XE (D): Q. 1 – Q. 9 carry one mark each & Q. 10 – Q. 22 carry two marks each.

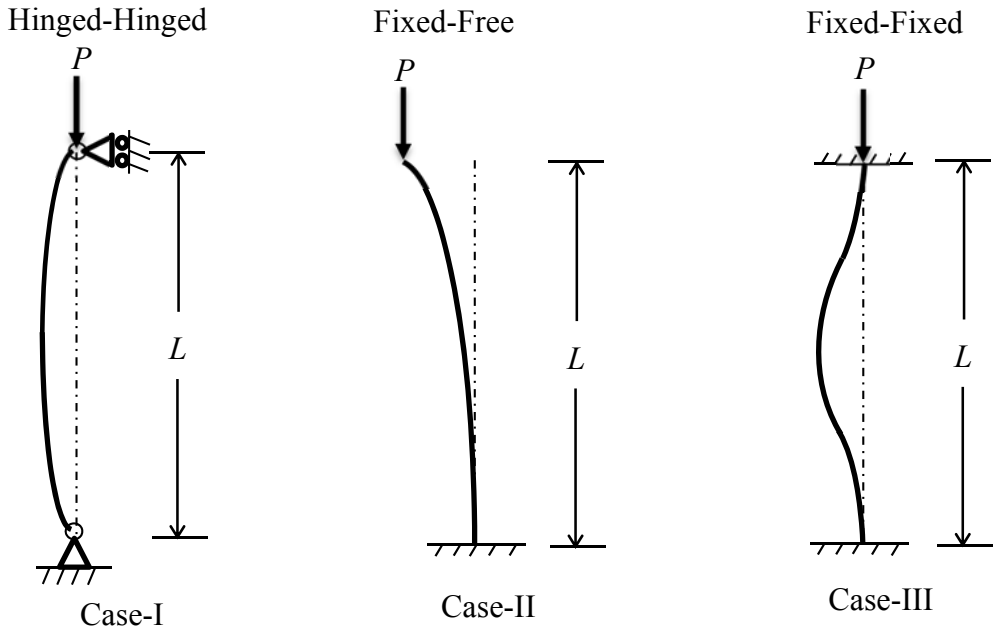
Q.1 A thin cylinder (thickness, t and diameter, d) with closed ends is subjected to an internal pressure, p. The ratio of hoop stress to longitudinal stress developed in the wall of the cylinder is

(A) 1:4 (B) 1:2 (C) 1:1 (D) 2:1

Q.2 A steel rod is fixed at one end and free at the other end. The coefficient of thermal expansion of the steel is α, and modulus of elasticity is E. If the temperature of the rod is increased by ΔT then the stress and strain developed in the rod are respectively

(A) zero, $\alpha\Delta T$
(B) $E\alpha\Delta T$, $\alpha\Delta T$
(C) $E\alpha\Delta T$, zero
(D) zero, zero

Q.3 The effective lengths of the columns with ideal boundary conditions shown in Case-I, Case-II, and Case-III are respectively

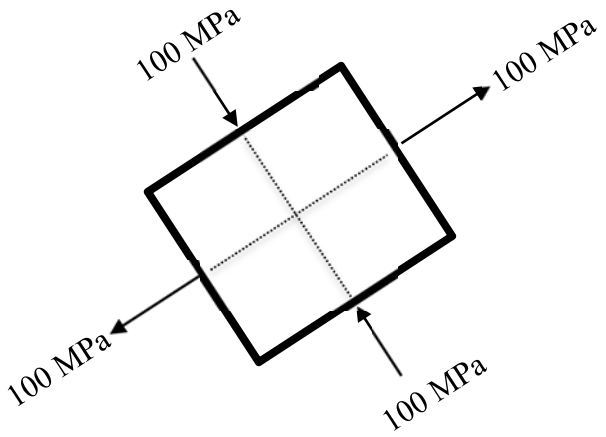


(A) L, $4L$, $2L$
(B) L, $2L$, $L/4$
(C) L, L, L
(D) L, $2L$, $L/2$

Q.4 At a point in a stressed body, sum of the normal stresses acting on perpendicular faces of an arbitrarily oriented plane stress element is always

