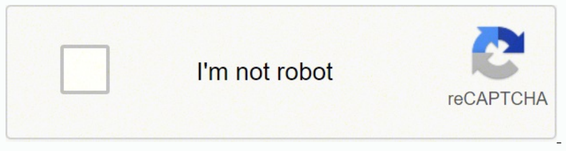

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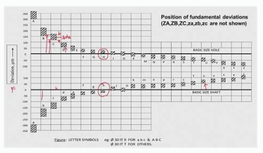
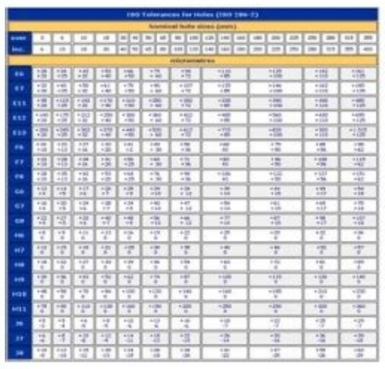
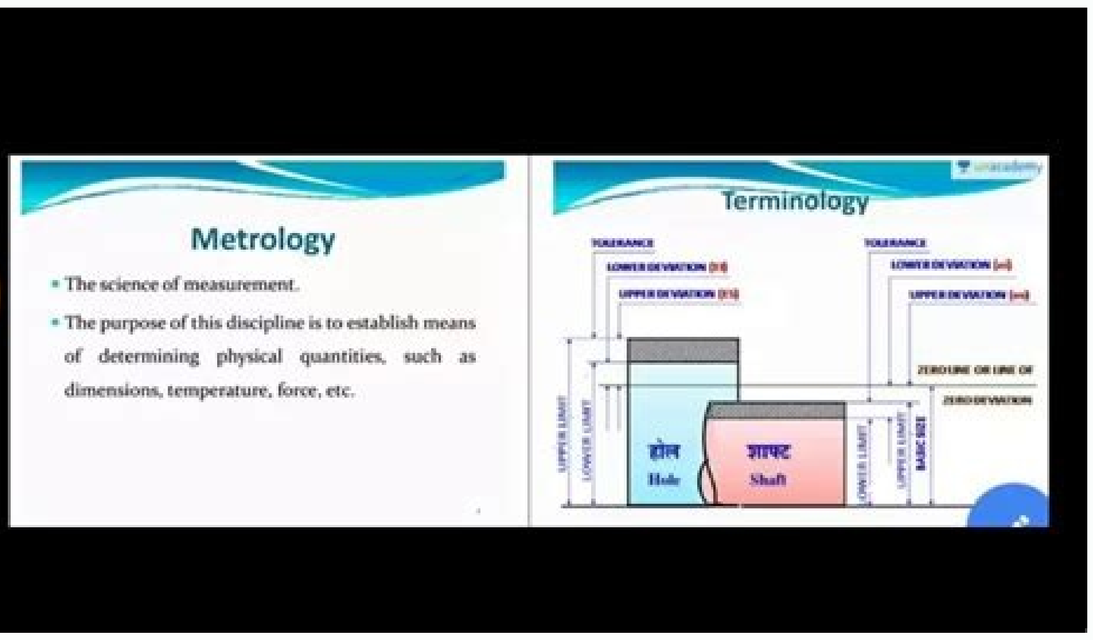




1.0 ☑ Design and optimization of dimensional chain

1.1 Design of dimensional chain — Clear table

Range	Component name	Component size [in] Nominal	Tolerance	Minimum	Maximum	μ	σ	Optimized tolerances Fixed	WC	RSS
A		-1.750	0 -0.00160	1.74840	1.75000	1.74920	0.000267	☑		
B		-2.500	+0.000090 -0.000090	2.49910	2.50090	2.50000	0.000300	☐		
C		5.750	+0.00125 -0.00125	5.74875	5.75125	5.75000	0.000417	☐		
D								☐		
E								☐		
F								☐		
G								☐		
H								☐		
I								☐		
J								☐		
Z	Closed component	1.500	+0.00375 -0.00215	1.49785	1.50375	1.50080	0.000579	☐	<---	<---



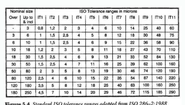


Figure 5.4 *Standard ISO tolerance ranges adopted from ISO 286-2:1988*

−0 · 009 50−0.025 mm Hole Tolerance = 25.033 – 25 = 0.033 mm For g6 shaft 77. • To satisfy the ever-increasing demand for accuracy. Here you can find objective type Technical Drawing Tolerancing questions and answers for interview and entrance examination. 30. Learning Objectives 5. of the shaft is smaller than the dia. INTRODUCTION • No two parts can be produced with identical measurements by any manufacturing process. Upper limit of 40+0.02 = 40.02 mm Lower limit of 40-0.02 = 39.98 mm. • Assay. • For proper fit between the two cylinders, both the centres to be in line. • The difference between the upper and lower limits is termed permissive tolerance. • Lower deviation of the hole is zero, i.e. the lower limit of the hole is same as the basic size. • Upper deviation: Designated as ‘ES’ for a Hole and as ‘es’ for a shaft. • D= 43. Transition fit Dia. • To equip with knowledge of limits, fits, tolerances and gauging. Unilateral tolerance: Above zero line: Positive 21. • Value of tolerance unit ‘i ’ is obtained for sizes up to 500 mm. • Third box: Indicates that the datum is with X. This ensures protection and elimination of defective assemblies. Calculate the limits of tolerance and allowance for a 25 mm shaft and hole pair designated by H8d9. Class & grade of tolerance, Fits, Types of fits, Numerical on limits, fit and tolerance. Clearance fit The largest permissible dia. FITS 1. For Shaft Maximum metal limit (MML) = 40.05 mm Least metal limit (LML) = 39.95 mm For Hole Maximum metal limit (MML) = 44.95 mm Least metal limit (LML) = 45.05 mm 33. • Limits of size: Maximum and minimum permissible sizes for a specific dimension. • The basic purpose of providing tolerances is to permit dimensional variations in the manufacture of components, adhering to the performance criterion. • Allowance: LLH –HLS 47. In a limit system, the following limits are specified for a hole and shaft assembly: 56. Hole Basis and Shaft Basis Systems • To obtain the desired class of fits, either the size of the hole or the size of the shaft must vary. 63. How to solve Technical Drawing Tolerancing problems? Module 2 System of Limits, Fits, Tolerance and Gauging: Definitions, Tolerance, Tolerance analysis (addition & subtraction of tolerances) Interchangeability & Selective assembly. FITS Application of Fits 41. (a) Hole basis system (b) Shaft basis system. End of Module • The permissible level of tolerance depends on the functional requirements, which cannot be compromised. FITS 2. • The ISO system provides tolerance grades from IT01, IT0, and IT1 to IT16. • Designated by the letters IT followed by a number. Tolerances 13. • Instrumentation, Measurement and Analysis, B C Nakra, K K Chaudhry, 4th Edition, McGraw Hill. 3. Either positive or negative, but not both. FITS Detailed classification of Fits 38. 