

**Vocational Higher Secondary
Education (VHSE)**

Second Year

**Graphic Design &
Printing Technology**

Reference Book



Government of Kerala
Department of Education

State Council of Educational Research and Training (SCERT),
KERALA
2016

List of Contributors

Participants

1. **Benno Joseph**
Vocational Teacher in Graphic Design & Printing Technology
Govt. Vocational Higher Secondary School, Mangayil, Maradu
Ernakulam
2. **Lathish Babu R Nath**
Vocational Teacher in Graphic Design & Printing Technology
Govt. Vocational Higher Secondary School (Boys),
Kunnamkulam, Thrissur.
3. **Dr. Mohammed Sudhir**
Vocational Teacher in Graphic Design & Printing Technology
Govt. Vocational Higher Secondary School, Puramattom
Pathanamthitta.
4. **S. Venugopal**
Vocational Teacher in Graphic Design & Printing Technology
Govt. Vocational Higher Secondary School, Muttara
Kollam.
5. **Premjith. V. C**
Vocational Instructor in Graphic Design & Printing Technology
Govt. Vocational Higher Secondary School for the Deaf, Jagathy
Thiruvananthapuram.

Experts

1. **Deepu P**
Asst. Professor
Department of Printing Technology
Institute of Engineering & Technology
Calicut University

Academic Co-ordinator

Dr.Gopalakrishnan N
Research Officer, SCERT

Prepared by :

State Council of Educational Research and Training (SCERT)

Poojappura, Thiruvananthapuram 695012, Kerala

Website : www.scertkerala.gov.in e-mail : scertkerala@gmail.com

Phone : 0471 - 2341883, Fax : 0471 - 2341869

Typesetting and Layout : SCERT

© Department of Education, Government of Kerala

Foreword

Dear Learners,

This book is intended to serve as a ready reference for learners of vocational higher secondary schools. It offers suggested guidelines for the transaction of the concepts highlighted in the course content. It is expected that the learners achieve significant learning outcomes at the end of the course as envisaged in the curriculum if it is followed properly.

In the context of the Right- based approach, quality education has to be ensured for all learners. The learner community of Vocational Higher Secondary Education in Kerala should be empowered by providing them with the best education that strengthens their competences to become innovative entrepreneurs who contribute to the knowledge society. The change of course names, modular approach adopted for the organisation of course content, work-based pedagogy and the outcome focused assessment approach paved the way for achieving the vision of Vocational Higher Secondary Education in Kerala. The revised curriculum helps to equip the learners with multiple skills matching technological advancements and to produce skilled workforce for meeting the demands of the emerging industries and service sectors with national and global orientation. The revised curriculum attempts to enhance knowledge, skills and attitudes by giving higher priority and space for the learners to make discussions in small groups, and activities requiring hands-on experience.

The SCERT appreciates the hard work and sincere co-operation of the contributors of this book that includes subject experts, industrialists and the teachers of Vocational Higher Secondary Schools. The development of this reference book has been a joint venture of the State Council of Educational Research and Training (SCERT) and the Directorate of Vocational Higher Secondary Education.

The SCERT welcomes constructive criticism and creative suggestions for the improvement of the book.

With regards,

Dr. P. A. Fathima
Director
SCERT, Kerala

CONTENTS

<i>About the Course</i>	<i>5</i>
<i>Syllabus</i>	<i>8</i>
<i>Module 3 - Offset and Modern Printing Techniques</i>	
<i>Printing Materials</i>	<i>17</i>
<i>Sheetfed Offset Press</i>	<i>35</i>
<i>Offset Press Operations</i>	<i>52</i>
<i>Web Offset Press</i>	<i>63</i>
<i>Press maintenance and Troubleshooting</i>	<i>69</i>
<i>Flexo and Gravure</i>	<i>80</i>
<i>Screen Printing</i>	<i>91</i>
<i>Module 4 - Binding and Packaging</i>	
<i>Safety, Health and Green printing</i>	<i>97</i>
<i>Conventional Binding</i>	<i>105</i>
<i>Modern Finishing Operations</i>	<i>115</i>
<i>Packaging</i>	<i>125</i>
<i>Basic Engineering</i>	<i>133</i>
<i>Engineering Graphics</i>	<i>141</i>
<i>Bibliography</i>	<i>160</i>

ABOUT THE COURSE

Printing is indispensable for the modern man as every product he comes across in his day-to-day life is directly related to it. We can see printing on a tooth paste tube or tooth brush that he uses immediately after waking up. From that moment, almost everything he uses for any purpose bears a printed impression. This course provides in-depth coverage of electronic text generation, desktop publishing, computer-to-plate operations, computer-controlled inking and printing, digital image generation and electronic prepress. Printing has undergone a complete transformation with the application of electronics, computers and microprocessors and advanced science and technology. This technology has developed by incorporating the advancements from other disciplines and adopting the latest technical information from commercial art, photography, applied science, computer, mechanical and electronic engineering, nano technology etc.

The importance of Printing Technology is fast increasing in today's commercial world. It has wide usage and applications. The range of products vary from newspapers, books, labels, business cards, stationery, inserts, catalogues, pamphlets, advertisements, carton & foil printing etc. The related activities associated with printing technology are data imaging, book binding, plate making, prepress services etc.

Firms are finding it time saving and economical to print their own newsletters and reports. Hence on completion of this course, there is a wide scope of wage and self employment.

The information revolution and consumerism create an ever increasing demand for printed materials in every field. Printed material is the main medium of communication and dissemination of knowledge. But more than this, the medium of print is improving its position in today's multimedia society. Day by day, people are becoming more and more quality conscious and this in turn increases the demand for quality printed products. The methods of print production are also changing; in the direction of environment-friendly, highly automated and easily operated printing systems integrated in a digital data environment.

Packaging is an integral part of printing Industry. The printing and packaging industries in India have assumed growing significance during the last decade. This has become a dynamic and key area for manufactures and trading companies all over the country with the element of aesthetics, hygienic and cost effectiveness receiving increasing importance in commercial operations. The exterior looks and present ability of marketable goods leave a lasting impression on the minds of consumers and in this context packaging occupies the centre stage.

Since there is increasing demand for printed products there is always scope for those who are skilled in the operation of printing machines either as workers or entrepreneurs.

The course is designed in four modules of six month each as detailed below.

1. Graphic Designing and DTP
2. Digital Pre-press and Printing
3. Offset and Modern Printing Techniques
4. Binding and Packaging

On completion of every module the student will get a certificate for the skill he acquired. On successful completion of the course two certificates will be issued - a regular higher secondary certificate and a Skill certificate in the level 3 & 4. The students who pass the exams can apply for any engineering, degree or diploma course just like any another student who passed higher secondary exam with the mathematics group.