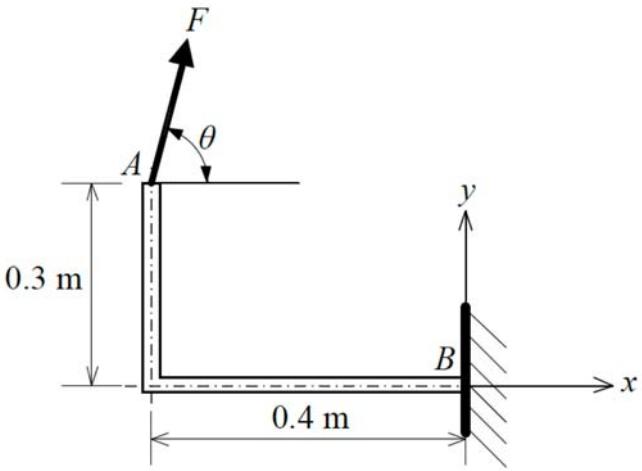
(A) dependent on the angle of orientation of the element
(B) constant and independent of angle of orientation of the element
(C) one half of the sum of the principal stresses
(D) zero

Q.5 The principal stresses on a plane stress element are shown in the figure. The maximum shear stress (in MPa) is



(A) 200 (B) 100 (C) 50 (D) 0

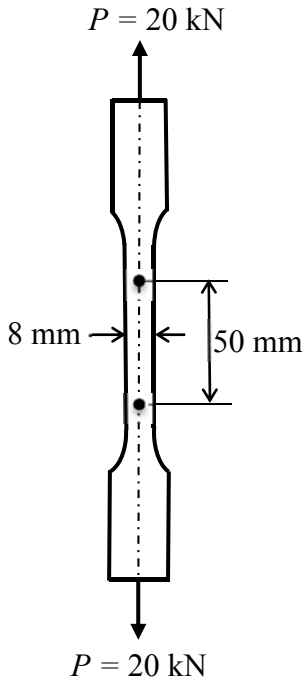
Q.6 A rigid and thin L-shaped bracket is fixed to the wall at point *B,* and a force *F* is applied at point *A* as shown**.** For a given force *F*, the point *B* experiences the maximum clockwise moment when the inclination θ (in degrees) with the *x*-axis is…….[*up to two decimal places*].



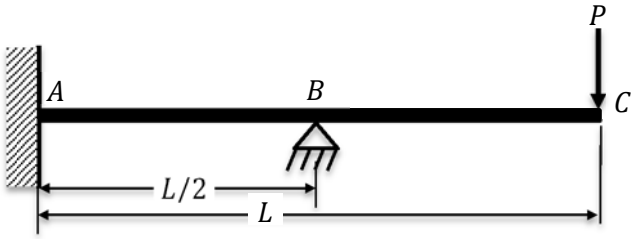
Q.7 A cantilever beam with length, L = 1 m, modulus of elasticity, E = 210 GPa, and area moment of inertia, $I = 1.2 \times 10^{-7}\text{m}^4$ carries a concentrated mass m = 100 kg at its free-end. By idealizing it as a single degree-of-freedom system and neglecting the mass of the cantilever beam, the natural frequency (in rad/s) of small transverse oscillations of the mass *m* is …….. [*up to two decimal places*]

Q.8 For a typical grade of steel, the value of modulus of elasticity (E) and Poisson's ratio (ν) are 208 GPa and 0.3 respectively. The value of shear modulus (G) of the steel (in GPa) is ……..

Q.9 A tensile test is performed on a metallic specimen of diameter 8 mm and gauge length 50 mm. When the tensile load P reaches a value of 20 kN, the distance between the gauge marks increases by 0.09 mm. If the sample remains within the elastic limit, the modulus of elasticity (in GPa) of the test metal is……..[*up to two decimal places*]

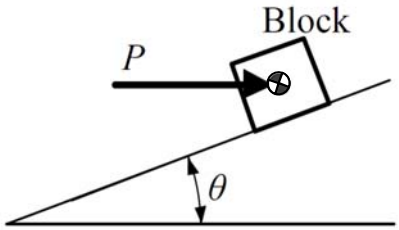


Q.10 A beam ABC is subjected to load P at its free end C as shown in the figure. The flexural rigidity of the beam is EI. The vertical support reaction at point B is



