### $\mathbf{Q}\mathbf{1}$

We know

$$p_j = \sum_{i=1}^n p_{ij} p_i, \quad j = 1, 2, \dots, n.$$
 (1)

From the figure, we have

$$p_{\rm A} = 0.8p_{\rm H},\tag{2}$$

$$p_{\rm B} = 0.7p_{\rm A} + 0.5p_{\rm E},$$
 (3)

$$p_{\rm C} = 1.0p_{\rm B} + 0.7p_{\rm D},$$
 (4)

$$p_{\rm D} = 0.5 p_{\rm E},\tag{5}$$

$$p_{\rm E} = 0.3p_{\rm A},\tag{6}$$

$$p_{\rm F} = 0.6p_{\rm C},\tag{7}$$

$$p_{\rm G} = 0.4p_{\rm C} + 1.0p_{\rm F} + 0.2p_{\rm H}$$
, and (8)

$$p_{\rm H} = 0.3p_{\rm D} + 1.0p_{\rm G}.\tag{9}$$

We also have

$$p_{\rm A} + p_{\rm B} + p_{\rm C} + p_{\rm D} + p_{\rm E} + p_{\rm F} + p_{\rm G} + p_{\rm H} = 1.$$
 (10)

With the aforementioned equations, we have a systems of equation that we can solve. Using software to solve these systems of equations, we get

$$p_{\rm A} \approx 0.1592,\tag{11}$$

$$p_{\rm B} \approx 0.1353,\tag{12}$$

$$p_{\rm C} \approx 0.1520,\tag{13}$$

$$p_{\rm D} \approx 0.0239,\tag{14}$$

$$p_{\rm E} \approx 0.0477,\tag{15}$$

$$p_{\rm F} \approx 0.0912,\tag{16}$$

$$p_{\rm G} \approx 0.1918$$
, and (17)

$$p_{\rm H} \approx 0.0199.$$
 (18)

Therefore we conclude the priority for testing should be

$$H > G > A > C > B > F > E > D.$$
 (19)

## $\mathbf{Q2}$

i)

When the functional dependencies among the input and output variables is not known, we have

$$#Test cases = #A \times #B \times #C \times #D \times #E \times #F$$
 (20)

$$= 5 \times 5 \times 3 \times 5 \times 2 \times 3 \tag{21}$$

$$=2250.$$
 (22)

ii)

When the functional dependencies among the input and output variables is known, we have

$$#Test cases = #X + #Y + #Z$$

$$(23)$$

$$= (\#A \times \#D \times \#E) + (\#B) + (\#C \times \#F) \tag{24}$$

$$= (5 \times 5 \times 2) + (5) + (3 \times 3) \tag{25}$$

$$= 64. (26)$$

Example test cases are shown below. "N/A" represents an entry that can be anything.

**Table 1:** Test cases for output X

Test case	A	В	C	D	$\mathbf{E}$	F
1	0	N/A	N/A	7	Y	N/A
2	0	N/A	N/A	7	N	N/A
3	0	N/A	N/A	8	Y	N/A
4	0	N/A	N/A	8	N	N/A
5	0	N/A	N/A	9	Y	N/A
6	0	N/A	N/A	9	N	N/A
7	0	N/A	N/A	10	Y	N/A
8	0	N/A	N/A	10	N	N/A
9	0	N/A	N/A	11	Y	N/A
10	0	N/A	N/A	11	N	N/A