MAJOR SKILLS

Identification of different types of paper

Paper calculation

Identification of different types of inks used in the printing industry

Identification of different chemicals used in printing industry

To operate single colour & multi colour offset machine

Work estimation

To operate a web offset press

Identify different problems during printing process

To handle different quality control devices used in printing industry

To prepare a flexographic printing plate

To operate flexo printing machine

To identify different security printing methods

To prepare a stencil for screen printing

To screen print images on various substrates

The use of safety equipments in printing press

Different type of binding, sewing, and covering operations

To operate a Cutting machine

To handle different modern post press machines

Identify different packaging materials

To design and prepare a package for different products

To prepare different carton styles and dies for packaging

To identify Mechanical, Electrical & Pneumatic parts of an offset machine

To get the basic concepts of Engineering drawing

SYLLABUS

Module 3 - Offset and Modern Printing Techniques

Unit 1 - Printing Materials

(Periods 65)

- 3.1 Printing Materials
 - 3.1.1 Paper - Brief history of Paper
 - Origin of paper from papyrus
 - Handmade paper
 - Machine made paper
 - 3.1.1 Paper making process
 - Raw materials for paper making
 - Pulping, Treating the pulp, Manufacturing paper using Fordrinier Paper Machine
 - 3.1.2 Physical properties of paper
 - Grain, Dimensional stability, fiber strength, finishing, pick resistance, whiteness and brightness, substance weight, flatness, squareness, ink drying, moisture absorbancy, opacity
 - 3.1.3 Paper classification, paper sizes & paper weight
 - Coated paper, Card, board
 - Business paper (Bond paper, carbon paper)
 - Book paper (offset paper - uncoated, coated, text paper)
 - Cover paper, Bristol paper
 - Utility paper (Newsprint, label paper, synthetic paper, mineral paper)
 - Paper size- ISO/International sizes, Conventional paper sizes
 - Paper Weight- GSM, Basis weight, M-weight, Conversion of GSM to basis weight
 - 3.1.4 Estimating Paper Quantity
 - Cancellation method for calculating the greatest no. of sheets that can be cut from a single, full size sheet
 - Paper Calculation
 - 3.1.5 Storage of paper / warehousing
 - Web offset roll storage
 - 3.1.6 Ink - Ingredients, Properties and Manufacturing
 - Pigment, Vehicle, Additives
 - Ink body, viscosity, length, tack, opacity, colour strength, ink stability, drying time, abrasion resistance
 - Mixing, milling
 - 3.1.7 Ink drying methods
 - Oxidation, evaporation, precipitation, penetration, polymerisation, radiation curing

3.1.8 Types of Ink

Sheetfed ink, rubberbased ink, web offset heatset inks, weboffset coldset inks, news inks, non-porous inks, uv inks, magnetic inks, invisible inks, soy inks, opaque inks, waterless inks, flourescent inks, metalic inks, overprint varnishes, toner ink, optically variable inks

3.1.9 Chemicals used in Printing

Dampening solution

Water, Acid (measuring pH, conductivity), Gum arabic, Wetting agents, Corrosion inhibitors, Anti foaming agents, Fungicides and drying stimulators, Alcohol dampening solution

Other press room chemicals

Unit 2 - Sheetfed Offset Press

(Periods 40)

3.2. Sheetfed Offset Press

3.2.1 Press classification

Duplicators and Presses

Sheetfed Presses

Webfed Presses

Mulit colour Presses

Perfecting Presses

Waterless offset Presses

Digital Offset Presses

3.2.2 Working Principle and Operating Units of an Offset machine

Feeder Unit

Successive sheet feeding, Continuous feeding, stream feeding

Parts of feeding unit

(Pile feeder, pile board, pile height governor, blower, sucker, sheet separator)

Registration Unit

Functions of registration unit

Parts

(Double sheet detector, front lay, side lay, conveyor tape, running in wheels, two point guide system, three point guide system, transfer cylinder system)

Printing Unit

Cylinder structure - undercut, bearer, gutter, cylinder body, drive gears, cylinder gap

Cylinders - The plate cylinder - function

Blanket cylinder - function

Impression cylinder - function

Grippers

Inking system

Parts - Ink fountain, fountain tray, fountain roller, fountain blade, form roller, ink agitator, distributing roller, oscillating roller, ink feed control, remote ink control

Dampening system

Parts of dampening unit

Conventional dampening system, continuous dampening system, alcohol dampening system (advantages), roller covers

Waterless offset, Advantages of waterless offset

Delivery Unit

Gravity delivery

Chain delivery

Parts of delivery unit

(Delivery pile, delivery chains, skeleton wheels, joggers, ancillary units - anti set off spray etc.)

Ancillary units

3.2.3 Offset Blanket

Structure of an offset blanket

Conventional blankets

Compressible blankets

Under blankets

Hardness of blanket (shore hardness, shoredurometer)

Types of blanket

a) based on hardness (hard, soft, medium, sandwich, special)

b) 1 Ply, 2 Ply, 3 Ply, 4 Ply blankets

Properties of a blanket

Storage of blanket

Unit 3 - Offset Press Operations

(Periods 45)

3.3. Offset Press Operations

3.3.1 Pre-make ready and Make ready Procedure

Preparing the inking unit

Preparing the dampening unit

Attaching the plate

Semi auto plate loading

Auto plate loading

Preparing the feeding unit and registration unit

(Feeding steps)

Setting the delivery unit

Feeding the test sheets

Checking the test sheets

- 3.3.2 Cylinder and roller pressure
- 3.3.3 Multi colour printing
- 3.3.4 Sequence of printing
- 3.3.5 Leading Offset machine manufacturers
 - International
 - Heidelberg, Komori, Mitsubish, Ryobi, Fuji, AB Dick
 - Indian
 - HMT, Manugraph, Orient, Optima, Autoprint
- 3.3.6 Automation in print production
 - Automatic wash-up, auto plate loading
- 3.3.7 Estimation procedure in offset printing
 - Calculating Production cost
 - Quotations
 - Job ticket / work order

Unit 4 - Web Offset Press

(Periods 30)

- 3.4. Web Offset Press
- 3.4.1 Types of web offset press designs
 - Perfecting / blanket to blanket
 - Inline presses
 - Stack / Tower Presses
 - Common impression cylinder presses (Satellite units)
- 3.4.2 Web operations
 - Roll stand, Splicer, Festoon, Tension control, Web guide, Dryer, Chill roller, Flying paster, Zero speed paster, Web break detectors, Image alignment and register, Printing unit, Adjustment, Ink drying systems, Filtration system, Dampening system
- 3.4.3 Inline finishing
 - Combination folding, inline stitching, single knife rotary die cutter, three knife trimmer, numbering tower, pattern perforators, pattern gluer
- 3.4.4 Web offset printing papers
- 3.4.5 Press console

Unit 5 Press maintenance and Troubleshooting

(Periods 60)

- 3.5 Press maintenance and Troubleshooting
- 3.5.1 Paper problems
 - Electrostatic charge on paper, Crease formation, Picking
- 3.5.2 Ink problems
 - Emulsification, Slow ink drying, chalking, Hickies, Piling
- 3.5.3 Printing problems
 - Blinding, Ghosting, Mis-registration, Mottling, Plate ware, Scum, Sett-off, Sluring, Tinting

- 3.5.4 Problems due to blanket and rollers
Glazing, Swelling, Paper sticking,
- 3.5.6 Preventive maintenance
- 3.5.7 Cleaning and caring the press
- 3.5.8 Quality Control in offset
Remote control press console, Plate image scanners, Magnifying glass, Colour viewer, Densitometer, Spectrophotometer, Colourimeter, Colour bar, Dot gain scale, Slur gauge, Register marks, Star Target, Gray balance patch

Unit 6 Flexo and Gravure

(Periods 40)