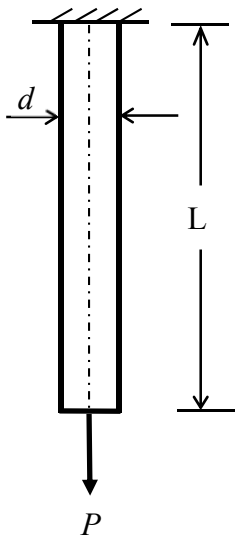
(A) $\frac{5P}{4}$ (B) $\frac{5P}{2}$ (C) $\frac{4P}{5}$ (D) $\frac{2P}{5}$

Q.11 A horizontal effort P is applied to raise a block of weight W on a rough surface inclined at an angle θ with the horizontal. If μ_s is the coefficient of static friction between the block and the surface, the minimum effort P required to impend the upward motion of the block along the surface is

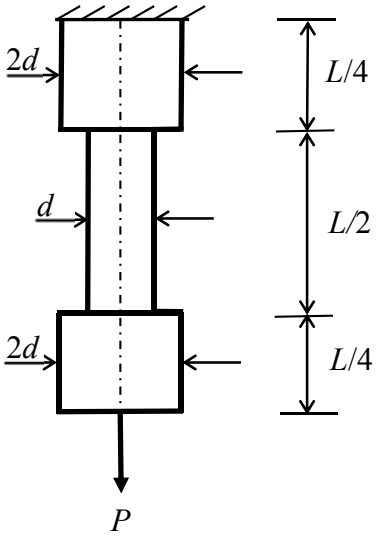


(A) $W\left(\frac{\mu_s-tan\theta}{1+\mu_s tan\theta}\right)$ (B) $W\left(\frac{\mu_s+tan\theta}{1-\mu_s tan\theta}\right)$ (C) $W\left(\frac{\mu_s-tan\theta}{1-\mu_s tan\theta}\right)$ (D) $W\left(\frac{\mu_s+tan\theta}{1+\mu_s tan\theta}\right)$

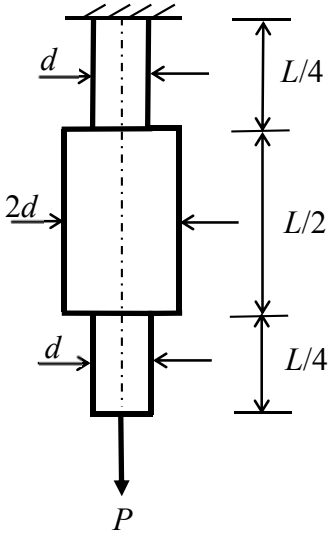
Q.12 Three round bars of same material, equal lengths, and different cross-sectional dimensions are shown in the figures as Case-I, Case-II and Case-III. All the bars are clamped at the upper end, and a concentrated load P is applied at the lower end of each bar. If the elastic strain energy stored in the bar shown in Case-I is U_1 then the elastic strain energy stored in Case-II and Case-III respectively is



Case-I



Case-II



Case-III

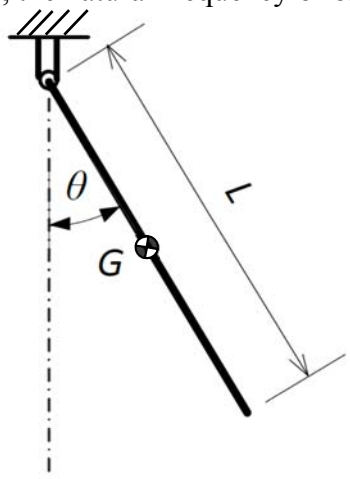
(A) $\left({}^{8}/_{5}\right)U_1$, $\left({}^{5}/_{8}\right)U_1$

(B) $\left({}^{5}/_{16}\right)U_1$, $\left({}^{5}/_{16}\right)U_1$

(C) $\left({}^{5}/_{8}\right)U_1$, $\left({}^{8}/_{5}\right)U_1$

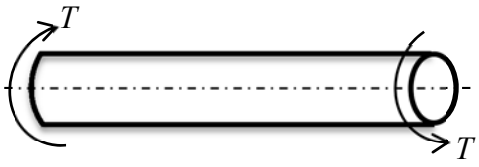
(D) $\left({}^{5}/_{8}\right)U_1$, $\left({}^{5}/_{8}\right)U_1$