11         1         N/A         N/A         7         N         N/A           12         1         N/A         N/A         7         N         N/A           13         1         N/A         N/A         8         Y         N/A           14         1         N/A         N/A         9         Y         N/A           15         1         N/A         N/A         9         N         N/A           16         1         N/A         N/A         9         N         N/A           16         1         N/A         N/A         9         N         N/A           17         1         N/A         N/A         10         N         N/A           18         1         N/A         N/A         10         N         N/A           19         1         N/A         N/A         11         N         N/A           19         1         N/A         N/A         11         N         N/A           20         1         N/A         N/A         11         N         N/A           21         2         N/A         N/A         8         N							
13         1         N/A         N/A         8         Y         N/A           14         1         N/A         N/A         8         N         N/A           15         1         N/A         N/A         9         Y         N/A           16         1         N/A         N/A         9         N         N/A           17         1         N/A         N/A         10         Y         N/A           18         1         N/A         N/A         10         N         N/A           19         1         N/A         N/A         11         Y         N/A           20         1         N/A         N/A         11         N         N/A           21         2         N/A         N/A         7         N         N/A           21         2         N/A         N/A         7         N         N/A           22         2         N/A         N/A         8         Y         N/A           23         2         N/A         N/A         9         Y         N/A           24         2         N/A         N/A         9         N	11	1	N/A	N/A	7	Y	N/A
14         1         N/A         N/A         8         N         N/A           15         1         N/A         N/A         9         Y         N/A           16         1         N/A         N/A         9         N         N/A           17         1         N/A         N/A         10         Y         N/A           18         1         N/A         N/A         10         N         N/A           19         1         N/A         N/A         11         Y         N/A           20         1         N/A         N/A         11         N         N/A           21         2         N/A         N/A         7         Y         N/A           21         2         N/A         N/A         7         N         N/A           22         2         N/A         N/A         8         Y         N/A           23         2         N/A         N/A         8         N         N/A           24         2         N/A         N/A         9         N         N/A           25         2         N/A         N/A         10         N	12	1	N/A	N/A	7	N	N/A
15         1         N/A         N/A         9         Y         N/A           16         1         N/A         N/A         9         N         N/A           17         1         N/A         N/A         10         Y         N/A           18         1         N/A         N/A         10         N         N/A           19         1         N/A         N/A         11         Y         N/A           20         1         N/A         N/A         11         N         N/A           21         2         N/A         N/A         7         Y         N/A           21         2         N/A         N/A         7         N         N/A           21         2         N/A         N/A         7         N         N/A           22         2         N/A         N/A         8         Y         N/A           23         2         N/A         N/A         8         Y         N/A           24         2         N/A         N/A         9         Y         N/A           25         2         N/A         N/A         10         Y	13	1	N/A	N/A	8	Y	N/A
16         1         N/A         N/A         9         N         N/A           17         1         N/A         N/A         10         Y         N/A           18         1         N/A         N/A         10         N         N/A           19         1         N/A         N/A         11         Y         N/A           20         1         N/A         N/A         11         N         N/A           21         2         N/A         N/A         7         Y         N/A           21         2         N/A         N/A         7         N         N/A           22         2         N/A         N/A         8         Y         N/A           23         2         N/A         N/A         8         Y         N/A           24         2         N/A         N/A         9         Y         N/A           25         2         N/A         N/A         9         N         N/A           26         2         N/A         N/A         10         Y         N/A           28         2         N/A         N/A         11         N	14	1	N/A	N/A	8	N	N/A
17         1         N/A         N/A         10         Y         N/A           18         1         N/A         N/A         10         N         N/A           19         1         N/A         N/A         11         Y         N/A           20         1         N/A         N/A         11         N         N/A           21         2         N/A         N/A         7         Y         N/A           21         2         N/A         N/A         7         N         N/A           22         2         N/A         N/A         8         Y         N/A           23         2         N/A         N/A         8         Y         N/A           24         2         N/A         N/A         8         N         N/A           25         2         N/A         N/A         9         Y         N/A           26         2         N/A         N/A         10         Y         N/A           27         2         N/A         N/A         10         N         N/A           28         2         N/A         N/A         11         N	15	1	N/A	N/A	9	Y	N/A