- 3.6 Flexo and Gravure
- 3.6.1 Flexography - Introduction
- 3.6.2 Advantages
Cylinder make ready, packaging application
- 3.6.3 Basic units
Infeed unit and unwinding unit
Printing unit
Components : Plate, fountain roller, anilox roller, printing and impression cylinder, reverse angle doctor blade, two roller and three roller inking system
Outfeed unit and rewinding unit
- 3.6.4 Flexographic plates
Rubber stereo plates
Photopolymer plates (sheet, liquid)
- 3.6.5 Plate making process
Laser plates
- 3.6.6 Press types
Stack press
Central impression cylinder
Inline press
- 3.6.7 Flexographic ink & substrates
- 3.6.8 Gravure Printing - Introduction
- 3.6.9 Advantages and disadvantages
- 3.6.10 Gravure printing units
Gravure printing cylinder
Impression cylinder
Ink duct
Doctor blade
Electrostatic assist

- 3.6.11 Cylinder preparation methods
 - Chemical engraving method
 - Electromechanical method
 - Laser beam engraving
- 3.6.12 Ink and substrates
- 3.6.13 Security Printing
 - Introduction to security printing -
definition, goal of security printing, various printing methods used for security printing
 - Security features
 - Watermark, security thread, latent image, micro lettering, see through register
 - Security ink, Numbering with MICR ink, Security paper
 - Currency printing, Cheque printing
 - Holograms
 - Hologram types
 - Holographic patterned foils
 - Three dimensional holograms
 - Multiple plane holograms
 - Stereograms
 - Bar codes, QR codes

Unit 7 Screen Printing

(Periods 60)

- 3.7 Screen Printing
 - 3.7.1 Applications of Screen Printing
 - 3.7.2 Screen Printing Process
 - Squeegee, screen printing inks, solvents, drying system
 - 3.7.3 Screen frames and Fabrics
 - Frame materials, print size
 - Fabric strength, mesh count, types of fabrics
 - 3.7.4 Stencil preparation
 - Hand cut stencils, Tusche and glue stencils, photographic stencils
 - 3.7.5 Substrates for screen printing
 - 3.7.6 Automation in screen printing
 - Lever action hand operated presses
 - Semi automatic presses
 - Fully automatic presses
 - 3.7.7 Special screen printing applications
 - Cylindrical screens
 - Screen printing on cylindrical surfaces
 - Carousel units

Module 4 - Binding and Packaging

Unit 1 - Safety, Health and Green printing

(Periods 40)

- 4.1 Safety and Health
 - 4.1.1 Safety regulations
 - Mechanical hazards
 - Chemical hazards
 - Noise hazards
 - Fire hazards
 - Light hazards
 - 4.1.2 Safety guards in an offset machine
 - Mechanisms that cause serious physical injury in a printing machine (spinning rollers, rotary chains and sprockets, turning gear, running belt)
 - Emergency stop buttons, feeder guards, registration board guard, cylinder guards, delivery guards
 - 4.1.3 Safety measures for operating a cutting machine
 - 4.1.4 Personal protective devices
 - Ear protection devices, eye protection devices, respiratory protection devices, skin protective devices
 - 4.1.5 Fire classifications & Fire extinguishers
 - Class A, Class B, Class C, Class D
 - 4.1.6 Green printing
 - Eco-friendly paper
 - Recycled paper (Steps in recycled paper production)
 - Logos of recyclable and recycled paper
 - Paper made with alternative chemicals (Acid free paper, Alkaline paper, ECF bleaching, TCF bleaching, Oxygen delignification)
 - Wood free paper
 - Bio degradable substrates
 - Low VOC inks - Vegetable inks (soy ink)
 - Re-manufactured cartridges
 - Soft proofs
- Use of renewable energy resources in printing

Unit 2 - Conventional Binding

(Periods 100)

- 4.2 Conventional binding
 - 4.2.1 Introduction & Definition
 - 4.2.2 Classification of binding
 - Letterpress binding
 - Publishers, Library, Miscellaneous binding, Extra letterpress binding
 - Stationery binding

- Office stationery, Manifold, Account book binding, Exercise note book binding
- 4.2.3 Styles of binding
 - Paper board, Cut flesh, Quarter cloth turned in, Half cloth, Full cloth, Quarter leather, Half leather, Full leather
- 4.2.4 Materials for Book binding
 - Board, Adhesives
- 4.2.5 Steps in Binding
 - Warehousing
 - Counting, Jogging, Pressing, Folding (signature), Smashing and Bundling, Gathering, Collating, Stitching, Sewing (types of sewing - Ordinary, Flexible sewing, Machine sewing, Hand sewing, Double flexible sewing- kettle stitch, tape sewing, sawn in sewing) Overcasting
 - Forwarding
 - End papers, Glueing, Edge cutting, Rounding, Backing, Edge decoration, Head banding and lining the back.
- 4.2.6 Covering and finishing
 - Paring leather, Pasting the cover, Drawing on, Turning in, Setting the joints, Setting the caps, Nipping up, Tying up, Opening up, Filling in, Siding, Pasting down open, Library

Unit 3 - Modern Finishing Operations

(Periods 45)

- 4.3 Modern Finishing Operations
 - 4.3.1 Cutting (paper cutting machine)
 - Guillotine cutter, Three knife cutter
 - 4.3.2 Folding operations
 - Types of foldres
 - 4.3.3 Other finishing operations
 - Perforation, Slitting, Creasing and scoring, Die cutting, Embossing, Stamping, Numbering, Punching and drilling, Varnishing, Lamination, Foil stamping, Thermography
 - 4.3.4 Binding
 - Pamphlet binding, Edition binding, Perfect binding, Mechanical binding, Plastic comb binding, Spiral Binding.

Unit 4 - Packaging

(Periods 70)

- 4.4 Packaging
 - 4.4.1 Defenition and functions of packaging
 - Packaging for communication
 - Objectives of packaging
 - 4.4.2 Design fundamentals of Packaging
 - Packaging design principles

- Typography and packaging design
- Packaging design and colour
- Images for packaging
- 4.4.3 Materials for packaging
 - Metal- Aluminium, Tin
 - Paper- Paper board, Corrugated paper board, Set up box
 - Plastic- Low density poly ethylene (LDPE), High density poly ethylene (HDPE), Poly ethylene terephthalate (PET), Poly propylene, Poly styrene (PS), Blister packs, Glass, Metal, Cans, Tubes, Flexible packaging, Labels, Closures, Stock packaging
 - Glass
 - Special Packages- Blister packs, Bubble wrap, Shrink wrap,
- 4.4.4 Carton styles and Packaging Die
 - Four pannel style box, Folding cartons, Straight tuck end , Reverse tuck end, Full seal end, Automatic lock bottom, Snap lock bottom, Tray style boxes, Seal end, Set-up boxes Die making process
- 4.4.4 Packaging Die

Unit 5 - Basic Engineering

(Periods 25)

- 4.5 Basic Engineering
 - 4.5.1 Direct current and Alternating current
 - 4.5.2 Motors and Transformers
 - 4.5.3 Basic Electronic Circuit
 - 4.5.4 Mechanical components
 - 4.5.5 Hydraulics and Pneumatics
 - 4.5.6 Mechanical, Electrical, Electronic and Pneumatic parts of a printing machine

