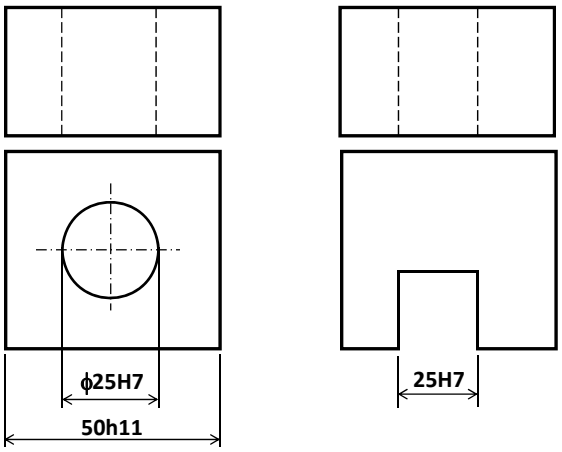
ME251A- Engineering Design and Graphics
Fits and Tolerances

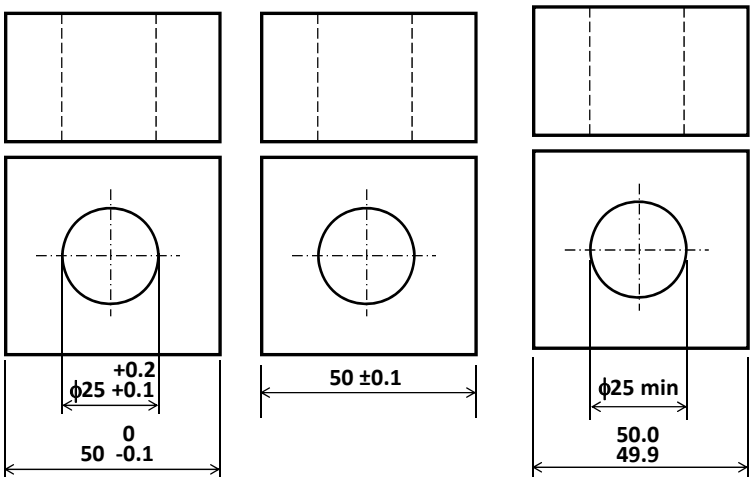
Indicating tolerances in a drawing

- Method-1: Giving the basic size, letter indicating the fundamental deviation, number giving the IT tolerance zone



Indicating tolerances in a drawing

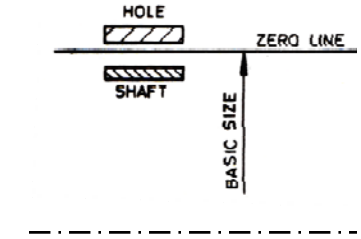
- By giving the basic size and the two deviations
- By giving the limits



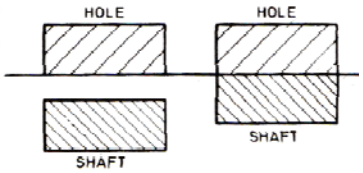
Fits

- When two parts are assembled, the relation resulting from the difference between their sizes before assembly is called a FIT
- A proper Fit is very important for satisfactory functioning of an assembly
- Depending on the respective tolerance zones of the assembled parts (a shaft and a hole) fits can be of three different types
  - Clearance fit
  - Transition fit
  - Interference fit
- Two most common basis for specifying fits are
  - Shaft based system
  - Hole based system

