PVP 23

Code: 23BS1402

II B.Tech - II Semester – Regular / Supplementary Examinations
APRIL 2026

PROBABILITY AND STATISTICS
(Common for ME, CSE, IT, AIML, DS)

Duration: 3 hours   Max. Marks: 70

Note: 1. This question paper contains two Parts A and B.
2. Part-A contains 10 short answer questions. Each Question carries 2 Marks.
3. Part-B contains 5 essay questions with an internal choice from each unit. Each Question carries 10 marks.
4. All parts of Question paper must be answered in one place.

BL – Blooms Level   CO – Course Outcome

PART – A

		BL	CO
1.a)	Define sample space and conditional probability.	L1	CO1
1.b)	State the addition law and multiplication law of probability.	L1	CO1
1.c)	Explain variance.	L2	CO2
1.d)	Identify the mean of Poisson distribution, where $p(x=1)=p(x=2)$.	L1	CO2
1.e)	Write any two properties of correlation coefficient.	L2	CO2
1.f)	Write any two properties of regression coefficients.	L2	CO2
1.g)	Define critical region.	L1	CO3
1.h)	Define level of significance.	L1	CO3
1.i)	What are the conditions of the validity of chi-square test?	L1	CO3
1.j)	Explain F-test.	L3	CO3

PART – B

			BL	CO	Max. Marks
UNIT-I					
2		The median and mode of the following wage distributions are known to be Rs 33.50 and Rs 34 respectively. Find the values of P, Q, and R.	L2	CO2	10 M

Wages	0-10	10-20	20-30	30-40	40-50	50-60	60-70
frequency	4	16	P	Q	R	6	4

			BL	CO	Max. Marks
OR					
3	a)	Box A contains 5 red and 3 white marbles and box B contains 2 red and 6 white marbles. If a marble is drawn from each box, what is the probability that they are both of same color?	L3	CO2	5 M
	b)	The chance that doctor A will diagnose a disease X correctly is 60%. The chance that a patient will die by his treatment after correct diagnosis is 40% and the chance of death by wrong diagnosis is 70%. A patient of doctor A, who had disease X, died. What is the chance that his disease was diagnosed correctly?	L4	CO4	5 M
UNIT-II					
4	a)	The mean of Binomial distribution is 3 and the variance is 9/4. Find i) the value of 'n' ii) $P(X \geq 7)$ iii) $P(1 \leq X < 6)$	L3	CO2	5 M
	b)	If X is a normal variate with mean 30 and standard deviation 5. Calculate i) $P(26 \leq X \leq 40)$ ii) $P(X \geq 45)$.	L4	CO4	5 M
OR					
5	a)	A random variable X has the following probability function	L3	CO2	5 M