Unit 6 - Engineering Graphics

(Periods 60)

- 4.6 Engineering Graphics
 - 4.6.1 Drawing instruments and uses
 - 4.6.2 Lines - Different types and its applications
 - 4.6.3 Lettering and numbering
 - 4.6.4 Dimensioning
 - 4.6.5 Construction of basic shapes - polygon, conic section, spiral curve
 - 4.6.6 Introduction of projection of points, lines, planes
 - 4.6.7 Quadrants and objects in different quadrants
 - 4.6.8 Basic section views
 - 4.6.9 Auxilliary views
 - 4.6.10 Isometric views
 - 4.6.11 Introduction to machine drawing

MODULE 3

OFFSET AND MODERN PRINTING TECHNIQUES

Overview of Module - 3

Printing industry has seen immense technological growth and changes in the past 20 years. Electronics and computers have completely changed the complexion of the industry. Most manual process has been eliminated in the printing process. . The smallest offset duplicators to the largest web offset use computer technology to run, monitor, and adjust everything from ink density to web tension. The advances and improvements, along with the conventional methods, have made offset lithography a mature combination of process and techniques.

There are many career and business opportunities for those who have necessary skills and educational background. This module has been designed and organized to teach you about offset printing materials, offset printing methods and other modern printing methods such as flexography, gravure and security printing. The practical activities of this module integrates the academic concepts with technical applications and work place approach.

Unit - 1

PRINTING MATERIALS

Introduction

Paper, ink, and various chemicals are the major consumables used in the printing industry. In this unit a detailed study on paper manufacture, physical properties of paper, its classification and uses, ink manufacture, ingredients of ink, ink properties, ink drying methods and properties of various chemicals especially dampening solution are discussed.

Learning Outcomes

The learner:

- summarises various steps involved in Paper making process.
- identifies the Physical properties of paper.
- classifies Paper according to its types, sizes & paper weight.
- estimates the quantity of Paper required for printing a work.
- understands Storage of paper / warehousing.

- lists the Ingredients of ink, its Properties and the steps in manufacturing of ink.
- categorises the methods of Ink drying.
- categorises different types of Ink.
- identifies the chemicals used in Printing.

Paper - Brief History of Paper

Origin of paper

Paper is a flat material produced from plant fibers that are mechanically or chemically treated or thermo-mechanically treated with chemicals. Of all the writing materials mankind has employed down through the ages, paper has become the most widely used around the world. The word paper is derived from papyrus, a plant which grows in Africa. Thin strips cut out of the inside of the plant were laid down next to each other, pressed, beaten, and smoothed out. Paper, as we know, traces its roots back to China at the beginning of the first millennium AD. Originally intended purely for writing and printing purposes, a dazzling array of paper products are available to today's consumer from papyrus.

China: birthplace of paper AD 105

The actual invention of paper produced from plant fibers such as bamboo fibers dates back to AD 105. Tsai Lun from China invented a paper making process which primarily used rags (textile waste) as the raw material.

Papermaking spreads across Asia, Middle East and Europe- AD 610

Chinese papermaking techniques reached Korea at an early date and were introduced to Japan in the year 610. In these two countries paper is still made by hand on a large scale in the old tradition

Very soon, knowledge of papermaking spread to Central Asia and Tibet and then on to India. As the Arab world expanded eastwards it too became acquainted with the production of paper and paper mills were set up in Baghdad, Damascus and Cairo, and later in Morocco, Spain and Sicily.

European papermakers continue the innovation- 14th Century

The export of the technique of papermaking to Europe, especially to Italy, has been well documented. The first documented papermaking on German soil was in 1390 when the Nuremberg councillor Ulmann Stromer commissioned a paper mill.

The advantages of mill-based papermaking spread throughout Europe in the 15th and 16th centuries. In Germany, by the end of the 16th century there were 190 mills.

Emergence of wood based paper and increased mechanisation- 19th Century

The systematic search for substitute raw materials with which to produce paper in Europe proved difficult. In the early 18th century straw was used as a raw material but it failed to make headway due to quality concerns.

Full-scale industrialisation - innovation and specification lead to new paper grades and paper uses.

19th & 20th Century

The paper production process became fully automated: from the preparatory and pulp production stages to the papermaking, use of fillers and finishing (including the headbox, wire section, pressing, drying, reeling, smoothing and packaging).

The paper industry developed appropriate industrial plants (groundwood and chemical pulp mills) in order to produce wood based paper on an industrial scale and to meet the demand for this increasingly valued substitute for rags which was set to become the dominant raw material for papermaking.

In the past 50 years the rate of innovation in papermaking has increased rapidly. New materials have been developed (using thermo-mechanical pulps, recovered paper and new fillers). New sheet forming options and neutral sizing have been accompanied by a greater awareness and focus on environmental impacts. Innovation has also led to greater specialisation by paper makers, for example in the development of new paper grades such as LWC - Light Weight Coated paper (mainly used in magazines, flyers and inserts such as coupons); and some paper groups have acquired their own raw material supply and trading organisations.

Paper making process

Raw materials for paper making

The main raw materials for papermaking in the past were cotton and linen fibers obtained from rags. Cellulose is the raw material used to make most paper today. It is obtained mainly from bamboo, eucalyptus, jute, buggase, pine, oak, accasia and other light woods. The length of the tree fiber determines various characteristics including strength of the paper. Now-a-days, waste paper is the major raw material used for papermaking, especially for recycled paper.

Papermaking is a complex manufacturing process. It uses both chemical and mechanical means to reduce wood fibers to pulp, which is the material used to produce paper in sheet form.

Chipping:- Logs are cut to uniform length, debarked and sent to a chipper or grinder. The chipper cuts the logs into chips. The chips are sized so the digester

is able to separate the cellulose fibers. After the chips are screened for size, they are put in a huge cooking kettle called digester.

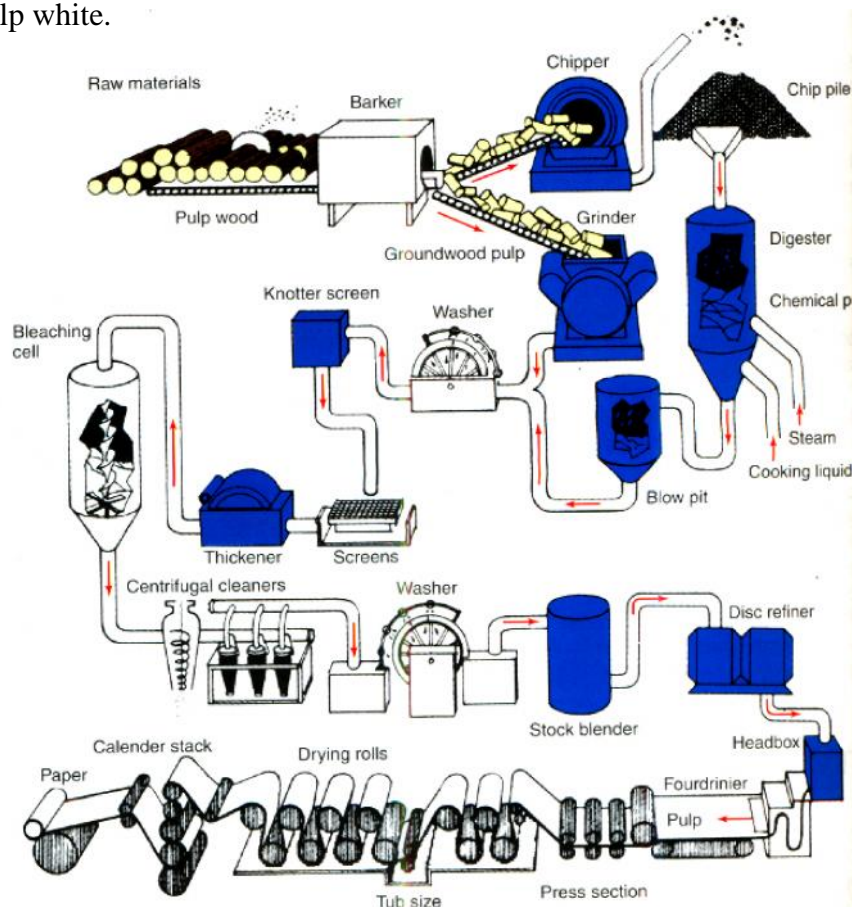
Pulping:- There are two types of pulping methods namely chemical pulping and mechanical pulping. Pulp made by chemical pulping is again divided into two - sulphate pulp (using alkali) and sulphite pulp (using acid).