26. Where can I get Technical Drawing Tolerancing questions and answers with explanation? • Fundamental deviation or the upper deviation of the shaft is zero. Designated as ‘ES’ for a hole and as ‘es’ for a shaft. Solved examples with detailed answer description, explanation are given and it would be easy to understand. General Terminology • Actual deviation: Algebraic difference between the actual size and its corresponding basic size. • Designer has to suggest these tolerance limits to ensure satisfactory operation. 49. Where can I get Technical Drawing Tolerancing Interview Questions and Answers (objective type, multiple choice)? Bilateral tolerance When the tolerance distribution lies on either side of the basic size. • Tolerance grade: IT7. Designated as ‘EI’ for a hole and as ‘ei’ for a shaft. • Parts have to be produced with less dimensional variation. Determine the tolerance on the hole and the shaft for a precision running fit designated by 50 H7g6. Condition Identical components, manufactured by different operators, using different machine tools and under different environmental conditions, can be assembled and replaced without any further modification during the assembly, without affecting the functioning of the component when assembled. Shaft Basis systems (a) Clearance fit (b) Transition fit (c) Interference fit 55. Shaft Basis systems • The size of the shaft is kept constant and the hole size is varied to obtain various types of fits. The various steps specified for the diameter steps are as follows: • 1–3, 3–6, 6–10, 10–18, 18–30, 30–50, 50–80, 80–120 • 120–180, 180–250, 250–315, 315–400, 400–500 • 500–630, 630–800, and 800–1000 mm. Tolerance Grade Standard tolerance units 44. Solution 50 mm diameter lies in the standard diameter step of 30-50 mm D= 30 × 50 = 38.7 mm Fundamental tolerance unit = i (microns) = 0.45$D$1/3 + 0.001D = 1.5597 μ Fundamental tolerance (tolerance grade table) = 16i = 24.9μ = 0.025 mm For ‘H’ Hole, fundamental deviation is 0 (from FD Table) Hence, hole limits are. Tolerances Manufacturing Cost and Work Tolerance Relationship between work tolerance and manufacturing cost Tolerance is a trade-off between the economical production and the accuracy required for proper functioning of the product. Compound tolerance 4. +0 · 025 50−0.000 mm For H7 hole 76. • Tolerance Zone: Zone between the maximum and minimum limit size. 48. Tolerance Grade • D = diameter of the part in mm. Unilateral tolerance Classification of Tolerance • When the tolerance distribution is only on one side of the basic size. Fundamental deviation for shafts and holes of sizes from above 500 to 3150 mm 67. Unilateral tolerance: Below zero line: Negative 20. 65. 50. Also called as nominal size. Hole Basis systems This system is widely adopted in industries, easier to manufacture shafts of varying sizes to the required tolerances. Solution (e) Since both maximum and minimum clearances are positive, it can be conclude that the given pair has a clearance fit. Symbolic representation of geometric tolerances 29. Three basic types of fits can be identified, depending on the actual limits of the hole or shaft. IndiaBIX provides you lots of fully solved Technical Drawing (Tolerancing) questions and answers with Explanation. • It may be equal or unequal 22. • System is not preferred in industries, as it requires more number of standard- size tools, like reamers, broaches, and gauges, increases manufacturing and inspection costs. of the smallest hole. • It is not necessary that Zero line will divide the tolerance zone equally on both sides. Upper limit of the hole is less than the lower limit of shaft. 2. 51. 