X	1	2	3	4	5	6	7	8
P(X)	k	2k	3k	4k	5k	6k	7k	8k

Find (i) k (ii) $P(X \leq 2) and\ P(2 \leq X \leq 5)$

<table>
<tr><td></td><td>b)</td><td>A car-hire firm has two cars which it hires out day by day. The number of demands for a car on each day is distributed as a Poisson distribution with mean 1.5. Calculate the proportions of days (i) on which there is no demand (ii) on which demand is refused.</td><td>L4</td><td>CO4</td><td>5 M</td></tr>
<tr><td colspan="6">UNIT-III</td></tr>
<tr><td>6</td><td>a)</td><td>The equation of two regression lines are $7x - 16y + 9 = 0 \; and \; 5y - 4x - 3 = 0$. Find the correlation coefficient and the means of x and y</td><td>L3</td><td>CO4</td><td>5 M</td></tr>
<tr><td></td><td>b)</td><td>Fit a curve $y = ax^b$ to the following data
<table>
<tr><td>x</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td>y</td><td>2.98</td><td>4.26</td><td>5.21</td><td>6.10</td><td>6.8</td><td>7.5</td></tr>
</table></td><td>L4</td><td>CO4</td><td>5 M</td></tr>
<tr><td colspan="6">OR</td></tr>
<tr><td>7</td><td>a)</td><td>Following are the ranks obtained by 10 students in two subjects, Statistics and Mathematics. To what extent the knowledge of the students in two subjects is related?
<table>
<tr><td>Statistics</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr>
<tr><td>Mathematics</td><td>2</td><td>4</td><td>1</td><td>5</td><td>3</td><td>9</td><td>7</td><td>10</td><td>6</td><td>8</td></tr>
</table></td><td>L4</td><td>CO4</td><td>5 M</td></tr>
<tr><td></td><td>b)</td><td>Determine the equation of a straight line of the form $y = a + bx$ that best fits the data.
<table>
<tr><td>X</td><td>10</td><td>12</td><td>13</td><td>16</td><td>17</td><td>20</td><td>25</td></tr>
<tr><td>Y</td><td>10</td><td>22</td><td>24</td><td>27</td><td>29</td><td>33</td><td>37</td></tr>
</table></td><td>L3</td><td>CO2</td><td>5 M</td></tr>
<tr><td colspan="6">UNIT-IV</td></tr>
<tr><td>8</td><td>a)</td><td>In a random sample of 100 packages shipped by air freight 13 had some damage. Construct 95% confidence interval for the true proportion of damage package.</td><td>L3</td><td>CO3</td><td>5 M</td></tr>
<tr><td></td><td>b)</td><td>In a sample of 1000 people in Karnataka 540 are rice eaters and the rest are wheat eaters. Can we assume that both rice and wheat are equally popular in this state at 1% level of significance?</td><td>L3</td><td>CO5</td><td>5 M</td></tr>
<tr><td colspan="6">OR</td></tr>
<tr><td>9</td><td>a)</td><td>A machine puts out 16 imperfect articles in a sample of 500 articles. After the machine is</td><td>L2</td><td>CO3</td><td>5 M</td></tr>
</table>

		overhauled it puts out 3 imperfect articles in a sample of 100 articles. Has the machine improved?			
	b)	In a sample of 600 students of a certain college 400 are found to use ball pens. In another college from a sample of 900 students 450 were found to use ball pens. Test whether 2 colleges are significantly different with respect to the habit of using ball pens.	L4	CO5	5 M
UNIT-V					
10	a)	The average breaking strength of the steel rods is specified to be 18.5 thousand pounds. To test this sample of 14 rods were tested. The mean and standard deviations obtained were 17.85 and 1.955 respectively. Is the result of experiment significant?	L3	CO3	5 M
	b)	A random sample of size 20 from a normal population gives a mean of 42 and a variance of 25. Test the hypothesis that the sample came from a population of mean 40 at 5% level of significance.	L3	CO3	5 M
OR					
11	a)	Pumpkins were grown under two experimental conditions. Two random samples of 11 and 9 pumpkins, show that the sample standard deviations of their weights as 0.8 and 0.5 respectively. Assuming that the weight distributions are normal, test the hypothesis that the true variances are equal.	L4	CO5	5 M
	b)	A sample analysis of examination results of 500 students was made. It was found that 220 students had failed, 170 had secured a third class, 90 were placed in second class and 20 got a first class. Do these figures commensurate with the general examination result which is in the ratio 4:3:2:1 for the various categories respectively.	L4	CO5	5 M

code: 23BS1402 (1)

II B.Tech. II Sem - Regular April 2026.

Probability and Statistics.