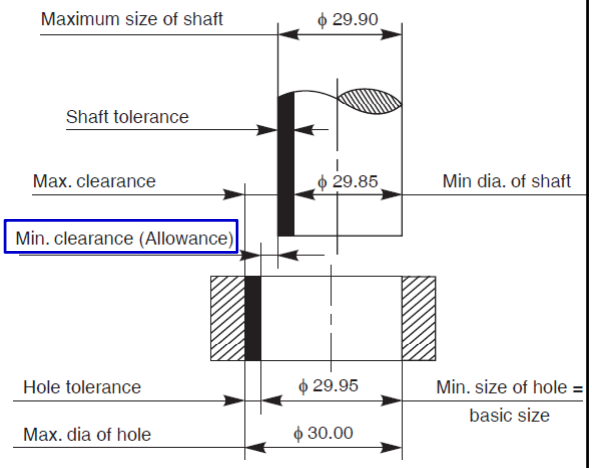
Clearance fit



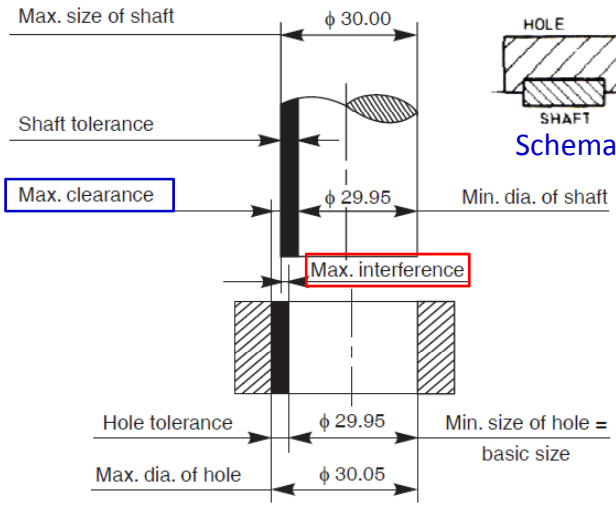
Upper limit of shaft less than the lower limit of hole