18         1         N/A         N/A         10         N         N/A           19         1         N/A         N/A         11         Y         N/A           20         1         N/A         N/A         11         N         N/A           21         2         N/A         N/A         7         Y         N/A           22         2         N/A         N/A         7         N         N/A           22         2         N/A         N/A         8         Y         N/A           23         2         N/A         N/A         8         Y         N/A           24         2         N/A         N/A         8         N         N/A           24         2         N/A         N/A         9         N         N/A           25         2         N/A         N/A         9         N         N/A           26         2         N/A         N/A         10         N         N/A           27         2         N/A         N/A         10         N         N/A           30         2         N/A         N/A         11         N	16	1	N/A	N/A	9	N	N/A
19         1         N/A         N/A         11         Y         N/A           20         1         N/A         N/A         11         N         N/A           21         2         N/A         N/A         7         Y         N/A           22         2         N/A         N/A         7         N         N/A           23         2         N/A         N/A         8         Y         N/A           24         2         N/A         N/A         8         N         N/A           24         2         N/A         N/A         9         Y         N/A           25         2         N/A         N/A         9         N         N/A           26         2         N/A         N/A         10         Y         N/A           27         2         N/A         N/A         10         N         N/A           28         2         N/A         N/A         11         Y         N/A           30         2         N/A         N/A         11         N         N/A           31         3         N/A         N/A         7         N	17	1	N/A	N/A	10	Y	N/A
20         1         N/A         N/A         11         N         N/A           21         2         N/A         N/A         7         Y         N/A           22         2         N/A         N/A         7         N         N/A           23         2         N/A         N/A         8         Y         N/A           24         2         N/A         N/A         8         N         N/A           24         2         N/A         N/A         9         Y         N/A           25         2         N/A         N/A         9         Y         N/A           26         2         N/A         N/A         10         Y         N/A           27         2         N/A         N/A         10         N         N/A           28         2         N/A         N/A         11         Y         N/A           29         2         N/A         N/A         11         N         N/A           31         3         N/A         N/A         7         N         N/A           32         3         N/A         N/A         8         N	18	1	N/A	N/A	10	N	N/A
21         2         N/A         N/A         7         Y         N/A           22         2         N/A         N/A         7         N         N/A           23         2         N/A         N/A         8         Y         N/A           24         2         N/A         N/A         8         N         N/A           24         2         N/A         N/A         9         Y         N/A           25         2         N/A         N/A         9         Y         N/A           26         2         N/A         N/A         10         Y         N/A           27         2         N/A         N/A         10         Y         N/A           28         2         N/A         N/A         10         N         N/A           29         2         N/A         N/A         11         Y         N/A           30         2         N/A         N/A         11         N         N/A           31         3         N/A         N/A         7         N         N/A           33         N/A         N/A         8         N         N/A	19	1	N/A	N/A	11	Y	N/A
22         N/A         N/A         7         N         N/A           23         2         N/A         N/A         8         Y         N/A           24         2         N/A         N/A         8         N         N/A           24         2         N/A         N/A         9         Y         N/A           25         2         N/A         N/A         9         Y         N/A           26         2         N/A         N/A         10         Y         N/A           27         2         N/A         N/A         10         Y         N/A           28         2         N/A         N/A         10         N         N/A           29         2         N/A         N/A         11         Y         N/A           30         2         N/A         N/A         11         N         N/A           31         3         N/A         N/A         7         N         N/A           32         3         N/A         N/A         8         Y         N/A           34         3         N/A         N/A         9         Y         N/A	20	1	N/A	N/A	11	N	N/A
23         2         N/A         N/A         8         Y         N/A           24         2         N/A         N/A         8         N         N/A           25         2         N/A         N/A         9         Y         N/A           26         2         N/A         N/A         9         N         N/A           27         2         N/A         N/A         10         Y         N/A           28         2         N/A         N/A         10         N         N/A           29         2         N/A         N/A         11         Y         N/A           30         2         N/A         N/A         11         Y         N/A           31         3         N/A         N/A         7         Y         N/A           31         3         N/A         N/A         7         N         N/A           32         3         N/A         N/A         8         Y         N/A           34         3         N/A         N/A         9         Y         N/A           35         3         N/A         N/A         9         N	21	2	N/A	N/A	7	Y	N/A