(Common to ME, CSE, IT, AIML, DS)

PART - A

(1a) Sample space:- The set of all possible events in a trial is called a sample space for the trial. → 1M

Conditional Probability:- If E_1 and E_2 are two events in a Sample space S and $P(E_1) \neq 0$, then the probability of E_2, after the event E_1 has occured is called Conditional probability of the event E_2 given E_1. → 1M

(1b) Addition law:- If S is a Sample Space and E_1, E_2 are any events in S then $P(E_1 \cup E_2) = P(E_1) + P(E_2) - P(E_1 \cap E_2)$ 1M

multiplication law:- In a random experiment if E_1, E_2 are two events such that $P(E_1) \neq 0, P(E_2) \neq 0$

then $P(E_1 \cap E_2) = P(E_2) \cdot P(E_1 | E_2)$
$= P(E_1) \cdot P(E_2 | E_1)$. → 1M

(1c) Variance is defined as the average of the squared differences from the mean. $\sigma^2 = \frac{\sum_{i=1}^{N} (x_i - \mu)^2}{N}$ → 2M

(1d) $P(x=1) = P(x=2)$

$\frac{\cancel{e^{-\lambda}} \lambda^1}{1!} = \frac{\cancel{e^{-\lambda}} \lambda^2}{2}$

$\lambda^2 - 2\lambda = 0$

$\Rightarrow \lambda = 0, 2$

$\because \lambda > 0;$

$\therefore \lambda = 2$ → 2M

(1e) (1) r lies b/w -1 and 1 inclusive → 1M

(2) $r = 1$ → perfect +ve linear correlation

$r = -1$ " -ve

$r = 0$. (no correlation)

→ 1M

(1 f) 1. $r^2 = b_{xy} \cdot b_{yx}$

$r = \pm\sqrt{b_{xy}\, b_{yx}}$ —— (1M)

2. If one of the regression coefficient is greater than unity then the other must be less than unity. ⟶ (1M)

(1 g) critical region:- The set of values of the test statistic for which the null hypothesis Ho rejected. Also called the rejection region. ⟶ (2M)

(1 h) The size of the critical region is equal to the level of significance. ⟶ (2M)

(1 i) The sum of the observed frequencies must equal to the sum of expected frequencies.

i.e, $\Sigma O_i = \Sigma E_i = N$ —— (2M)

Total frequency N should be reasonably large. generally $N \geq 50$.

(1 j) F-test is used to compare the variances of two populations. —— (1M)

$F = \frac{S_1^2}{S_2^2} \quad (S_1^2 > S_2^2)$ —— (1M).

The larger variance is always placed in the numerator.

(2) Given that median = 33.50; Mode = 34.

Total $N = 4+16+P+Q+R+6+4 = 30+P+Q+R$.

mode lies in the class 30-40 ∴ $l = 30$; $f_1 = Q$; $f_0 = P$; $f_2 = R$; $h = 10$.

$\text{Mode} = l + \frac{f_1 - f_0}{2f_1 - f_0 - f_2} \times h$

$34 = 30 + \frac{Q-P}{2Q-P-R} \times 10$.

$\Rightarrow 3P - Q - 2R = 0$ —— (1) ⟶ (5M)

$\text{Median} = l + \frac{\frac{N}{2} - c}{f} \times h$

from (1) $Q = 3P - 2R$

$$35.5 = 30 + \frac{\frac{30+P+Q+R}{2} - (20+P)}{Q} \times 10$$

Check for median.

$$\Rightarrow P - 0.3Q + R = 10$$

$$l + \frac{\frac{N}{2} - C}{Q} \times h.$$

from (1) $P - 0.3(3P - 2R) + R = 10.$

$$\Rightarrow P + 16R = 100 \longrightarrow 3M$$

$$= 30 + \frac{85-56}{100} \times 10$$

$$= 32.9$$

$$\simeq 33.$$

Try for $R = 4$: then $P = 36$

$$Q = 3P - 2R$$
$$= 100. \longrightarrow 2M$$

$N = 170$; $\frac{N}{2} = 85$; $C = 20 + P$
$= 56.$

3a) let E_1 = The event that the marbles is drawn from box A is red.
E_2 = The event that the marbles from box B is red.