1. • Parts to be manufactured within min. 24. You can easily solve all kind of Technical Drawing questions based on Tolerancing by practicing the objective type exercises given below, also get shortcut methods to solve Technical Drawing Tolerancing problems. General Terminology • Deviation: Algebraic difference between a size and its corresponding basic size. Hole Basis systems • The size of the hole is kept constant and the shaft size is varied to give various types of fits. 31. 4. • IT9 tolerance grade. INTRODUCTION Example Shaft has to be manufactured to a diameter of 40 ± 0.02 mm. • Tolerance: Difference between the maximum and minimum limits of size. The shaft has a basic size of 40 mm. INTRODUCTION • No component can be manufactured precisely to a given dimension; it can only be made to lie between two limits, upper (maximum) and lower (minimum). • Manufacture of parts under such conditions is called interchangeable manufacture. Selective Assembly • In selective assembly the parts produced are classified into groups according to their size / dimensions by automatic gauging. Interchangeability • Manufacturing a large number of parts, it is not economical to produce both the mating parts by the same operator. Numerical Examples 72. • IS: 18 grades of fundamental tolerances are available. 35. Hole base system & shaft base system. Solution 61. Solution 25 mm diameter lies in the standard diameter step of 18-30 mm D= 18 × 30 =23.238 Fundamental tolerance unit = i = 0.45 3 D + 0.001D i= 1.307 μ Fundamental tolerance, (tolerance grade table) = 40i = 40 x 1.3 =52 μ = 0.052 mm For ‘d’ shaft, fundamental deviation (from FD Table) =−16D0·44 = - 0.064 mm Hence, shaft limits are 25 – 0.064 =24.936 mm and 25 – (0.064+0.052) =24.884 mm Shaft Tolerance = 24.936 – 24.884 = 0.052 mm For d9 shaft 74. 1. Given: 1) 50 mm lies between 30- 50 mm 2) i (microns) = 0.45$D$1/3 + 0.001D 3) Fundamental deviation for ‘H’ hole = 0 4) Fundamental deviation for ‘g’ shaft = −2.5D0·34 5) IT7 = 16i and IT6 = 10i State the actual maximum and minimum sizes of the hold and shaft and maximum and minimum clearance. • D= Tolerance unit, 69. Multiple choice and true or false type questions are also provided. 36. Numerical Examples 75. 66. • D is the geometric mean of the lower and upper diameters. • Explain the principle of limit gauging and its importance in inspection in industries. INTRODUCTION • It is impossible to produce a part to an exact size or basic size, some variations, known as tolerances, need to be allowed. Solution 25 mm diameter lies in the standard diameter step of 18-30 mm D= 18 × 30 =23.238 Fundamental tolerance unit = i = 0.45 3 D + 0.001D i= 1.307 μ Fundamental tolerance (tolerance grade table) = 25i = 32.5~33μ =0.033 mm For ‘H’ Hole, fundamental deviation is 0 (from FD Table) Hence, hole limits are 25 mm and 25+0.033 = 25.033 mm Hole Tolerance = 25.033 – 25 = 0.033 mm For H8 hole 73. • Shaft need additional force to fit into the hole. Transition fit 34. Used to specify the tolerance and fits for mating components. • BIS: 18 grades of fundamental tolerances are available. Tolerances 1. Geometric tolerance Classification of Tolerance • First box: On the left indicates the feature to be controlled, represented symbolically (example: concentricity). Interchangeability Interchangeability: Any one component selected at random should assemble with any other arbitrarily chosen mating component. Tolerances 15. 32. Symbolic representation of geometric tolerances 27. Tolerances for a hole and shaft assembly having a nominal size of 50 mm are as follows: Numerical Examples 60. 