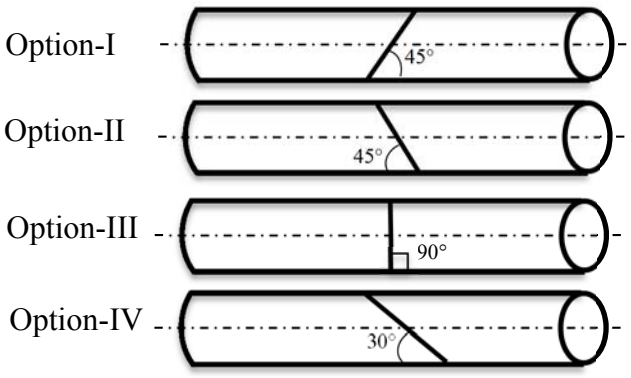
Q.13 A rigid uniform rod with mass *m*, length *L* and center of gravity *G* is freely suspended from a hinge as shown in the figure. The rod is given a small angular displacement θ in the counter-clockwise direction from the position in which it hangs vertically ($\theta = 0$). If g is the acceleration due to gravity, the natural frequency of oscillations (in rad/s) is



(A) $\sqrt{\frac{6g}{L}}$ (B) $\sqrt{\frac{2g}{L}}$ (C) $\sqrt{\frac{3g}{2L}}$ (D) $\sqrt{\frac{g}{L}}$

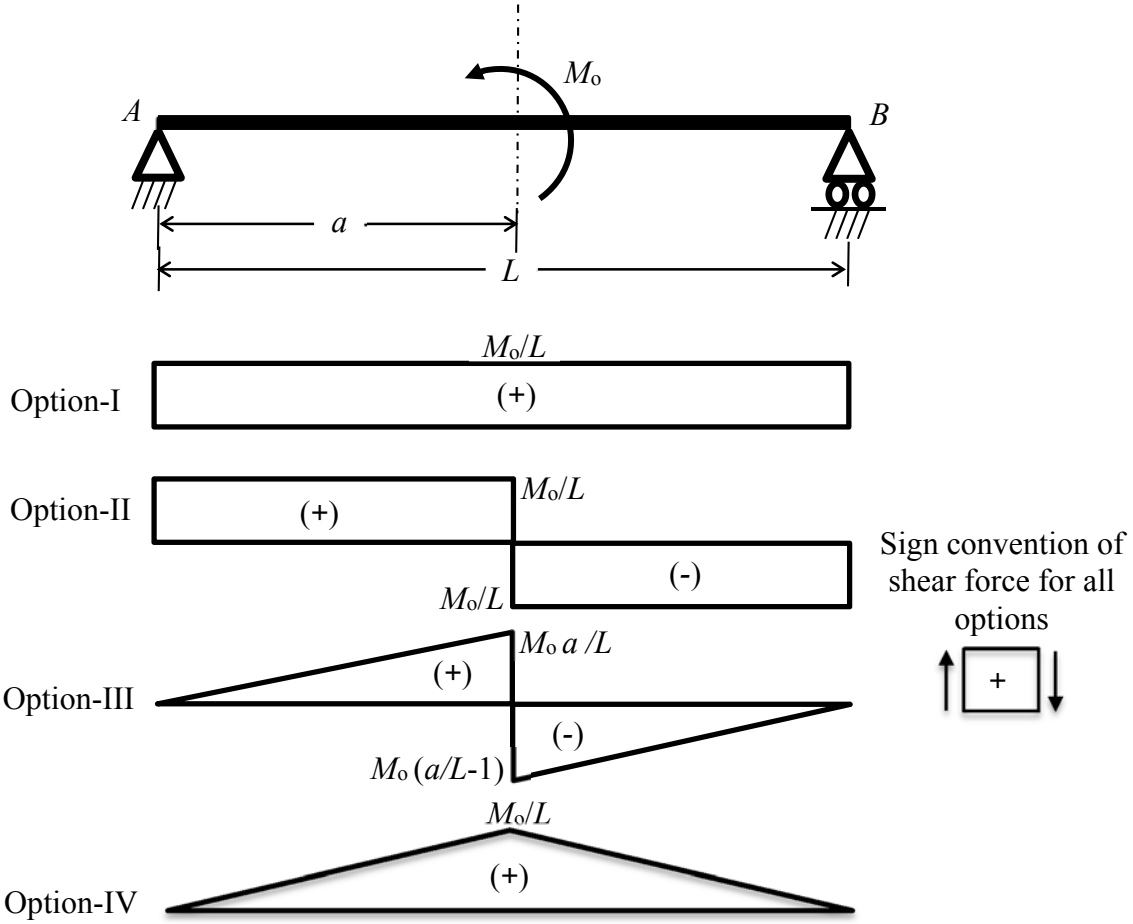
Q.14 A cylindrical member, made up of ductile material, is subjected to pure torsion as shown in the figure. The failure plane (from Option-I to Option-IV) for ductile material as per maximum shear stress theory is represented by