$P(E_1) = \frac{1}{2} \cdot \frac{5}{8} = \frac{5}{16}$;

$P(E_2) = \frac{1}{2} \cdot \frac{2}{8} = \frac{1}{8}$

$P(E_1 \cap E_2) = P(E_1) \cdot P(E_2) = \frac{5}{128} \longrightarrow 2M$

E_3: The event that the marbles drawn from box A and is white; E_4: The event that the marble drawn from box B is white.

$P(E_3) = \frac{1}{2} \cdot \frac{3}{8} = \frac{3}{16}$;

$\frac{5\times2}{8\times8} + \frac{3\times6}{8\times8}$

$P(E_4) = \frac{1}{2} \cdot \frac{6}{8} = 3/8.$

$P(E_3 \cap E_2) = \frac{9}{128}. \longrightarrow 2M$ $= \frac{10}{64} + \frac{18}{64} = \frac{28}{64}$

The probability that the marbles of the same color

$P(E_1 \cap E_2) + P(E_3 \cap E_4)$

$= \frac{5}{128} + \frac{9}{128} = \frac{7}{64}. \longrightarrow 1M$ $\frac{28}{64}$

3b) let E_1 = The event that "disease x is diagnosed correctly by doctor A

E_2 = The event that a patient of doctor A who has disease x died.

$P(E_1) = 0.6 : \quad P(\overline{E_1}) = 0.4$

$P(E_2|E_1) = 0.4 \quad P(E_2|\overline{E_1}) = 0.7 \longrightarrow$ 2M

by Bayes th: $P(E_1|E_2) = \dfrac{P(E_1)\cdot P(E_2|E_1)}{P(E_1)\cdot P(E_2|E_1) + P(\overline{E_1})\cdot P(E_2|\overline{E_1})}$ $\to$ 1M

$= \dfrac{0.6 \times 0.4}{0.6 \times 0.4 + 0.4 \times 0.7}$

$= \dfrac{6}{13} = \underline{0.4615} \longrightarrow$ 2M

4a) Mean of the binomial distribution = 3; variance of the binomial distribution is 9/4 — (2)

$\therefore np = 3$ — (1)

$\therefore npq = 9/4$

$\therefore \dfrac{(2)}{(1)} \Rightarrow q = 3/4 \quad \therefore p = 1/4 ; n = 12$

$P(X \geq 7) = 1 - P(X < 7)$

$= 1 - [P(X=0) + P(X=1) + \cdots + P(X=6)]$

$= 1 - [12_{C_0}(\tfrac{1}{4})^0(\tfrac{3}{4})^{12} + 12_{C_1}(\tfrac{1}{4})^1(\tfrac{3}{4})^{11} + \cdots + 12_{C_6}(\tfrac{1}{4})^6(\tfrac{3}{4})^6]$

$= \underline{0.1446} \longrightarrow$ 3M

$P(1 \leq X < 6) = P(X=1) + \cdots + P(X=5)$

$= 12_{C_1}(1/4)^1(\tfrac{3}{4})^{11} + 12_{C_2}(\tfrac{1}{4})^2(\tfrac{3}{4})^{10} + \cdots + 12_{C_5}(\tfrac{1}{4})^5(\tfrac{3}{4})^7$

$= \underline{0.82} \longrightarrow$ 2M

4b) $\mu = 30 ; \sigma = 5$

when $x = 26$; $z = \dfrac{x-\mu}{\sigma} = \dfrac{26-30}{5} = -0.8$

when $x = 40$; $z = 2$

$\therefore P(26 \leq x \leq 40) = P(-0.8 \leq z < 2)$

$= \int_{-0.8}^{0} \phi(z)\,dz + \int_0^2 \phi(z)\,dz$

$= 0.4772 + 0.2881 = \underline{0.7653} \to$ 3M

(ii) when $x = 45$; $z = 3$

$$P(x \geq 45) = P(z \geq 3)$$
$$= 0.5 - \int_0^3 \phi(z)\,dz$$
$$= 0.5 - 0.4986$$
$$= 0.00135 \longrightarrow 2M$$