24         2         N/A         N/A         8         N         N/A           25         2         N/A         N/A         9         Y         N/A           26         2         N/A         N/A         9         N         N/A           27         2         N/A         N/A         10         Y         N/A           28         2         N/A         N/A         10         N         N/A           29         2         N/A         N/A         11         Y         N/A           30         2         N/A         N/A         11         N         N/A           31         3         N/A         N/A         7         Y         N/A           31         3         N/A         N/A         7         N         N/A           32         3         N/A         N/A         7         N         N/A           33         3         N/A         N/A         8         Y         N/A           34         3         N/A         N/A         9         N         N/A           36         3         N/A         N/A         9         N	22	2	N/A	N/A	7	N	N/A
25         2         N/A         N/A         9         Y         N/A           26         2         N/A         N/A         9         N         N/A           27         2         N/A         N/A         10         Y         N/A           28         2         N/A         N/A         10         N         N/A           29         2         N/A         N/A         11         Y         N/A           30         2         N/A         N/A         11         N         N/A           31         3         N/A         N/A         7         Y         N/A           32         3         N/A         N/A         7         N         N/A           33         3         N/A         N/A         8         Y         N/A           34         3         N/A         N/A         8         N         N/A           35         3         N/A         N/A         9         Y         N/A           36         3         N/A         N/A         9         N         N/A           38         3         N/A         N/A         10         N	23	2	N/A	N/A	8	Y	N/A
26         2         N/A         N/A         9         N         N/A           27         2         N/A         N/A         10         Y         N/A           28         2         N/A         N/A         10         N         N/A           29         2         N/A         N/A         11         Y         N/A           30         2         N/A         N/A         11         N         N/A           31         3         N/A         N/A         7         Y         N/A           32         3         N/A         N/A         7         N         N/A           33         3         N/A         N/A         8         Y         N/A           34         3         N/A         N/A         8         N         N/A           34         3         N/A         N/A         8         N         N/A           35         3         N/A         N/A         9         N         N/A           36         3         N/A         N/A         9         N         N/A           38         3         N/A         N/A         10         N	24	2	N/A	N/A	8	N	N/A
27       2       N/A       N/A       10       Y       N/A         28       2       N/A       N/A       10       N       N/A         29       2       N/A       N/A       11       Y       N/A         30       2       N/A       N/A       11       N       N/A         31       3       N/A       N/A       7       Y       N/A         32       3       N/A       N/A       7       N       N/A         33       3       N/A       N/A       8       Y       N/A         34       3       N/A       N/A       8       N       N/A         35       3       N/A       N/A       9       Y       N/A         36       3       N/A       N/A       9       N       N/A         37       3       N/A       N/A       10       Y       N/A         38       3       N/A       N/A       10       N       N/A         39       3       N/A       N/A       11       Y       N/A         40       3       N/A       N/A       7       Y       N/A <td>25</td> <td>2</td> <td>N/A</td> <td>N/A</td> <td>9</td> <td>Y</td> <td>N/A</td>	25	2	N/A	N/A	9	Y	N/A
28       2       N/A       N/A       10       N       N/A         29       2       N/A       N/A       11       Y       N/A         30       2       N/A       N/A       11       N       N/A         31       3       N/A       N/A       7       Y       N/A         32       3       N/A       N/A       7       N       N/A         33       3       N/A       N/A       8       Y       N/A         34       3       N/A       N/A       8       N       N/A         35       3       N/A       N/A       9       Y       N/A         36       3       N/A       N/A       9       N       N/A         37       3       N/A       N/A       10       Y       N/A         38       3       N/A       N/A       10       N       N/A         39       3       N/A       N/A       11       Y       N/A         40       3       N/A       N/A       11       N       N/A         41       4       N/A       N/A       7       N       N/A <td>26</td> <td>2</td> <td>N/A</td> <td>N/A</td> <td>9</td> <td>N</td> <td>N/A</td>	26	2	N/A	N/A	9	N	N/A
29       2       N/A       N/A       11       Y       N/A         30       2       N/A       N/A       11       N       N/A         31       3       N/A       N/A       7       Y       N/A         32       3       N/A       N/A       7       N       N/A         33       3       N/A       N/A       8       Y       N/A         34       3       N/A       N/A       8       N       N/A         35       3       N/A       N/A       9       Y       N/A         36       3       N/A       N/A       9       N       N/A         37       3       N/A       N/A       10       Y       N/A         38       3       N/A       N/A       10       N       N/A         39       3       N/A       N/A       11       Y       N/A         40       3       N/A       N/A       11       N       N/A         41       4       N/A       N/A       7       N       N/A         42       4       N/A       N/A       N/A       Y       N/A </td <td>27</td> <td>2</td> <td>N/A</td> <td>N/A</td> <td>10</td> <td>Y</td> <td>N/A</td>	27	2	N/A	N/A	10	Y	N/A