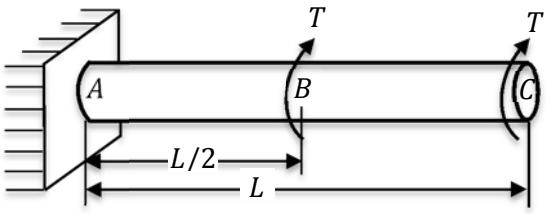
(A) Option I
(B) Option II
(C) Option III
(D) Option IV

Q.15 A simply supported beam of span L is subjected to a couple M_o at a distance a from support A. Among the four options (Option-I to Option-IV) shown, the correct shear force diagram of the beam is



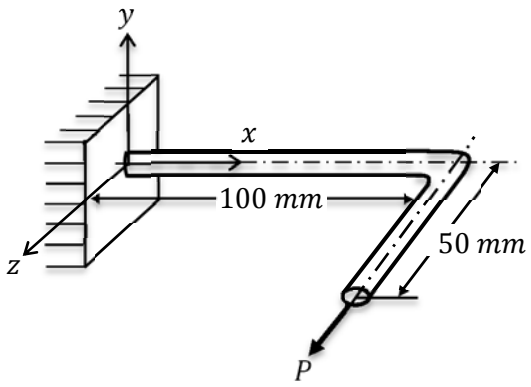
(A) Option-I (B) Option-II (C) Option-III (D) Option-IV

Q.16 A circular shaft ABC of diameter, d and length, L is fixed at end A. It is subjected to the torsional moments at point B and point C as shown in the figure. The ratio of angle of twists at point B to point C is