In the chemical pulping process, chemicals in the sealed, pressurised digester break down in the lignin present in the cellulose fibers. The cellulose fibers become pulp, a mass of soft, spongy matter. The pulp is blown into a pit where the chemicals are washed away.

The mechanical pulpmaking process uses grinding wheels to reduce the logs to fiber. Pulp with high opacity but relatively low strength is produced.

Treating the pulp :- Sizing chemicals are added to the pulp slurry to make the paper more resistant to moisture. Resin and alum are added during this process. Fillers like clay and titanium dioxide are added to improve a paper's opacity, brightness, softness and ink receptivity.

Dyes and pigments are added to produce coloured paper; bleaching makes the pulp white.



The fibers are refined by a jordan machine which eliminates 99% water from the pulp. The solution is pumped into a head box of the paper making machine.

Manufacturing paper using Fordrinier Paper Machine:- The pulp is evenly dispersed on the fourdrinier wire mesh. The mesh vibrates as it travels along an endless belt, aligning the fibers in the direction of travel. The alignment of the fibers decides the grain direction of the paper. A continuous web of paper is formed in this process. Gravity and suction remove about 35% of the water. Watermarks can be given to paper at this stage with the help of dandy rollers. *Watermarks are translucent identifying designs of symbols or images impressed in the paper by rearranging the fibers.*

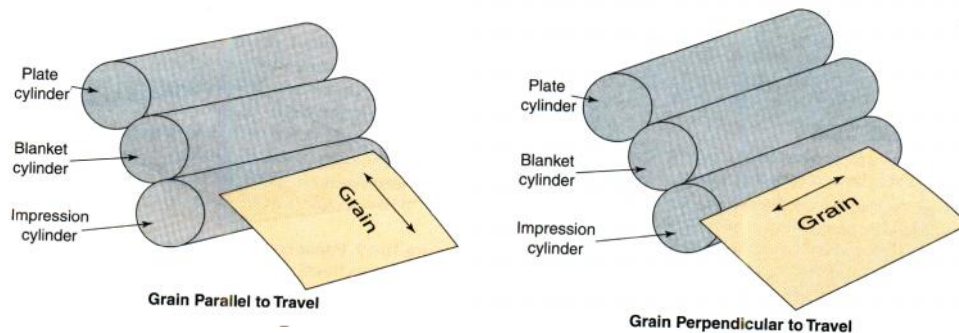
Drying:- The web enters the press section as it leaves the wiremesh for removal of more water. Then it passes through the dryer section consisting of temperature controlled rollers thereby removing more moisture. Coatings are applied to the paper at this stage.

Calendering is the process of flattening and smoothing the paper surface by passing it between a series of rollers. Super calendering uses heated steel rollers and pressure to form a very smooth, high gloss finish.

Rolling:- The untrimmed paper is wound into rolls. Some rolls are rewound, slit and cut into lengths to make flat packages of paper.

Physical properties of paper

Grain direction:- The direction in which most of the cellulose fibers are aligned. Paper that is cut into sheets with the fibers aligned parallel to the sheet's longer dimension is long grain. Paper with fibers that are aligned parallel to the sheet's shorter dimension is called short grain.



Dimensional stability:- Ability of the paper to retain its original length and width when exposed to moisture.

Fiber strength:- Paper with longer fiber length has better resistance to tearing. A sheet's tear strength is proportional to the length of its fiber.

Finish:- It is the degree of smoothness of a paper's surface. Example of different finishes are antique finish, eggshell finish, vellum finish, machine finish, embossed finish, matt finish, dull finish and gloss finish.

Pick resistance:- It is the ability of a paper to resist surface rupturing during printing.

Whiteness and brightness:- Whiteness refers to the extent to which it reflects nearly equal amount of RGB light from its surface. Brightness can be defined as the percentage of striking light a surface reflects.

Substance weight:- The weight of a paper is measured by its substance weight or basis weight. The substance weight is the weight of a ream of paper in a specified size.

Flatness:- It is a measurement of how much the paper curls or become wavy.

Squareness:- A sheet's squareness describes the sheet being exactly 90° at all four corners. Squareness is important for sheets that will be printed with a work and turn or work and tumble imposition.

Ink drying:- Variations in paper quality can result in slow ink drying.

Moisture absorbancy:- Paper is hygroscopic in nature. Paper absorbs moisture from its surroundings. It causes the cellulose fibers to expand in the direction of its width and this results in change of dimension of paper.

Opacity:- Refers to the ability of paper to hide or mask a colour or object on the back of the sheet. Poor opacity causes show-through in which the image on one side of a sheet of paper is seen on the other side.

Paper classification, paper sizes & paper weight

Classification of paper based on grammage and structure

Paper is a tubular structure generated by natural agglutination and felting of fibers and having a grammage of 7g/m² to 150 g/m². On the basis of the composition of the pulp or raw material paper is divided into woodfree paper, paper containing wood, paper containing waste paper and paper containing rag.

Wood free paper is mainly produced from chemical pulp fibers and must contain a maximum of 5% of ground wood pulp. Lot of printing and writing paper, as

well as uncoated and finished paper with coated surface are wood free paper. Paper containing wood is produced by using high proportion of ground wood pulp and lignin so that it yellows quickly. Newsprint and magazine paper are examples.

Paper containing waste paper (recycled paper) are those with 100% recycled and secondary fibers. They are used to make paper for simple boards, folding box card, newsprint etc.

Paper containing rag (textiles, linen, hemp fibers etc.) is used for manufacturing security materials like banknote paper, document paper etc.

Coated paper are papers coated on both side which are suitable for best quality web-offset, sheet-fed and gravure printing. Examples are Light Weight Coated paper (LWC)- (paper with grammage upto 72g/m^2), Medium Weight Coated paper (MWC)- Paper with grammage ranging from $80\text{--}130\text{g/m}^2$), original coated art paper, cast-coated paper (paper with mirror or glossy finish surface with grammage ranging from $70\text{--}400\text{g/m}^2$)

Card (cardboard) is a tubular material consisting of plant fibers. The grammage of cards vary between 150g/m^2 to 600g/m^2

Boards are products of simple raw material such as ground wood pulp and secondary fibers and has a grammage over 600g/m^2 . Straw board and Mill board are examples.