12. MECHANICAL MEASUREMENTS AND METROLOGY CHAPTER 3: Limits, Fits, Tolerance and Gauging 4. It will be acceptable if its diameter lies between the limits of sizes. Tolerance symbols • Fundamental Deviation: Deviation either the upper or lower deviation, nearest to the zero line. Geometric tolerance Classification of Tolerance • Diameters of the cylinders need be concentric with each other. • Understand the importance of manufacturing components to specified sizes. Numerical Examples 1. • ISO/BIS: IT01, IT0, and IT1 to IT16. FITS Applications 40. 53. Geometric tolerance Classification of Tolerance Geometric dimensioning and tolerancing (GD&T) is a method of defining parts based on how they function, using standard symbols. possible time without compromising on quality. Then, permissive tolerance is equal to 40.02 − 39.98 = 0.04 mm. Standard-size plug gauges are used to check hole sizes accurately. 11. Two types of systems are used to represent three basic types of fits, clearance, interference, and transition fits. Solution Maximum clearance = 50.025 - 49.975 = 0.05 mm Minimum clearance = 50.000 - 49.991 = 0.009 78. • Centre box: indicates distance between the two cylinders, centres cannot be apart by more than 0.01 mm (Tolerance). Hole Basis systems (a) Clearance fit (b) Transition fit (c) Interference fit 52. All students, freshers can download Technical Drawing Tolerancing quiz questions with answers as PDF files and eBooks. • Nature of fit for the hole basis system is designated by H • Fundamental deviation of the hole is zero. Such variations are referred as ‘assignable causes’ and can be identified and controlled. Tolerance Grade D= 70. Solution 57. It may be positive, negative, or zero. • In any production process, regardless of how well it is designed or how carefully it is maintained, a certain amount of variation (natural) will always exist. Tolerances grades for applications 45. The following limits are specified in a limit system, to give a clearance fit between a hole and a shaft: Numerical Examples 58. Deviations are measured from this line. • Appreciate the significance of different types of limits, fits, and tolerances in design and manufacturing fields, required for efficient and effective performance of components. FITS Applications 39. 54. 7. Tolerance symbols • First eight designations from A (a) to H (h) for holes (shafts) are used for clearance fit • Designations, JS (js) to ZC (zc) for holes (shafts), are used for interference or transition fits 64. • Tolerance grades indicates the degree of accuracy of manufacture. Tolerance Grade 42. Solution 59. MAXIMUM AND MINIMUM METAL CONDITIONS Consider a shaft having a dimension of 40 ± 0.05 mm and Hole having a dimension of 45 ± 0.05 mm. Symbolic representation of geometric tolerances 28. • Tolerance values corresponding to grades IT5 – IT16 are determined using the standard tolerance unit (i, in μm), which is a function of basic size. of the largest permissible hole is greater than the dia. Tolerance Grade Standard tolerance units 71. General Terminology 46. Tolerances 16. Compound tolerance Classification of Tolerance Tolerance for the dimension R is determined by the combined effects of tolerance on 40 mm dimension, on 60o, and on 20 mm dimension 23. In this section you can learn and practice Technical Drawing Questions based on "Tolerancing" and improve your skills in order to face the interview, competitive examination and various entrance test (CAT, GATE, GRE, MAT, Bank Exam, Railway Exam etc.) with full confidence. 