Question No. 1:

Naive Bayes Classification.

$P(\text{Class} \mid \text{Data}) = P(\text{Class}) \times P(\text{Data} \mid \text{Class})$

$P(\text{Class}) \Rightarrow$ $P(\text{Partial}) = 4/14$

$P(\text{Normal}) = 8/14$

$P(\text{Abnrml}) = 2/14$

Comparision of Data with labels:-

⇒ P(Exposure | Class)

	Partial	Normal	Abnrml	Total
No	2/4	3/8	2/2	7
Gd	0/4	3/8	0/2	3
Av	2/4	2/8	0/2	4

⇒ P(Garage Type)

	Partial	Normal	Abnrml	Total
Attchd	2/4	6/8	0/2	8
Detchd	0/4	2/8	1/2	3
Builtin	2/4	0/8	1/2	3

⇒ P(Mass | Class)

	Partial	Normal	Abnrml	Total
Brkface	2/4	3/8	1/2	6
Stone	1/4	3/8	1/2	5
tile	1/4	2/8	0/2	3

⇒ P(Type 2 | Class)

	Partial	Normal	Abnormal	Total
G	3/4	6/8	0/2	9
A	1/4	2/8	2/2	5

Test set:

Exposure	Garage Type	Mass	Type1	Sale Condition
Gd	Detchd	Tile	A	?

⇒ P(Partial | Data) = P(Partial) × P(Data | Partial)

P(Partial | Data) = P(Partial) × P(Exposure | Class) × P(GT | Class) × P(Mass | Class) × P(type1 | Class)

∴ Class = Partial

$$P(\text{Partial} \mid \text{Data}) = \frac{4}{14} \times 0 \times 0 \times \frac{1}{4} \times \frac{1}{4}$$

P(Partial | Data) = 0

⇒ P(Normal | Data) = P(Normal) × P(Exposure | Normal) × P(GT | Normal) × P(Mass | Normal) × P(Type1 | Normal)

$$P(\text{Normal} \mid \text{Data}) = \frac{8}{14} \times \frac{3}{8} \times \frac{3}{8} \times \frac{3}{8} \times \frac{3}{8}$$

$$= \frac{3}{896}$$

$$= 3.35482 \times 10^{-3} \Rightarrow 0.00334821$$

$P(Partial) + P(Normal) + P(Abnrml) = 1$

$0 + 0.0034821 + P(Abnrml) = 1$

$P(Abnrml) = 1 - 0.0034821$

$P(Abnrml) = 0.9965179$

Sale condition will be Abnrml.

QUESTION NO. 2:

Gaussian Naive Bayes classification

$P(Class | Data) = P(Class) \times P(Data | Class)$

Formulas to use:

Mean $\longrightarrow$ $U = \frac{1}{N} \sum X_i$

Variance $\longrightarrow$ $\sigma^2 = \frac{(X-U)^2}{n-1}$

$f(x) = \frac{1}{2\pi\sigma^2} e^{-\left[\frac{(X-U)^2}{2\sigma^2}\right]}$

—	R_m	R_v	T_m	T_v	P_m	P_v
M	17.992	14.50032	16.824	22.5071	119.676	575.279
B	12.2748	2.917048	17.282	19.5699	79.012	136.1527

$$M\text{-}R_v = \frac{(17.99-17.992)^2}{4} + \frac{(20.57-17.992)^2}{4} + \frac{(19.69-17.992)^2}{4}$$
$$+ \frac{(11.42-17.992)^2}{4} + \frac{(20.29-17.992)^2}{4}$$

$$MR_v = 0.000001 + 1.661521 + 0.720801 + 10.799796 + 1.320201$$

$$M\text{-}R_v = 14.500032$$

$$B\text{-}R_v = \frac{(13.54-12.278)^2}{4} + \frac{(13.08-12.278)^2}{4} + \frac{(19.504-12.27)^2}{4}$$
$$+ \frac{(13.49-12.278)^2}{4} + \frac{(11.76-12.278)^2}{4}$$

$$B\text{-}R_v = 0.398161 + 0.160801 + 1.923769 + 0.367236 + 0.067081$$

$$B\text{-}R_v = 2.917048$$

$$M\text{-}T_v = \frac{(10.38-16.824)^2}{4} + \frac{(17.77-16.824)^2}{4} + \frac{(21.25-16.824)^2}{4}$$
$$\frac{(20.38-16.824)^2}{4} + \frac{(14.34-16.824)^2}{4}$$

$$M\text{-}T_v = 10.381284 + 0.223729 + 6.165269 + 4.194304 + 1.542564$$

$$M\text{-}T_v = 22.5071$$

$$B\text{-}T_v = \frac{(14.36-17.282)^2}{4} + \frac{(15.71-17.282)^2}{4} + \frac{(12.44-17.282)^2}{4}$$
$$\frac{(22.3-17.282)^2}{4} + \frac{(21.6-17.282)^2}{4}$$

$$B\text{-}T_v = 2.134521 + 0.617798 + 5.881241 + 6.295081$$

$B-T_V = 19.5699$

$M-P_V = (122.8-119.676)^2 + (132.9-119.676)^2$

$+ (130-119.676)^2 + (77.54-119.676)^2 + (135.1-119.676)^2$

$M-P_V = 2.439844 + 43.718544 + 2.6.516244$

$443.018304 + 58.706244 = 575.297$

$M-P_V = 575.297$

$B-P_V = (87.46-79.012)^2 + (86.63-79.012)^2 + (80.34-79.012)^2$

$+ (86.91-79.012)^2 + (74.72-79.012)^2$

$B-P_V = 17.842176 + 10.94981 + 87.160896 +$

$15.594601 + 4.605316$

$B-P_V = 136.1527$

Test data :