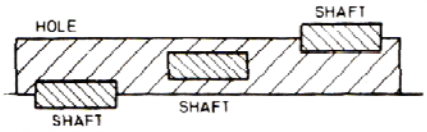


Schematic Representation



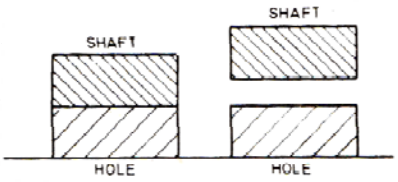
Transition fit



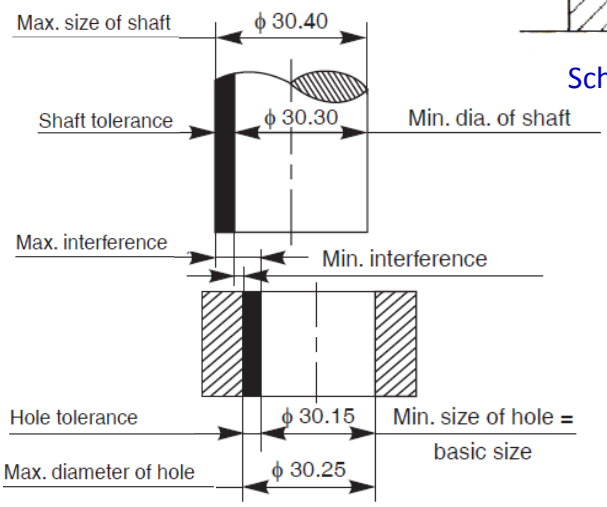


Schematic Representation

Interference fit



Schematic Representation



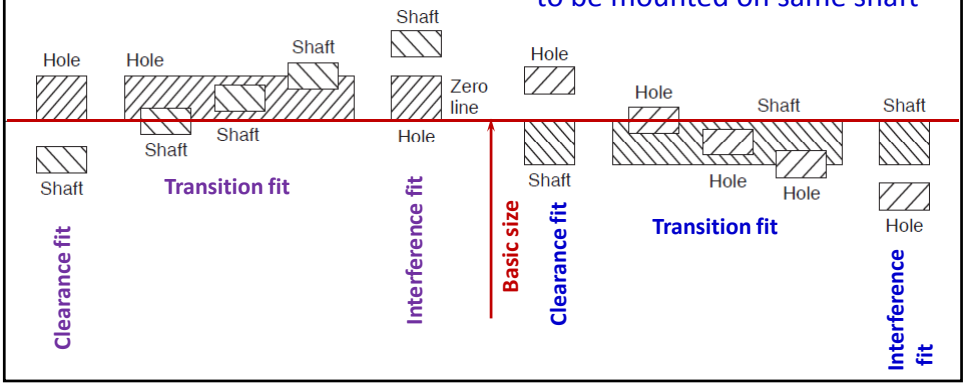
Hole and Shaft basis system

Hole basis system

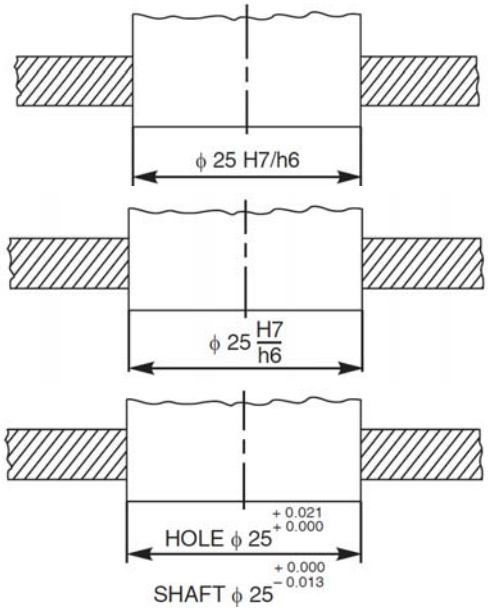
- Fundamental (lower) deviation for hole is zero (H)
- Preferred as tools used for making holes (drill bits, reamers etc.) come in standard size

Shaft basis system

- Fundamental (upper) deviation of shaft is zero (h)
- Used when several parts (gears, pulleys) having different fits are to be mounted on same shaft



Indicating tolerances in assembly of mating parts



Equivalent fits

Clearance		*Transition*		*Interference*	
Hole basis	*Shaft basis*	*Hole basis*	*Shaft basis*	*Hole basis*	*Shaft basis*
H7 – c8	C8 – h7	H6 – j5	J6 – h5	H6 – n5	N6 – h5
H8 – c9	C9 – h8	H7 – j6	J7 – h6		
H11 – c11	C11 – h11	H8 – j7	J8 – h7	H6 – p5	P6 – h5
				H7 – p6	p7 – h6
H7 – d8	D8 – h7	H6 – k5	K6 – h5		
H8 – d9	D9 – h8	H7 – k6	K7 – h6	H6 – r5	R6 – h5

- H8-f8 hole basis- Basic size 40 mm
- Hole
  - H- lower deviation zero for hole, IT 8- tolerance is 39 µm
  - Hole limits are 40 mm and 40.039 mm
- Shaft
  - For f fundamental (upper) deviation is - 25 µm
  - Shaft limits are 39.975 mm and 39.936 mm
- Clearance fit

Example

- H8-m7 Hole basis; Basic size 40 mm
- Hole
  - H- lower deviation zero for hole, IT 8- tolerance is 39 μm
  - Hole limits are 40 mm and 40.039 mm
- Shaft
  - For m fundamental (lower) deviation is 9 μm
  - IT 7- tolerance is 25 μm
  - Shaft limits are 40.009 mm and 40.034 mm
- Transition fit
  - Max. Clearance= 40.039-40.009=0.030 mm
  - Min. Clearance= 40.039-40.034=0.005 mm
  - Max. Interference= 40.034-40.000=0.034 mm
  - Min. Interference= 40.009-40.000= 0.009 mm

Example

- h7-S8 Shaft basis; Basic size is 40 mm
- Shaft
  - h- upper deviation is 0, IT 7 – tolerance is 25 μm
  - Shaft limits are 40 mm and 39.975 mm
- Hole
  - S- fundamental (lower) deviation is -43 μm, IT 8- 39 μm
  - Hole limits are 39.957 mm and 39.918 mm
- Interference fit
  - Max. interference= 40.000-39.918=0.072 mm
  - Min. interference= 39.975-39.918=0.057 mm

Choice of fits and tolerances

- Choice of fits depends on
  - material of mating parts
  - workmanship, surface finish
  - length of engagement, bearing load, speed
  - type of lubrication, temperature variations, humidity
- Choice of tolerance:
  - Most economic to manufacture consistent with quality
  - Provide the largest tolerance compatible with use
  - Provide wider tolerance to the hole when compared to the shaft as holes are difficult to produce (H8-f7)
- Refer to Table C1 (page 98) for preferred tolerance zones