30       2       N/A       N/A       11       N       N/A         31       3       N/A       N/A       7       Y       N/A         32       3       N/A       N/A       7       N       N/A         33       3       N/A       N/A       8       Y       N/A         34       3       N/A       N/A       8       N       N/A         35       3       N/A       N/A       9       Y       N/A         36       3       N/A       N/A       9       N       N/A         37       3       N/A       N/A       10       Y       N/A         38       3       N/A       N/A       10       Y       N/A         39       3       N/A       N/A       11       Y       N/A         40       3       N/A       N/A       11       N       N/A         41       4       N/A       N/A       7       N       N/A         42       4       N/A       N/A       8       Y       N/A         43       4       N/A       N/A       8       Y       N/A	28	2	N/A	N/A	10	N	N/A
31       3       N/A       N/A       7       Y       N/A         32       3       N/A       N/A       7       N       N/A         33       3       N/A       N/A       8       Y       N/A         34       3       N/A       N/A       8       N       N/A         35       3       N/A       N/A       9       Y       N/A         36       3       N/A       N/A       9       N       N/A         37       3       N/A       N/A       10       Y       N/A         38       3       N/A       N/A       10       N       N/A         39       3       N/A       N/A       11       Y       N/A         40       3       N/A       N/A       11       N       N/A         41       4       N/A       N/A       7       Y       N/A         42       4       N/A       N/A       8       Y       N/A         43       4       N/A       N/A       8       Y       N/A	29	2	N/A	N/A	11	Y	N/A
32       3       N/A       N/A       7       N       N/A         33       3       N/A       N/A       8       Y       N/A         34       3       N/A       N/A       8       N       N/A         35       3       N/A       N/A       9       Y       N/A         36       3       N/A       N/A       9       N       N/A         37       3       N/A       N/A       10       Y       N/A         38       3       N/A       N/A       10       N       N/A         39       3       N/A       N/A       11       Y       N/A         40       3       N/A       N/A       11       N       N/A         41       4       N/A       N/A       7       Y       N/A         42       4       N/A       N/A       8       Y       N/A         43       4       N/A       N/A       8       Y       N/A	30	2	N/A	N/A	11	N	N/A
33       3       N/A       N/A       8       Y       N/A         34       3       N/A       N/A       8       N       N/A         35       3       N/A       N/A       9       Y       N/A         36       3       N/A       N/A       9       N       N/A         37       3       N/A       N/A       10       Y       N/A         38       3       N/A       N/A       10       N       N/A         39       3       N/A       N/A       11       Y       N/A         40       3       N/A       N/A       11       N       N/A         41       4       N/A       N/A       7       Y       N/A         42       4       N/A       N/A       8       Y       N/A         43       4       N/A       N/A       8       Y       N/A	31	3	N/A	N/A	7	Y	N/A
34       3       N/A       N/A       8       N       N/A         35       3       N/A       N/A       9       Y       N/A         36       3       N/A       N/A       9       N       N/A         37       3       N/A       N/A       10       Y       N/A         38       3       N/A       N/A       10       N       N/A         39       3       N/A       N/A       11       Y       N/A         40       3       N/A       N/A       11       N       N/A         41       4       N/A       N/A       7       Y       N/A         42       4       N/A       N/A       8       Y       N/A         43       4       N/A       N/A       8       Y       N/A	32	3	N/A	N/A	7	N	N/A
35 3 N/A N/A 9 Y N/A 36 3 N/A N/A 9 N N/A 37 3 N/A N/A 10 Y N/A 38 3 N/A N/A 10 N N/A 39 3 N/A N/A 11 Y N/A 40 3 N/A N/A 11 N N/A 41 4 N/A N/A 7 Y N/A 42 4 N/A N/A N/A 8 Y N/A	33	3	N/A	N/A	8	Y	N/A
36       3       N/A       N/A       9       N       N/A         37       3       N/A       N/A       10       Y       N/A         38       3       N/A       N/A       10       N       N/A         39       3       N/A       N/A       11       Y       N/A         40       3       N/A       N/A       11       N       N/A         41       4       N/A       N/A       7       Y       N/A         42       4       N/A       N/A       7       N       N/A         43       4       N/A       N/A       8       Y       N/A	34	3	N/A	N/A	8	N	N/A
37       3       N/A       N/A       10       Y       N/A         38       3       N/A       N/A       10       N       N/A         39       3       N/A       N/A       11       Y       N/A         40       3       N/A       N/A       11       N       N/A         41       4       N/A       N/A       7       Y       N/A         42       4       N/A       N/A       7       N       N/A         43       4       N/A       N/A       8       Y       N/A	35	3	N/A	N/A	9	Y	N/A
38       3       N/A       N/A       10       N       N/A         39       3       N/A       N/A       11       Y       N/A         40       3       N/A       N/A       11       N       N/A         41       4       N/A       N/A       7       Y       N/A         42       4       N/A       N/A       7       N       N/A         43       4       N/A       N/A       8       Y       N/A	36	3	N/A	N/A	9	N	N/A
39       3       N/A       N/A       11       Y       N/A         40       3       N/A       N/A       11       N       N/A         41       4       N/A       N/A       7       Y       N/A         42       4       N/A       N/A       7       N       N/A         43       4       N/A       N/A       8       Y       N/A	37	3	N/A	N/A	10	Y	N/A
39       3       N/A       N/A       11       Y       N/A         40       3       N/A       N/A       11       N       N/A         41       4       N/A       N/A       7       Y       N/A         42       4       N/A       N/A       7       N       N/A         43       4       N/A       N/A       8       Y       N/A	38	3	N/A	N/A	10	N	N/A
41 4 N/A N/A 7 Y N/A 42 4 N/A N/A 7 N N/A 43 4 N/A N/A 8 Y N/A	39	3	N/A		11	Y	
41       4       N/A       N/A       7       Y       N/A         42       4       N/A       N/A       7       N       N/A         43       4       N/A       N/A       8       Y       N/A	40	3	N/A	N/A	11	N	N/A
43 4 N/A N/A 8 Y N/A	41	4	N/A		7	Y	N/A
43 4 N/A N/A 8 Y N/A	42	4	N/A		7	N	N/A
	43	4	N/A		8	Y	
44   4   N/A   N/A   8   N   N/A	44	4	N/A	N/A	8	N	N/A