5a

$$\sum_{x=1}^{8} P(x) = 1$$
$$\therefore \quad 36k = 1 \Rightarrow k = 1/36 \longrightarrow 1M$$

$$P(X \leq 2) = P(X=1) + P(X=2)$$
$$= 3k$$
$$= 3/36 = \cancel{1/12}\ \frac{1}{12} \longrightarrow 2M$$

$$P(2 \leq X \leq 5) = P(X=2) + P(X=3) + P(X=4) + P(X=5)$$
$$= 14k$$
$$= 14/36 = 7/18 \longrightarrow 2M$$

5b.

mean $= 1.5 \Rightarrow \lambda = 1.5$

$$P(X = x) = \frac{e^{-\lambda}\lambda^x}{\lfloor x}$$

(i) $P(\text{no demand}) = P(0) = \dfrac{e^{-1.5}(1.5)^0}{\lfloor 0} = 0.2231 \longrightarrow 2M$

(ii) Some demand is refused if the no. of demands is more than 2.

$$P(\text{demand is refused}) = P(X > 2) = 1 - [P(X=0) + P(X=1) + P(X=2)]$$

$$= 1 - \left\{ e^{-1.5} + \frac{e^{-1.5}(1.5)}{\lfloor 1} + \frac{e^{-1.5}(1.5)^2}{\lfloor 2} \right\}$$

$$= 1 - \cancel{3.625}^{\,4.375}(e^{-1.5})$$

$$= 1 - \cancel{0.8088}^{\,1.059}$$

$$= 0.9\cancel{4}13 \longrightarrow 3M$$

$= 0.1912$

6a. Given regression lines. $7x - 16y = -9$ — ①

$-4x + 5y = 3$ — ②

solve these two eqns $x = -0.103$; $y = 0.517$

$\therefore \bar{x} = -0.103$; $\bar{y} = 0.517$. $\longrightarrow$ 2m

$16y = 7x + 9$; $4x = 5y - 3$

$y = \frac{7}{16}x + \frac{9}{16}$; $x = \frac{5}{4}y - 3/4$

$\therefore b_{xy} = 5/4$ $\longrightarrow$ 2m

$b_{yx} = 7/16$

$r^2 = \frac{7}{16} \times \frac{5}{4} = \frac{35}{64} = 0.5469$.

$\therefore r = 0.7395$ ($\because r$ is +ve) $\longrightarrow$ 1m

6b $y = ax^b$.

$\log y = \log a + b \log x$.

$Y = A + bX$ where $Y = \log y$; $A = \log a$; $X = \log x$.

normal eqs are $\Sigma Y = nA + b\Sigma X$

$\Sigma XY = A\Sigma X + b\Sigma X^2$ $\longrightarrow$ 1m

$\Sigma x = 21$; $\Sigma Y = 4.3132$; $\Sigma X = 2.8571$; $\Sigma XY = 2.2266$

$\Sigma X^2 = 1.7744$ $\longrightarrow$ 1m

$$\left.\begin{aligned} 4.3132 &= 6A + 2.8571b \quad ① \\ 2.2666 &= 2.8571A + 1.7744b \quad ② \end{aligned}\right\}$$ normal eqns. for base 10. $\longrightarrow$ 2m

Solve ① & ②: $b = 0.5139$; $A = 0.4741$

$a = 10^A = 2.979$.

required curve $y = ax^b$

$= 2.979 \cdot x^{0.5139}$ $\longrightarrow$ 1m

7a) let X = statistics ; Y = Mathematics.
x = rank in X $\quad$ y = rank in Y. $\longrightarrow$ 1m

$d = x - y$; $\Sigma d^2 = 40$ $\longrightarrow$ 2m $\quad$ n = no of students $= 10$

$$r = 1 - \frac{6 \Sigma d^2}{n(n^2-1)}$$

$$= 1 - \frac{6 \times 40}{10(100-1)} = 0.7576 \longrightarrow 2m$$

7b) let the straight line eqn be $y = a + bx$.
normal eqns are $\Sigma y = na + b\Sigma x$
$\Sigma xy = a\Sigma x + b\Sigma x^2$ ——— 1m