Paper classifications are used to identify and categorise different types of paper. The five classifications of paper are business paper, book paper, cover paper, bristol paper, utility paper.

Business paper

It includes sheets commonly found in business world. The basic size of all business papers is 17" X 22". Most common categories of business papers are bond paper, carbonless bond paper, envelope paper and safety paper.

Bond paper:- papers which are used for letter heads, stationery, business forms, writing, typing and photocopying.

Carbonless bond paper:- papers coated with microcapsules that, under pressure, transfer an image to a sheet or sheets underneath it. They are used to transfer and copy written, printed or typed images between sheets. There are three types of carbonless paper - coated back, coated front and back, coated front.

Envelope paper:- papers used to manufacture envelopes. They have enhanced burst, fold strength, opacity and ability to be gummed and moistened with a minimum of curl.

Safety paper:- commonly used to add security to certificates of title and bank cheques. This paper carries a printed image to thwart alteration by erasure and carries an image in invisible ink that becomes visible if bleach is used to chemically alter an image.

Book paper

Book papers are papers having high opacity so that it can carry print on both sides. Used to print various products such as annual reports, pamphlets, magazines, text books, posters, newsletters, journals, brochures, menus etc. Different types of book papers are offset paper and text paper.

Offset paper:- used for offset printing. They have good opacity and ink absorption. There are two types of offset papers- uncoated paper and coated paper (coated on one or both sides).

Text paper:- grade of paper made from either wood or cotton fibers.

Cover paper

It is a thick or heavy paper, typically used for the covers of books, catalogues, brochures, manuals and similar publications.

Bristol paper

Heavy papers with at least 0.006" thick are termed bristols. Different types of bristol papers are index bristol, post card bristol, tag board bristol, paper board, blank and railroad board.

Utility paper

Papers that do not belong to these first four classifications are termed as utility paper. Newsprint, label paper, synthetic paper, mineral paper are examples for utility paper.

Newsprint is one of the lowest grades of printing paper. It is made by the mechanical method of papermaking. Newsprint has very short fibers which enables the paper to be folded easily in any direction. When new, it has a grayish-white colour but it turns yellow and becomes brittle with age. Since newsprint absorbs ink readily, a drying system on the press is not needed.

Label paper are paper coated with adhesive material. They must be able to accept ink on one side and gumming on the other side without curling. Gum will be covered by a wax coated releasing sheet.

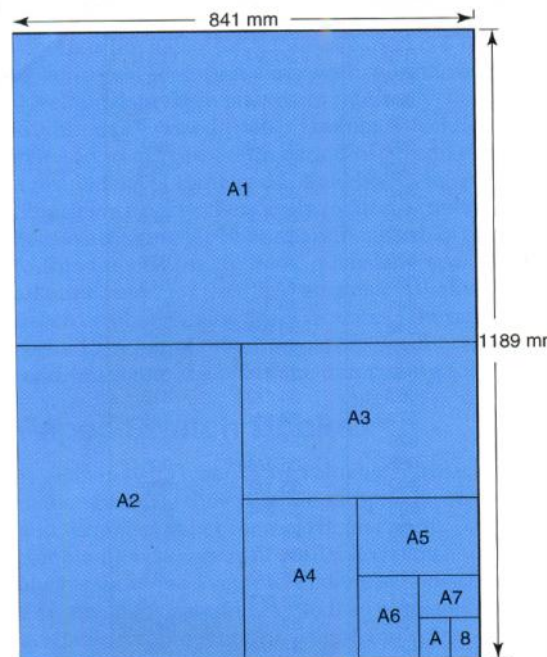
Synthetic paper is a thin sheet of plastic with a clay coating on both sides that accepts the ink. They are resistant to stains and tearing.

Mineral paper is made from pulverised limestone particles held by a binding agent. This paper has no grain direction, is water proof and resist tearing because it is not made from cellulose fibers.

Recycled paper:- Recycled paper is produced from pulp from recovered paper and paper products, manufacturing wastes, non paper material and wood residues.

Paper sizes and weight

Paper sizes are broadly classified into two: ISO or International size and Conventional size.



ISO/International size

It is the internationally accepted size. It falls into 3 divisions namely A, B & C series and the size is denoted in millimeters.

A Series:- In the A Series, A0 has an area of 1 m^2 . The sheet is not a true square but has a proportion of 5:7. Used for printing books, notice, posters etc. A0 size is 841 mm X 1189 mm

B Series:- B series paper used for printing maps, charts, large size posters etc. B0 size is 1000 mm X 1414 mm

C Series:- C series is used for office stationery. C0 size is 917 mm X 1297 mm

Conventional paper sizes

Conventional paper size is also known as Indian paper size. Commonly used Indian paper sizes are :

Foolscap	13.5" X 17"
Crown	15" X 20"
Demy	17.5" X 22.5"
Medium	18" X 23"
Royal	20" X 25"
Imperial	22" X 30"
Elephant	23" X 28"

GSM:- Basic weight system of paper is expressed in Grams per Square Meter. It is the weight in grams of a paper with one square meter size.

GSM below 150	- Paper
GSM between 150 & 600	- Card
GSM above 600	- Board

Ream:- 500 sheets of paper of same size and weight is termed as Ream.

Basis weight:- Weight of 500 sheets of paper of standard sheet size.

For example, the basis weight of 70 GSM paper with basic size as double demy is 18.6 kg.

M-weight:- Weight of 1000 sheets of paper of standard sheet size.

For example, the M weight of 70 GSM paper with basic size as double demy is 37.2 kg.

Conversion of GSM to basis weight

$$\frac{\text{Length in meter} \times \text{breadth in meter} \times \text{GSM}}{1000} \times \text{No. of sheets(500)}$$

Estimating Paper Quantity

Cancellation method for calculating the greatest no. of sheets that can be cut from a single, full size sheet.

Eg: Sheet size - 11 × 17

Required card size - 5 X 8

Cancellation method

$$\frac{\overset{2}{\cancel{11}} \times \overset{2}{\cancel{17}}}{\underset{5}{\cancel{5}} \times \underset{8}{\cancel{8}}} = 2 \times 2 = 4 \quad \left| \quad \frac{\overset{1}{\cancel{11}} \times \overset{3}{\cancel{17}}}{\underset{8}{\cancel{8}} \times \underset{5}{\cancel{5}}} = 1 \times 3 = 3$$

Divide the sheet size with the required card size in two possible ways. In the first method, we get 4 cards in landscape position from a sheet. In the second method, we get 3 cards if we cut the sheet in portrait style. We get more number of cards if we cut the sheet as in the first method and the wastage is less compared to the second method.

Paper Calculation

The quantity of paper required for any job can be calculated by using the following formula:

Quantity of Paper Required

In order to calculate the quantity of paper required for the production of a complete job in a particular size. The following formula may be used.

$$\text{Paper required in reams} = \frac{\text{No. of pages in a copy} \times \text{No. of copies to be printed}}{\text{Section} \times 500}$$

Where section = No. of pages obtained from one sheet of the required size of paper.