Diagnosis	Radius mean	Texture Mean	Perimeter Mean
?	15	11	110

$$P(M \mid Data) = P(M) \times P(RM \mid M) \times P(TM \mid M) P(PM \mid M)$$

$$P(RM \mid M) = \frac{1}{\sqrt{2\pi}\,\sigma_{RM}} \times e^{-\left[\frac{(x_{RM} - \mu_{RM})^2}{2\sigma_{RM}}\right]}$$

$$P(RM \mid M) = \frac{1}{\sqrt{2(3.14)(14.56032)}} \times e^{-\left[\frac{(15 - 17.99232)^2}{2(14.56032)}\right]}$$

$$P(RM \mid M) = 0.1098 \times 2.718^{-\left[\frac{8.9580}{29.00064}\right]}$$

$$= 0.3086$$

$$P(RM \mid M) = 0.1098 \times 2.718$$

$$P(RM \mid M) = 0.8064$$

$$P(TM \mid M) = \frac{1}{\sqrt{2\pi}\,\sigma_{TM}} \times e^{-\left[\frac{(x_{TM} - \mu_{TM})^2}{2\sigma_{TM}}\right]}$$

$$P(TM \mid M) = 0.007074 \times 2.718^{-\left[\frac{33.9189}{45.0142}\right]}$$

$$= 0.7535$$

$$P(TM \mid M) = 0.007074 \times 2.718$$

$$P(TM \mid M) = 0.00336$$

$$P(PM|M) = \frac{1}{\sqrt{2\pi\sigma_{PM}^2}} \times e^{-\frac{(X_{PM}-\mu_{PM})^2}{2\sigma_{PM}}}$$

$$P(PM|M) = 0.0002767 \times 2.718^{-\left[\frac{93.6249}{1150.558}\right]}$$

$$P(PM|M) = 0.0002767 \times 2.718^{-0.08137}$$

$$P(PM|M) = 0.000255$$

$$P(M|Data) = \frac{1}{2} \times 0.8064 \times 0.0033 \times 0.000255$$

$$P(M|Data) = 0.0000003392$$

$$P(B|Data) = 1 - 0.0000003392$$

$$P(B|Data) = 0.9999996607$$

Diagnose will be Benign (B).

Question No 3:
Linear Regression.

X BMI	Y MI charges	XY	X^2	
27.9	16884.92	471071.691	778.41	
33.77	1725.552	58271.8891	1140.4129	
33	4449.462	146832.246	1089	
22.705	21984.47	499157.3914	515.517	
28.88	3866.855	111674.7724	834.0544	
25.74	3756.622	96698.4502	662.547	
33.44	8240.59	27,5585.329	1118.233	
27.74	7281.506	201988.976	769.507	
29.83	6406.411	191103.2401	889.828	
25.84	28923.14	747373.937	667.7056	
26.22	2721.321	71383.036	687.4884	
315.065	106240.849	2871087.9606	9152.7033	SUM
$\bar{X}$=28.6422	$\bar{Y}$= 9658.259	$\overline{XY}$ 261009.9964	$\overline{X^2}$=832.0639	Mean
$\bar{X}^2$= 820.3756				

$$W_1 = \frac{\overline{XY} - (\bar{X})(\bar{Y})}{\overline{X^2} - \overline{X}^2}$$

$$W_0 = \overline{Y} - W_1 \overline{X}_1$$

$$W_1 = \frac{\overline{XY} - (\overline{X})(\overline{Y})}{\overline{X^2} - \overline{X}^2}$$

$$W_1 = \frac{261007.9964 - (28.6422)(9658.259)}{832.0639 - 820.3756}$$

$$W_1 = \frac{261007.9964 - 276633.7859}{11.6883}$$

$$W_1 = \frac{-15625.7895}{11.6883}$$

$$W_1 = -1336.34069 \quad 1337.8744$$

$$W_0 = 9658.259 - (-1336.34069)(28.6422)$$

$$W_0 = 9658.259 + 38275.7373$$

$$W_0 = +47933.9963$$

$$\hat{Y}_{26.29} = (-1336.34069)(26.29) + 47933.9963$$

$$\hat{Y}_{26.29} = -35132.3967 + 47933.9963$$

$$\bar{Y}_{26.29} = 12801.5995 \quad 12787.568$$

$$\hat{Y}_{34.4} = (-1336.34069)(34.4) + 47933.9963$$

$$\hat{Y}_{34.4} = -45970.1197 + 47933.9963$$

$$Y_{X=34.4} = 1963.8765 \quad 1945.516$$

$\hat{y}_{39.82} = (-1336.8744)(39.82) + 47933.9963$

$\hat{y}_{39.82} = -5300$

$y_{24.6} = (-1336.8744)(24.6) + 47933.963$

$y_{24.6} = 15046.886$

$y_{30.78} = 6785.0022$