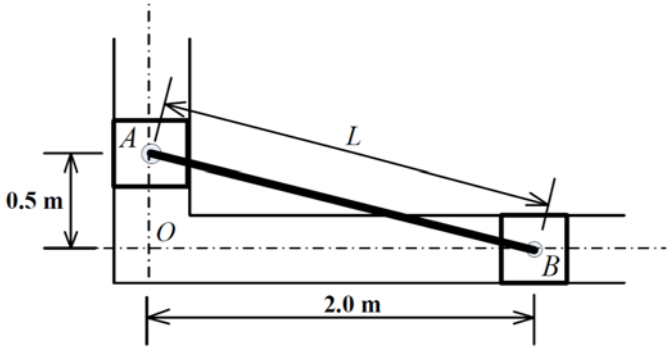


(A) 1.5 : 1 (B) 1 : 3 (C) 1 : 2 (D) 1 : 1.5

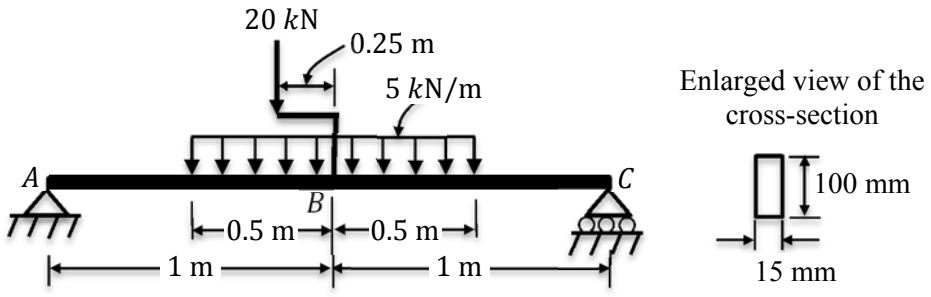
Q.17 A circular steel bar of diameter 10 mm is bent into the shape as shown in figure, and lies in *x*-*z* plane. A horizontal force *P* is applied along the positive *z*-direction as shown. The yield strength of the steel is 200 MPa. Neglecting the effect of transverse shear, the load *P* (in Newton) required to initiate yielding as per maximum shear stress theory of failure is……[*up to two decimal places*]



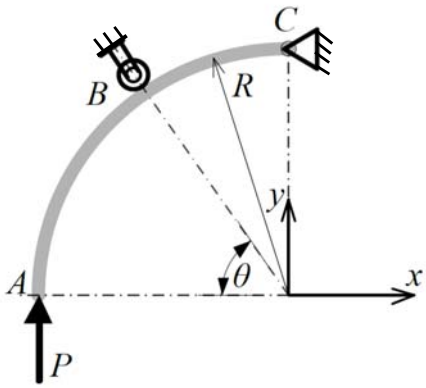
Q.18 Two sliders *A* and *B*, connected by a rigid link of length *L*, slide in two mutually perpendicular and frictionless guide-ways. At a particular instance, the slider *A* is moving in the downward direction with a speed of 0.05 m/s. At this instance, the magnitude of the velocity of slider *B* (in m/s) is ……[*up to two decimal places*]



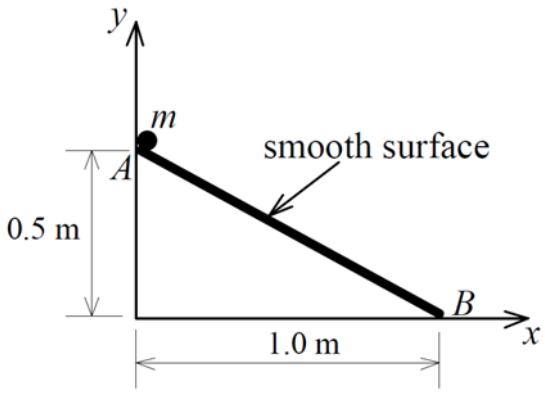
Q.19 A simply supported beam *ABC* is subjected to load as shown in the figure. The 20 kN load is applied at point *B* with the help of a welded bracket as shown. The beam has a rectangular cross-section of 15 mm width and 100 mm depth as shown. The maximum transverse shear stress developed in the beam (in MPa) is ……..[*up to one decimal place*]



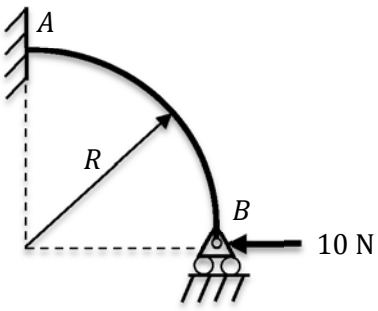
Q.20 A rigid rod *ABC*, in the form of a quarter-circular arc of radius *R*, is hinged at *C* and supported by a roller at *B***.** A vertical force *P* is applied at the end *A* of the bar. For the reactions at *B* and *C* to be equal in magnitude, the value of the angle θ (in degrees) is ……. [*up to two decimal places*].



Q.21 A marble of mass *m* slides along a frictionless linear slide *AB* kept in a vertical plane. The marble is released from point *A* with zero initial velocity, and it reaches point *B* under the action of gravity. Assuming the acceleration due to gravity to be 9.81 m/s^2, the speed (in m/s) of the marble when it just reaches point *B* is……[*up to two decimal places*].