For example : To find out the total quantity of paper required in 61 cm x 88 cm size for the printing of 20,000 booklets in 210mm X 297mm size assuming that each booklet contains 24 pages?

Since 16 pages of size 210 x 297 mm are obtained from one sheet of 61 cm x 88 cm size, the value of a section shall be 16.

$$\text{Therefore paper required} = \frac{24 \times 20000}{16 \times 500} = 60 \text{ Reams without wastage}$$

Storage of paper / Warehousing

Web offset roll storage:- Do not store rolls on sides. Largest diameter roll should always be at bottom. Do not store rolls on bare floors, they could become dirty or wet. Use scrap paper as dividers when stacking unwrapped rolls.

Use roll clamp truck and minimum pressure to lift rolls.

Ink - Ingredients, Properties and Manufacturing

Ink is a coloured coating used to place a printed image on a substrate. Ink has several properties that can affect print quality. Ink is formed by a mixture of three ingredients- pigment, vehicle and additives.

Ingredients in Ink

Pigment:- It provides the colour of an ink. Pigments are of 4 types - Black pigment, white pigment, organic colour pigment, inorganic colour pigment.

Black pigments are produced by burning natural gas and oil on to a collecting device. The by-products from the burning process are called thermal black and furnace black.

White pigments are sub divided into two groups - opaque and transparent pigments. White ink containing 'opaque pigments' (through which light can not pass) is used when transferring an image to cover a substrate or when overprinting another colour. Opaque whites are also used for mixing with other inks to lighten the colour or hue.

'Transparent' white pigments (through which light can pass) are used to allow the background material or ink to be seen.

Organic pigments are derived from living organisms. All organic pigments contain carbon and hydrogen, and most are made from petroleum; however, coal, wood, animal fats and vegetable oils are also used in organic pigment manufacture. The major advantages of organic pigments over inorganic pigments are that organic pigments provide a wider selection of colours, tend to be richer in colour, brighter, more transparent and purer than inorganic pigments. These qualities are important for four-colour printing.

Inorganic pigments are made from minerals and are classified according to their chemical make up - chromes, cadmiums, irons and earth colours.

Vehicle:- Vehicle is a binding agent that holds the ink together. It also carries the pigment. Vehicle is often a solvent resin or oil resin combination. Now-a-days soya based paste inks are widely used.

Additives:- Ingredients such as drier, lubricant, wax or starch are added to the ink to impart special characteristics such as tack, workability and drying time.

Properties of Ink

Viscosity:- is the resistance to flow under applied force. Lithographic and letterpress inks have high viscosity because they are paste like. Flexo and gravure inks are less viscous. Viscometers are used to measure the viscosity of liquids.

Tack:- Tack or stickiness is a property of ink that must be controlled in order to transfer images and deliver the sheets through the press. Tack can cause paper (especially coated paper) to adhere or stick to the blanket of an offset press. Ink that is excessively tacky may also pick the surface of the paper and cause misfeeding. Tack increases as one colour is printed over another. An inkometer is used to measure the tack of ink.

Opacity:- Opacity refers to the covering ability of an ink. High opacity means very little light is transmitted. Most lithographic inks are transparent, so two colours can be over printed to create a third colour. Process colour printing is dependent on light passing through all the layers of ink. Screen printing inks are highly opaque.

Ink stability:- Ink stability or thixotropy is the tendency of an ink to flow more freely after being agitated by the ink rollers.

Drying time:- There are two stages in the ink drying process; first the ink should instantly set or stick to the paper. The second stage in the drying process is hardening. When ink has hardened the vehicle has completely solidified on the paper surface. The time it takes for liquid ink to harden to a solid state is called the drying time.

Manufacture of Lithographic Ink

Lithographic ink is manufactured by mixing vehicles, pigments and additives, There are two stages in ink manufacture- mixing and milling

Mixing:- The pigment is introduced into and distributed throughout the vehicle and the mixing process is performed as blades slowly rotate to stir ink inside a metal container.

Milling:- It is a process used to crush and further blend the ink pigment into the vehicle.

Ink drying methods

There are several methods for getting the inks to dry. Drying occurs when a liquid becomes solid through one or more chemical methods. The most common ink drying methods are oxidation, polymerisation, evaporation, penetration (absorption), precipitation, radiation curing, etc.

Oxidation:- Oxidation drying ink dries by absorbing oxygen from the surrounding air. By combining the ink's drying oil, the oxygen of the air changes the vehicles of the ink from a liquid to a solid. Letter press and offset printing use oxidation drying inks.

Polymerization:- Polymerization drying inks dry by a chemical reaction that causes molecules in the ink to combine. Oxygen thickens to a gel-like material

allowing the printed product to be handled without spreading before it is fully dried. This type of drying inks can be used to print on metals.

Evaporation:- Evaporation drying ink dries as the solvent is evaporated into the surrounding air, leaving a solid film of resin on the paper. It is the passage of the liquid to a gaseous state. This type of drying ink are used in flexography, gravure, web offset and other processes where fast drying time is important.

Penetration (absorption):- It is a physical drying process. When ink dries by penetration most of the vehicle is absorbed into the substrate.

Precipitation:- Precipitation drying inks also called moisture set ink, dry by reacting with water. Steam or water is sprayed on to the ink after printing causing the ink to set quickly.

Radiation curing:- Radiation curing causes a wet ink to become solid in about a second. There are two types of radiation curing - ultraviolet (UV) and electron beam (EB).

Ultraviolet (UV)-cured inks:- After being applied to the paper UV ink pass under a strong source of UV light while still on the press. The UV light activates special molecules in the ink and causes the inks individual molecules to lock together and solidifies immediately. They are used both in sheet-fed and web offset presses.

Electron Beam (EB):- EB curing is similar to UV curing except it radiates electrons directly on to the fresh ink. EB curing inks cure more thoroughly than UV curing inks do because electron beams are able to penetrate and activate the entire ink film.

Types of Ink

Special formulae are used to produce inks that are compatible with certain printing processes. The characteristics of ink formulation are determined by the plates, press units, type of substrates and the basic printing processes. The common type of inks are Sheet-fed ink, rubber based ink, web offset heatset ink, web offset coldset ink, news ink, magnetic ink, invisible ink, opaque ink, waterless offset ink, fluorescent ink, metallic ink, overprint varnishes, soy ink, etc.

Sheet-fed ink:- Sheet-fed inks dry by oxidative polymerization. They are highly tacky ink which is required for sharp image definition. They avoid filling in of halftone dots and set-off.

Rubber Based ink:- The vehicle in rubber based inks contain cyclized rubber that allows these inks to remain on the ink train of the press for several hours

without drying. These inks dry quickly on paper and are commonly used in small sheet-fed presses.

Web-offset heat-set ink:- Web-offset heatset ink requires the application of high temperature immediately after the ink film reaches the substrate. Heat-set inks are inks that dry when hot air accelerates the evaporation of solvents.

Web-offset cold-set ink:- They are inks that are used to print on absorbent paper in order to dry properly.

News ink:- They are generally thin and fluid ink made of mineral oil and carbon black which dry by absorption.

Magnetic ink:- Magnetic inks are designed primarily for printing products such as cheques, bank notes and business forms that are sorted and read electronically.

