equations. Then, the system of equations has

(a) a unique solution for arbitrary value of a.
(b) infinitely many solutions when the value of a is 2.
(c) a unique solution and the value of $a = 2$.
(d) none of the above options.

6. The value of $\binom{10}{1} + 2 \times 2 \times \binom{10}{2} + 3 \times 2^2 \times \binom{10}{3} + \cdots + 10 \times 2^9 \times \binom{10}{10}$ is

(a) 10×3^9. (b) 3^{10}. (c) 10×3^{10}. (d) none of the other options.

7. The number of integer solutions of the equation $a \times b \times c \times d = 1$ is

(a) 1. (b) 2. (c) 3. (d) 8.

8. Researchers are interested in the effect of students' coffee consumption on their exam performances. A sample of 55 students is taken from a large calculus class and each student's daily coffee consumption (oz/day) and final exam score (%) are recorded. Summary statistics:

$$\bar{x} = 25,\ s_x = 12,\ \bar{y} = 80,\ s_y = 3, \text{ and } r = 0.8.$$

The slope of the regression is

(a) 0.8. (b) more than 0.8.
(c) less than 0.8. (d) can not be determined from the given information.

9. For the problem in Question number 8, what is the predicted value of the exam score of a student who drinks 33 oz of coffee per day?

(a) 81.6 (b) 33 (c) 25 (d) none of the other options

10. For the problem in Question number 8, is there a relation between students' daily coffee consumption and their exam scores? Perform the test at 1 % significance level.

(a) yes (b) no
(c) cannot be determined (d) We need a separate sample to decide this.