Q.22 A horizontal force 10 N is applied at support *B* on the frame as shown in figure. Considering only bending deformation, the vertical reaction (in N) at support *B* is ……. [*up to one decimal place*]



END OF THE QUESTION PAPER

Q.No.	Type	Section	Key/Range	Marks
1	MCQ	GA	A	1
2	MCQ	GA	C	1
3	MCQ	GA	B	1
4	MCQ	GA	B	1
5	MCQ	GA	B	1
6	MCQ	GA	A	2
7	MCQ	GA	D	2
8	MCQ	GA	D	2
9	MCQ	GA	B	2
10	MCQ	GA	C	2
1	MCQ	XE-A	D	1
2	MCQ	XE-A	A	1
3	NAT	XE-A	0.01 to 0.01	1
4	NAT	XE-A	5 to 5	1
5	NAT	XE-A	0.29 to 0.32	1
6	NAT	XE-A	250 to 250	1
7	NAT	XE-A	108 to 108	1
8	MCQ	XE-A	B	2
9	MCQ	XE-A	C	2
10	NAT	XE-A	3 to 3	2
11	NAT	XE-A	0.04 to 0.04	2
1	MCQ	XE-B	B	1
2	MCQ	XE-B	A	1

Q.No.	Type	Section	Key/Range	Marks
3	MCQ	XE-B	D	1
4	MCQ	XE-B	A	1
5	MCQ	XE-B	C	1
6	MCQ	XE-B	B	1
7	MCQ	XE-B	A	1
8	NAT	XE-B	4 to 4	1
9	NAT	XE-B	39 to 42	1
10	MCQ	XE-B	B	2
11	MCQ	XE-B	C	2
12	MCQ	XE-B	C	2
13	MCQ	XE-B	A	2
14	NAT	XE-B	900 to 990	2
15	NAT	XE-B	40 to 42	2
16	NAT	XE-B	2.9 to 3.1	2
17	NAT	XE-B	107 to 127	2
18	NAT	XE-B	440000 to 442000	2
19	NAT	XE-B	0.001 to 0.002	2
20	NAT	XE-B	30 to 45	2
21	NAT	XE-B	4800 to 4800	2
22	NAT	XE-B	1200 to 1350	2
1	MCQ	XE-C	C	1
2	MCQ	XE-C	A	1
3	MCQ	XE-C	B	1

Q.No.	Type	Section	Key/Range	Marks
4	MCQ	XE-C	C	1
5	MCQ	XE-C	A	1
6	MCQ	XE-C	D	1
7	MCQ	XE-C	C	1
8	NAT	XE-C	2 to 2	1
9	NAT	XE-C	6 to 6	1
10	MCQ	XE-C	B	2
11	MCQ	XE-C	A	2
12	MCQ	XE-C	B	2
13	NAT	XE-C	430 to 500	2
14	NAT	XE-C	124 to 124	2
15	NAT	XE-C	2.60 to 2.70	2
16	NAT	XE-C	59.00 to 60.00	2
17	NAT	XE-C	1.85 to 2.00	2
18	NAT	XE-C	132 to 132	2
19	NAT	XE-C	5.01 to 5.17	2
20	NAT	XE-C	5 to 5	2
21	NAT	XE-C	15.5 to 18.5	2
22	NAT	XE-C	1420 to 1480	2
1	MCQ	XE-D	D	1
2	MCQ	XE-D	A	1
3	MCQ	XE-D	D	1
4	MCQ	XE-D	B	1

Q.No.	Type	Section	Key/Range	Marks
5	MCQ	XE-D	B	1
6	NAT	XE-D	52.50 to 53.50	1
7	NAT	XE-D	27.00 to 28.00	1
8	NAT	XE-D	80 to 80	1
9	NAT	XE-D	220.00 to 222.00	1
10	MCQ	XE-D	B	2
11	MCQ	XE-D	B	2
12	MCQ	XE-D	D	2
13	MCQ	XE-D	C	2
14	MCQ	XE-D	C	2
15	MCQ	XE-D	A	2
16	MCQ	XE-D	D	2
17	NAT	XE-D	195.00 to 197.00	2
18	NAT	XE-D	0.01 to 0.02	2
19	NAT	XE-D	14.5 to 15.5	2
20	NAT	XE-D	26.00 to 27.00	2
21	NAT	XE-D	3.10 to 3.20	2
22	NAT	XE-D	13.5 to 14.5	2
1	MCQ	XE-E	B	1
2	MCQ	XE-E	A	1
3	MCQ	XE-E	C	1
4	MCQ	XE-E	A	1
5	MCQ	XE-E	C	1