8. General Terminology • Basic size: Exact theoretical size arrived at by design. Outcomes 6. Interference fit 3. • Neither loose nor tight like clearance fit and interference fit. • It is essential for the manufacturer to have an in-depth knowledge of the tolerances to manufacture parts economically, adhere to quality and reliability • To achieve an increased compatibility between mating parts. • Engineering Metrology, R.K. Jain, Khanna Publishers, Delhi, 2009 REFERENCE BOOKS: • Engineering Metrology and Measurements, N.V.Raghavendra and L.Krishnamurthy, Oxford University Press.. • The components are manufactured in one or more batches by different persons on different machines at different locations and are assembled at one place. • Upper deviation: Algebraic difference between the maximum limit of size and its corresponding basic size. Clearance fit 2. Interference fit • No gap between the faces and intersecting of material will occur. Tolerances 14. • Actual size: Size of a part as found by measurement • Zero Line: Straight line corresponding to the basic size. Solution 50 mm diameter lies in the standard diameter step of 30-50 mm D= 30 × 50 = 38.7 mm Fundamental tolerance unit = i (microns) = 0.45$D$1/3 + 0.001D = 1.5597 μ Fundamental tolerance (tolerance grade table) = 10i = 16μ = 0.016 mm For ‘g’ shaft, fundamental deviation is −2.5D0·34 = 9 μ Hence, shaft limits are. Further Reference: National Programme on Technology Enhanced Learning (NPTEL) 3. E.g.: Shaft rotating in a bush Upper limit of shaft is less than the lower limit of the hole. • To manufacture identical parts; mass production was the idea. Unilateral tolerance 2. costs are reduced, as the parts are produced with wider tolerances. Exercise :: Tolerancing - General QuestionsTolerancing - General QuestionsTolerancing - True or False View Answer Discuss in Forum Workspace Report View Answer Discuss in Forum Workspace Report Page 2 Page 2 Page 3 Page 4 Page 5 1. of the smallest shaft. 62. Department of Mechanical Engineering JSS Academy of Technical Education, Bangalore-560060 MECHANICAL MEASUREMENTS AND METROLOGY (Course Code:18ME36B) 2. Taylor’s principle, Types of limit gauges, Numerical on limit gauge design. (provides the position of the tolerance zone). Bilateral tolerance 3. • Lower deviation: Algebraic difference between the minimum limit of size and its corresponding basic size. INTRODUCTION Variations arises from; • Improperly adjusted machines • Operator error • Tool wear • Defective raw materials etc. 17. 10. • The algebraic difference between the upper and lower acceptable dimensions. • 0.001D = Linear factor counteracts the effect of measuring inaccuracies. Tolerances (a) Unilateral (b) Bilateral 19. 37. • Two limits of the shaft and the higher dimension of the hole are varied to obtain the desired type of fit. FITS • The degree of tightness and or looseness between the two mating parts. • This information is represented in the feature control frame. • Tolerance values corresponding to grades IT5 – IT16 are determined using the standard tolerance unit (i, in μm) Tolerance Grade 68. 25. • The shaft has a d-type fit, the fundamental deviation has a negative value. • Feature control frame comprises three boxes. • Both the mating parts are segregated according to their sizes, and matched with the groups of mating parts are assembled. TEXT BOOKS • Mechanical Measurements, Beckwith Marangoni and Lienhard, Pearson Education, 6th Ed., 2006. Tolerance symbols Example: Consider the designation 40 H7/d9 • Basic size of the shaft and hole = 40 mm. Geometric tolerance Classification of Tolerance 18. 9. Typical representation of different types of fundamental deviations (a) Holes (internal features) (b) Shafts (external features) • Upper deviation: Designated as ‘ES’ for a Hole and as ‘es’ for a shaft. • It is an absolute value. • Tolerance zones of the shaft and the hole will be overlapped between the interference and clearance fits. • Lower deviation: Designated as ‘EI’ for a Hole and as ‘ei’ for a shaft.

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