

Prof. Dr. P. Venugopal, Professor & Head, Materials Forming Laboratory, Department of Metallurgical & Materials Engineering, IIT Madras, Chennai – 600 036/India ( Manual Prepared in six months in the year of 2005)

- Expt.01. Strain Gages and its Application in Metal Forming. (Familiarization with bridge connections).
- Expt.02. Linear Variable Differential Transducer (LVDT) and its relevance to Metal Forming. (To be conversant with amplifier, recorder, sine bar balancing circuit etc).
- Expt.03. Design, fabrication and Calibration of Load Cell/Electrical Resistance Strain Gage Dynamometer (ERSD).
- Expt.04. Compression test to determine the Flow Curve, Coefficient of Friction.
- Expt.05. Cold Forward Extrusion of a Solid Body. (A cursory exposure which can suit B.Tech also).
- Expt.06. Cold Forward Extrusion in details.
- Expt.07. Phase-I Backward can Extrusion. (Understanding the boat curve).
- Expt.08. Phase-II Backward Can Extrusion. (Influence of non rotation symmetric and axis and rotation symmetric billet in reducing the punch pressure)
- Expt.09. Phase-I Combined Extrusion of Can to Can.
- Expt.10. Phase-II Combined Extrusion of Can to Can. (Grid marking and study of flow patterns, isostrain plots understanding extrusion friction coefficient, understanding the significance in reduction in surface stretching).
- Expt.11. Phase-III Combined Extrusion (understanding the influence of  $u_B$  to  $u_F$  ratio in controlling the flow ratio,  $h_B$  to  $h_F$ ).
- Expt.12. Phase-I Green compaction of Solid and Tubular geometry (preparing the powder, compaction, green density curves).
- Expt.13. Phase-II Green Compaction of Solid and Tubular geometry (de-waxing vide Expt 12, sintering, thinning curve plot, mean preform density, its application in metal working).
- Expt.14. Phase-I Ring Compression Tests on Sintered P/M Preforms (Stage wise upsetting to estimate the densification curves).
- Expt.15. Phase-II Ring Compression tests on Sintered P/M Preforms (to estimate the Plastic flow properties,  $K_a$ ,  $n_a$ ,  $u$  and thence to evolve the Formability Limit Diagrams [FLD] concerned with sintered P/M Preforms for workability).
- Expt.16. Phase-I Hooker Extrusion of Sintered P/M Preforms (tubular extrusion of sintered preforms of varying mean preform densities at four extrusion reductions and recording the F-S Diagrams).
- Expt. 17. Phase-II Hooker extrusion of sintered P/M Preforms Data Analysis (forces characterize the density, disciplining of the boat curve concerned with thinning of preforms, mechanical properties for comparison).

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- Expt. 18. Phase-I Open Die extrusion. (direct extrusion with different die angles, reductions and obtaining the limit strain).  
Expt. 19. Phase-II Open Die Extrusion. (indirect extrusion *ibid*).  
Expt. 20. Phase –I V Free Bending Experimentation to understand the mechanism, free bending force, spring back.  
Expt. 21. Phase-II V Die Bending Experimentation in preferred numbers of free bending force to ensure zero spring back.  
Expt. 22. Phase-III Generation of Nomograms for V bending containing FB and die bending against  $\sigma_{FMEAN}$  and  $n$  for varying widths (for normalization).  
Expt. 23. Phase-I U Free Bending Experimentation vide experiment 20. Phase-I.  
Expt. 24. Phase-II U Die Bending Experimentation vide experiment 21. Phase-II.  
Expt. 25. Phase-III Generation of Nomograms for U bending vide experiment 22. Phase-III  
Expt. 26. Coining Studies to Estimate the Coefficient of Friction, Equations vide Friction Hill, Validation with Ring Compression Test.
- Expt. 27. Phase-I Deep Drawing Experiment to understand OBHP, LDR, First order and second order wrinkles.  
Expt. 28. Phase-II Deep Drawing Experiment to understand the position at which the maximum force occurs, for the LDR, different materials are to be tried from  $n=0.08$  to  $0.56$ ).  
Expt. 29. Rubber pad forming which includes drawing as well cutting.  
Expt. 30. Phase-I Ironing Experiment to establish minimum base thickness so that tearing does not occur.  
Expt. 31. Phase-II Ironing Experiment at different reductions and die included angle to bring the merit that, it is a friction aided process.  
Expt. 32. Phase-I V Bending Studies on Sintered Copper P/M Preforms. Vide Experiment Phase-I.  
Expt. 33. Phase-I I Bending Studies on Sintered Iron Preform Sheets. Vide Experiment Phase II and comparison of Expts 32 & 33.  
Expt. 34. A Metal Forming Machine Tool Oriented Experiment on Spring Constant Measurement of a Press.  
Expt. 35. Test run on Belt Drop Hammer to determine various Efficiencies.  
Expt. 36. Two Wattmeter Power Measurement for Steady State Motors in Presses.  
Expt. 37. Three Phase Dynamic Power measurement in a non-steady steady state motors (bi-directional motor).  
Expt. 38. Experiments 37 & 38 applied to Percussion Press to determine Efficiency and Operating Conditions in terms of blow.  
Expt. 39. Test Run on Hydraulic Press.  
Expt. 40. Green Compaction on High Velocity Hammer to determine the rate of pressure for maximum theoretical density.