Q.No.	Type	Section	Key/Range	Marks
6	MCQ	XE-E	D	1
7	NAT	XE-E	160.0 to 161.0	1
8	NAT	XE-E	14.5 to 15.0	1
9	NAT	XE-E	0.30 to 0.32	1
10	MCQ	XE-E	C	2
11	MCQ	XE-E	C	2
12	MCQ	XE-E	D	2
13	MCQ	XE-E	B	2
14	MCQ	XE-E	A	2
15	MCQ	XE-E	D	2
16	NAT	XE-E	332.5 to 336.5	2
17	NAT	XE-E	3.01 to 3.07	2
18	NAT	XE-E	838.0 to 844.0	2
19	NAT	XE-E	961.0 to 962.0	2
20	NAT	XE-E	5.7 to 6.1	2
21	NAT	XE-E	12950.0 to 13000.0	2
22	NAT	XE-E	513.0 to 517.0	2
1	MCQ	XE-F	C	1
2	MCQ	XE-F	A	1
3	MCQ	XE-F	D	1
4	MCQ	XE-F	B	1
5	MCQ	XE-F	D	1
6	MCQ	XE-F	B	1

Q.No.	Type	Section	Key/Range	Marks
7	MCQ	XE-F	A	1
8	NAT	XE-F	1500.00 to 1500.00	1
9	NAT	XE-F	48.52 to 48.72	1
10	MCQ	XE-F	D	2
11	MCQ	XE-F	A	2
12	MCQ	XE-F	B	2
13	MCQ	XE-F	D	2
14	MCQ	XE-F	B	2
15	MCQ	XE-F	D	2
16	MCQ	XE-F	C	2
17	MCQ	XE-F	C	2
18	NAT	XE-F	-25.00 to -24.50	2
19	NAT	XE-F	98.80 to 99.10	2
20	NAT	XE-F	0.90 to 0.93	2
21	NAT	XE-F	17.91 to 18.00	2
22	NAT	XE-F	2600 to 2600	2
1	MCQ	XE-G	B	1
2	MCQ	XE-G	A	1
3	MCQ	XE-G	C	1
4	MCQ	XE-G	D	1
5	MCQ	XE-G	D	1
6	NAT	XE-G	1.55 to 1.65	1
7	NAT	XE-G	103.0 to 103.2	1

Q.No.	Type	Section	Key/Range	Marks
8	NAT	XE-G	54 to 56	1
9	NAT	XE-G	0 to 0	1
10	MCQ	XE-G	B	2
11	MCQ	XE-G	C	2
12	MCQ	XE-G	C	2
13	MCQ	XE-G	A	2
14	MCQ	XE-G	D	2
15	MCQ	XE-G	A	2
16	MCQ	XE-G	C	2
17	MCQ	XE-G	B	2
18	NAT	XE-G	9.8 to 10.2	2
19	NAT	XE-G	1.1 to 1.8	2
20	NAT	XE-G	14.5 to 15.5	2
21	NAT	XE-G	6.0 to 6.4	2
22	NAT	XE-G	10 to 10	2
1	MCQ	XE-H	B	1
2	MCQ	XE-H	C	1
3	MCQ	XE-H	A	1
4	MCQ	XE-H	B	1
5	MCQ	XE-H	B	1
6	MCQ	XE-H	C	1
7	MCQ	XE-H	D	1
8	MCQ	XE-H	D	1

Q.No.	Type	Section	Key/Range	Marks
9	MCQ	XE-H	B	1
10	MCQ	XE-H	A	2
11	MCQ	XE-H	B	2
12	MCQ	XE-H	A	2
13	MCQ	XE-H	B	2
14	NAT	XE-H	1254 to 1256	2
15	NAT	XE-H	19.42 to 19.44	2
16	NAT	XE-H	734.8 to 735.0	2
17	NAT	XE-H	9.16 to 9.18	2
18	NAT	XE-H	12.8 to 13.2	2
19	NAT	XE-H	92.4 to 92.8	2
20	NAT	XE-H	1.3 to 1.4	2
21	NAT	XE-H	0.11 to 0.12	2
22	NAT	XE-H	9.99 to 10.01	2