Clearance fits

			H6	H7	H8	H9	Functional classification	Application example
Parts can move relative to each other	Clearance fit	Loose fit				c9	Part which for functional reasons requires a large gap { Expands. Large positional error. / Long fitting length	Piston ring and piston ring groove Fitting by means of a loose set pin
		Loose roll fit			d9	d9	Cost needs to be reduced. { Manufacturing cost / Maintenance cost	Crank web and pin bearing (side) Exhaust valve box and spring bearing sliding part Piston ring and piston ring groove
				e7	e8	e9	Regular rotating or sliding part (Must be well lubricated.)	Fitting of exhaust valve seat Main bearing for crankshaft Regular sliding part stripper bolt MSB (e9)
		Roll fit	f6	f7	f7 f8		Regular fitting part (is often disassembled)	Part where a cooled exhaust valve box is inserted Regular shaft and bushing Link device lever and bushing
		Tight roll fit	g5	g6			Part requiring precision motion with almost no gap	Link device pin and lever Key and key groove Precision control valve rod Guide lifter pin (g6)

- Refer IS standard for more information on commonly used fits

Transition fit

		H6	H7	H8	H9	Functional classification		Application example
Transition fit	Sliding fit	h5	h6	h7 h8	h9	Difficult to disassemble without damaging the part.	Fitting force alone is insufficient for transmitting force	Fitting of rim and boss Fitting of gears in a precision gear device Dowel pin MSTH (h7)
	Push fit	h5 h6	js6					Fitting two coupling flanges Governor path and pin Fitting of gear rim and boss
	Striking	js5	k6					Fitting of gear pump shaft and casing Reamer bolt
		k5	m6					Reamer bolt Dowel pin MSTM (m6) Fastening of hydraulic device pistons and shafts Fitting of coupling flange and shaft
	Light press fit	m5	n6				Fitting force alone is sufficient for transmitting force	Fitting of flexible shaft coupling and gear (passive side) Precision fitting Punch SPAS, etc. (m5) Insertion of suction valve and valve guide Die MHD, etc. (m5)

➢ Refer IS standard for more information on commonly used fits

Interference fit

		H6	H7	H8	H9	Functional classification		Application example
Interference fit	Press fit	n5 n6	p6			Difficult to disassemble without damaging the part.	Fitting force alone is sufficient for transmitting force	Insertion of suction valve and valve guide Straight die MSD, etc. (n5) Fixing a gear and shaft together (small torque) Dowel pin MST (p6) Flexible coupling shaft and gear (drive side)
		p5	r6					Coupling and shaft
	Strong press fit, shrinkage press fit, cold press fit	r5	s6 t6 u6 x6				Fitting force is capable of transmitting considerable force	Fitting and fixing a bearing bushing Insertion of suction valve and valve seat Fixing a coupling flange and shaft together (large torque) Fixing a drive gear rim and boss together Fitting and fixing a bearing bushing

➢ Refer IS standard for more information on commonly used fits

General tolerances for linear dimension

- Permissible machining variations on linear dimensions without tolerance indication for turning, milling, drawing, pipe bending etc.
- Not applicable for forging, welding, casting, flame cutting etc.
- Refer IS standard for general tolerances on angular dimensions, radii and chamfers

Class of deviation	Range of nominal dimension (mm)							
	Above	0.5	3	6	30	125	315	1000
	Up to and including	3	6	30	125	315	1000	2000
Fine		± 0.05	± 0.05	± 0.1	± 0.15	± 0.2	± 0.3	± 0.5
Medium		± 0.10	± 0.10	± 0.2	± 0.30	± 0.5	± 0.8	± 1.2
Coarse			± 0.20	± 0.5	± 0.80	± 1.2	± 2.0	± 3.0
Extra course			± 0.50	± 1.0	± 1.50	± 2.0	± 3.0	± 4.0