$\Sigma x = 113$; $\Sigma y = 182$; $\Sigma xy = 3186$; $\Sigma x^2 = 1983$ — 2

normal eqns $\left.\begin{array}{l} 182 = 7a + 113b \\ 3186 = 113a + 1983b \end{array}\right\}$ $\longrightarrow$ 1m

solve these eqns. $a = 0.8$; $b = 1.561$
$\therefore$ required curve is $y = 0.8 + 1.56x$ $\longrightarrow$ 1m

8a) Confidence interval $\left(P - z_{\alpha/2}\sqrt{\frac{PQ}{n}}, P + z_{\alpha/2}\sqrt{\frac{PQ}{n}}\right)$ $\longrightarrow$ 1m
No of damaged packages : $x = 13$.
n = sample size $= 100$
P = proportion of bad packages in the sample
$P = \frac{x}{n} = \frac{13}{100} = 0.13$ $\quad$ $z_{\alpha/2} = 1.96$ $\longrightarrow$ 2m
$Q = 1 - P = 0.87$

$\sqrt{\frac{PQ}{n}} = 0.0337$; $z_{\alpha/2}\sqrt{\frac{PQ}{n}} = 0.96 \times 0.0337$
$= 0.066$

$\therefore$ Confidence interval $(0.064, 0.196)$ $\longrightarrow$ 2m

(8b)

$n = 1000$

p = Sample proportion of rice eaters $= \frac{540}{1000} = 0.54$

P = population proportion of rice eaters $= 1/2 = 0.5$

$\therefore Q = 0.5$ → (1m)

Null hypothesis H_0: Both rice eaters and wheat eaters are equally popular in the State.

Alternative hypothesis H_1: $P \neq 0.5$ (two tailed test)

test statistic $z_{cal} = \frac{p - P}{\sqrt{\frac{PQ}{n}}} = \frac{0.54 - 0.5}{\sqrt{\frac{0.5 \times 0.5}{1000}}} = 2.532$ → (3m)

7c 7oo

$\alpha = 0.01$; $z_{\alpha/2} = 2.58$ (tabulated value)

$\therefore |z|_{cal} < |z|_{tab}$

$2.53 < 2.58$;

$\therefore$ accept H_0. → (1m)

(9a)

~~H_0~~ Given that $n_1 = 500$; $n_2 = 100$; $x_1 = 16$; $x_2 = 3$

$p_1 = \frac{x_1}{n_1} = 0.032$; $p_2 = 0.03$; $p = \frac{x_1 + x_2}{n_1 + n_2} = \frac{19}{600} = 0.0316$

$\therefore q = 0.9684$ $\qquad$ $q = 0.9684$. → (1m)

$H_0 : p_1 = p_2$

$H_1 : p_2 < p_1$

l.o.s $= 0.05$

$z_{cal} = \frac{p_1 - p_2}{\sqrt{pq\left[\frac{1}{n_1} + \frac{1}{n_2}\right]}}$ → (2m)

$\Rightarrow \frac{0.032 - 0.03}{\sqrt{0.0316 \times 0.9684\left[\frac{1}{500} + \frac{1}{100}\right]}} = 0.1043$.

$|z|_{tab} = 1.645$

$\therefore |z|_{cal} < |z|_{tab}$. → (2m)

$\therefore$ accept H_0.

9b

x_1 = no. of students who use ball pens of Ist college = 400

x_2 = " " " 2nd " = 900

$H_0: p_1 = p_2$

$H_1: p_1 \neq p_2$

n_1 = Ist sample size = 600; $n_2 = 900$

l.o.s = 5%

$p_1 = \frac{2}{3}$; $p_2 = 1/2$; $P = \frac{x_1+x_2}{n_1+n_2} = \frac{850}{1500} = \frac{17}{30}$ → 2m

test statistic

$Q = \frac{13}{30}$ $z_{cal} = \dfrac{2/3 - 1/2}{\sqrt{\frac{17}{30} \cdot \frac{13}{30} \cdot \left[\frac{1}{600}+\frac{1}{900}\right]}} = \cancel{6.49}\ 2.125$ → 2M

$|Z|_{tab}$ at 5% 1.96.