45	4	N/A	N/A	9	Y	N/A
46	4	N/A	N/A	9	N	N/A
47	4	N/A	N/A	10	Y	N/A
48	4	N/A	N/A	10	N	N/A
49	4	N/A	N/A	11	Y	N/A
50	4	N/A	N/A	11	N	N/A

Table 2: Test cases for output Y

Test case	A	В	C	D	$\mathbf{E}$	F
51	N/A	A	N/A	N/A	N/A	N/A
52	N/A	В	N/A	N/A	N/A	N/A
53	N/A	С	N/A	N/A	N/A	N/A
54	N/A	D	N/A	N/A	N/A	N/A
55	N/A	Е	N/A	N/A	N/A	N/A

**Table 3:** Test cases for output Z

Test case	A	В	$\mathbf{C}$	D	$\mathbf{E}$	$\mathbf{F}$
56	N/A	N/A	100	N/A	N/A	$\alpha$
57	N/A	N/A	100	N/A	N/A	β
58	N/A	N/A	100	N/A	N/A	$\gamma$
59	N/A	N/A	200	N/A	N/A	$\alpha$
60	N/A	N/A	200	N/A	N/A	β
61	N/A	N/A	200	N/A	N/A	$\gamma$
62	N/A	N/A	300	N/A	N/A	$\alpha$
63	N/A	N/A	300	N/A	N/A	β
64	N/A	N/A	300	N/A	N/A	$\gamma$

# $\mathbf{Q3}$

If we wanted to test all combinations using combinatorial testing, we would have

#Test cases = 
$$3 \times 3 \times 4 \times 3 \times 5 \times 4 \times 4 \times 5 \times 4$$
 (27)

$$= 172800.$$
 (28)

Next, we wrote a Python script to automate generating the pairwise test cases. The result is shown below.