$|Z|_{cal} > |Z|_{tab}$.

∴ Reject H_0. → 1M

∴ There is a significant difference b/w two proportions

10a

Sample size $n = 14$; Sample mean $\bar{x} = 17.85$;

S.D. $\sigma = 1.955$; population mean $\mu = 18.5$

d.o.f. $\nu = n-1 = 13$; l.o.s = 5%.

Null hypothesis $H_0: \mu = 18.5$

Alternative hypothesis $H_1: \mu \neq 18.5$ → 2m

test statistic $t_{cal} = \dfrac{\bar{x}-\mu}{\frac{s}{\sqrt{n-1}}} = \dfrac{17.85-18.5}{\frac{1.955}{\sqrt{13}}} = -1.199$ → 2m

-1.24 $\sqrt{14}$

$|t|_{cal} < |t|_{tab}$

$1.99 < 2.16$. → 1M

we accept H_0 at 5% l.o.s.

10b.

Sample size $n = 20$; Sample mean $\bar{x} = 42$; $s = 5$

$\mu = 40$; l.o.s = 5%.

RR — 2304262308 $H_0: \mu = \mu_0$

LA — 2306 ✓ $H_1: \mu \neq 40$ (two tailed test). → (1m)

KL — 2305 ✓

2303 ✓ test statistic $t_{cal} = \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n-1}}} = \frac{42-40}{\frac{5}{\sqrt{19}}} = 1.7406$ → (2m)

Bn — 2302 ✓

SG —

$|t|_{tab} = |t|_{0.025, 19} = 2.093$.

$\therefore |t|_{cal} < |t|_{tab}$ → (2m)

accept H_0.

(11a). $n_1 = 11$; $n_2 = 9$; $s_1 = 0.8$; $s_2 = 0.5$.

Null hypothesis : $H_0: \sigma_1^2 = \sigma_2^2$

Alternative hypothesis : $H_1: \sigma_1^2 \neq \sigma_2^2$; l.o.s = 5%.

$S_1^2 = \frac{n_1 s_1^2}{n_1 - 1} = \frac{11 \times (0.8)^2}{10} = 0.704$ → (1m)

$S_2^2 = \frac{n_2 s_2^2}{n_2 - 1} = \frac{9 \times (0.5)^2}{8} = 0.281$ → (1m)

test statistic $F_{cal} = \frac{S_1^2}{S_2^2} = 2.5$ ($S_1^2 > S_2^2$) → (2m).

$F_{tab} = F_{0.05}(10, 8) = 3.35$ $\therefore |F|_{cal} < |F|_{tab}$. → (1m)

$2.5 < 3.35$

accept H_0

(11b). Null hypothesis H_0: The observed results commensurate with the general examination results.

expected frequencies are in the ratio: 4 : 3 : 2 : 1

expected frequencies we divide the total frequency 500

total frequency = 500 ; we divide the total frequency 500 in the ratio 4 : 3 : 2 : 1 $\therefore$ E_i = 200, 150, 100, 50

O_i = 220, 170, 90, 20 } → (2m)

$\chi^2_{cal} = \frac{\Sigma (O_i - E_i)^2}{E_i} = \frac{(220-200)^2}{200} + \frac{(170-150)^2}{150} + \frac{(90-100)^2}{100} + \frac{(20-50)^2}{50}$

$= 23.667$; $\chi^2_{tab} = \chi^2_{0.05, 3} = 7.81$ → (2m)

$\chi^2_{cal} > \chi^2_{tab}$ $\therefore$ we reject null hypothesis H_0. → (1m)