Table 4: Results from Python using pairwise testing

#	НКВН	KBH	KB	NVH	NV	OR	SLL	SLS	TS
1	NO	NO	12KEY	NO	DPAD	LAND	MASK	LRG	FNGR
2	NDEF	NDEF	NOKEYS	NDEF	NONAV	PORT	NO	MASK	FNGR
3	YES	YES	QWERTY	YES	TRKBALL	SQR	NDEF	NORM	FNGR
4	YES	NDEF	NDEF	NO	NDEF	NDEF	YES	SML	NTOUCH
5	NDEF	NO	NDEF	YES	WHEEL	NDEF	NDEF	NDEF	STYLUS
6	NO	YES	NOKEYS	NDEF	WHEEL	SQR	YES	NDEF	NDEF
7	NO	NDEF	QWERTY	YES	NDEF	LAND	NO	LRG	NDEF
8	NDEF	YES	12KEY	NO	NONAV	SQR	MASK	SML	STYLUS
9	YES	NO	NOKEYS	NDEF	TRKBALL	LAND	MASK	MASK	NTOUCH
10	NO	NO	QWERTY	NO	NONAV	PORT	YES	NORM	NTOUCH
11	YES	YES	12KEY	YES	DPAD	PORT	NO	NDEF	NTOUCH
12	NDEF	NDEF	12KEY	NDEF	DPAD	NDEF	NDEF	NORM	NDEF
13	NDEF	NDEF	QWERTY	NDEF	WHEEL	LAND	MASK	SML	STYLUS
14	NO	YES	NDEF	NDEF	NDEF	PORT	NDEF	LRG	STYLUS
15	NDEF	NO	NDEF	NO	TRKBALL	SQR	NO	SML	NDEF
16	YES	YES	NOKEYS	YES	NONAV	NDEF	NDEF	MASK	NDEF
17	NDEF	NDEF	NOKEYS	NO	NDEF	SQR	YES	LRG	NTOUCH
18	NO	NDEF	NDEF	NO	TRKBALL	NDEF	MASK	NDEF	FNGR
19	YES	YES	NDEF	NO	WHEEL	LAND	NDEF	NORM	NTOUCH
20	YES	NO	12KEY	YES	NDEF	PORT	MASK	NORM	NDEF
21	YES	YES	12KEY	YES	WHEEL	PORT	YES	MASK	STYLUS
22	NO	YES	NOKEYS	NO	DPAD	SQR	YES	MASK	STYLUS
23	YES	YES	QWERTY	YES	DPAD	NDEF	NO	SML	STYLUS
24	YES	YES	NDEF	NO	NONAV	LAND	YES	NDEF	FNGR
25	YES	YES	NDEF	NO	DPAD	NDEF	NDEF	LRG	STYLUS
26	NO	YES	NOKEYS	NO	TRKBALL	PORT	YES	SML	STYLUS
27	YES	YES	QWERTY	NO	WHEEL	PORT	NO	NORM	STYLUS
28	YES	YES	QWERTY	NO	NDEF	PORT	NDEF	NDEF	FNGR
29	YES	YES	NDEF	NO	WHEEL	PORT	NDEF	SML	FNGR
30	YES	YES	NDEF	NO	WHEEL	PORT	NDEF	MASK	STYLUS
31	YES	YES	QWERTY	NO	WHEEL	PORT	NDEF	MASK	STYLUS
32	YES	YES	NOKEYS	NO	WHEEL	PORT	NDEF	NORM	STYLUS
33	YES	YES	12KEY	NO	TRKBALL	PORT	NDEF	LRG	STYLUS
34	YES	YES	NDEF	NO	WHEEL	PORT	NDEF	LRG	STYLUS
35	YES	YES	NDEF	NO	NDEF	PORT	NDEF	MASK	STYLUS
36	YES	YES	NDEF	NO	NONAV	PORT	NDEF	LRG	STYLUS

As we can see from the above table, we have 36 test cases from pairwise testing. This is significantly less than the 172800 cases from combinatorial testing.

## $\mathbf{Q4}$

The grammar can be tested with a single test case. An example of such a test case is  $abcdefghijklmnopqrstuvwxyz + A - 1*B/CDEFGHIJKLMNOPQRSTUVWXYZ. \eqno(29)$ 

#### i)

We have 4 different operators, 52 different letters, and 10 different digits. This means we have 4 + 52 + 10 = 66 possible symbols.

#### ii)

 $\langle \exp r \rangle$  has 3 permutations,  $\langle id \rangle$  has 2 permutations, and  $\langle num \rangle$  has 2 permutations. This means we have 3+2+2+66=73 cases for production coverage.

#### iii)

We can't perform derivation coverage because  $\langle id \rangle := \langle letter \rangle | \langle letter \rangle \langle id \rangle$  leads to infinite tests.