Invisible ink:- It is a security type of ink which prints clear, but they show up as fluorescent blue or yellow when placed under back light.

Opaque inks:- These inks are required for printing on dark coloured papers, to hide the colour of the underlying substrate and to prevent the colour of the substrate from influencing the ink colour.

Waterless offset inks:- They are formulated for offset presses that do not use dampening solutions.

Fluorescent ink:- These inks are made with fluorescent pigments that transform UV light into visible light.

Metallic ink:- They are made with small metal flakes or particles (Aluminium for silver and Bronze or Brass for gold).

Over print varnishes:- They are transparent coating applied over ink. They are used to protect the printed surface from moisture, abrasion or other potential sources of damage. They are also applied to create gloss, matt or satin finish.

Soy ink:- Soy ink uses oil extracted from soyabean as part of vehicle. They are bio-degradable inks which replace petroleum used oils with vegetable oils and clearly volatile organic levels in the press room.

Chemicals used in Printing

Dampening solution

Dampening solutions are mixtures of water and other chemicals distributed by the dampening system of offset press. Most dampening solutions are made up with basic ingredients such as water, acid, gum arabic, wetting agents, corrosion inhibitors, anti foaming agents, fungicides and drying stimulators.

Water:- The quality of the water used in dampening solution greatly affect the performance of dampening solution and ink. Distilled water that is colourless, tasteless and odourless and having a pH of 7 is used for preparing dampening solution.

Acid:- The acid used in dampening solution varies according to the desired pH. The pH of a dampening solution is the measure of how acidic or alkaline the solution is. The pH scale begins at 0 (very strong acid) and ends at 14 (very strong base). The half point 7 represents a neutral solution. For offset printing a pH value of 4.5 to 5.5 is found good. Ideal value is 5.5. Change in pH value of dampening solution can greatly influence ink drying time and cause a variety of printing problems.

In addition to pH level, dampening solution should be consistant in its conductivity- the amount of electricity the solution will carry. Conductivity is a more accurate means for measuring concentration than pH. Dampening solution's conductivity is related to maintaining the solution's pH level.

Gum arabic:- It is a gummy, water-soluable substance obtained from certain types of trees. Gum arabic serves to protect the plate from scratches and prevents it from oxidising, while in storage. It desensitises the non image area of printing plate and prevent them from accepting ink. When a job is over, the plate is cleaned and gummed evenly to preserve for future use. This solution of gum arabic is strained through a cotton cloth before using, small particles of dirt may cause serious troubles on the printing plate.

Wetting agents:- These are substances such as iso propyl alcohol, glycerin and glycol added to dampening solution to lower its surface tension. It allows water to spread over non image area of a plate more quickly and maintain the water's wetting ability and allow the operator to run less water.

Corrosion inhibitors:- These are compounds used in dampening solution to prevent or minimise damage to the printing plate through oxidation or other chemical reaction. They increase print quality and extend the life of plates. Magnesium nitrate is commonly used for this purpose.

Anti-foaming agents:- These are typically silicone based fluids or emulsions added to dampening solution to reduce the tendency of the solution to foam or bubble and it reduces distribution problems on the press.

Fungicides and drying stimulators:- Fungicides help to kill any organic growth in the fountain or in the dampening system. Drying stimulators enhance the effectiveness of the drier in the ink.

Alcohol dampening solution:- Iso Propyl Alcohol (IPA) is added to conventional dampening solution at 10 to 15%. IPA reduces the surface tension of water and thus considerably increases the wetting power. IPA makes dampening film more uniform and allows a thinner application.

Other press room chemicals

Other chemicals used in a press room are plate developers, gumming and preserving chemicals, image removers, blanket lift, plate cleaners (special cleaners for conventional plates and thermal plates), deposits remover, wash up solution.

Practical Activity

Paper

1. Collect different kinds of paper.
2. Find out the GSM of a given paper sample.
3. Collect different size of paper (Conventional and International paper sizes).
4. Collect different types of cover paper.
5. Identify various kinds of paper and boards used for different printing jobs such as notice, cover printing, visiting card, envelope and packaging industry
6. Paper calculation method for sheets, boards and reel.
7. Different paper testing methods
 - Curl test
 - Grain direction test
 - GSM test
 - Moisture content test of paper
 - Paper smoothness test
 - Roughness test
 - Gloss test
8. List out the paper warehousing methods.

2. Ink

1. Use of various types of inks on different types of paper.
2. Ink mixing processes.
3. Ink calculation method.
4. Ink testing methods.

3. Chemicals in Printing

1. Prepare an ideal dampening solution.
2. Measure the pH and conductivity of dampening solution.
3. Use of image removers on a printing plate.
4. Use of blanket lift in press room.

Seminar

1. Student should make a presentation about different press room chemicals and its contents.

Field visit

1. Student should visit paper manufacturing company and understand paper making process.

Additional Activity

1. Prepare a chart showing the list of major paper mills in India and abroad along with the names of their popular brands.

TE Questions

1. Explain the paper making process using the Fourdrinier machine?
2. What are the different physical properties of paper?
3. Watermarks can be given to paper with the help of _____ rollers.
4. Briefly explain the five different classification of paper.
5. What is GSM?
6. Explain the A, B, and C series of paper sizes?
7. List out the different ink drying methods you have studied?
8. Ink which print clear, but show up as fluorescent blue or yellow when placed under black light are _____ inks.
9. What are the major ingredients of dampening solution?
10. Ideal pH of dampening solution is _____

Unit - 2

SHEETFED OFFSET PRESS

Introduction

A printing press is a machine that transfers an image from some sort of plate or image carrier to a substrate such as paper. Basically the presses are classified as sheet-fed and Web-fed presses. Four units make a printing press. They are feeding unit, registration unit, printing unit, and delivery unit. To print an acceptable finished product, all of the units must be properly adjusted. In this unit we will discuss in detail about different units of sheet-fed offset press and its working.

Learning Outcomes

The learner:

- classifies presses based on various aspects.
- understands working principle of an offset press.
- operates different units of an offset machine.
- understands the structure and properties of offset blankets.

Press classification

Offset presses are categorised according to different criteria- maximum sheet size the press can handle, number of colours that can be applied in a single pass, whether one or both sides of the paper can be printed in a single pass, how the paper feeds into the press etc.

Duplicators and Presses:- Small sheet-fed offset presses printing upto a maximum sheet size of about 11" X 17" are classified as offset duplicators and those printing on sheets larger than 11" X 17" are called offset presses. Offset presses are larger and more sophisticated and capable than duplicators.

Sheet-fed Presses:- Offset presses and duplicators designed to print a single sheet of paper at a time are referred to as sheet-fed presses. These presses pickup individual sheets of paper from a feed table. Sheets are delivered one at a time to the printing unit.

Web-fed Presses:- Presses that feed from a roll of paper is classified as web offset. These presses are used for work requiring long runs such as magazines, newspaper and other similar publications.

Multi colour Presses:- Presses that can print more than one colour during a single pass are referred to as multi colour presses. These presses consist of a

series of single printing units connected in tandem to form one press. The paper can be fed in either sheets or rolls.

Perfecting Presses:- Presses that print on both sides of paper at the same time are known as perfecting presses or perfectors. Both sheet-fed and web-fed presses can be perfecting.

Waterless offset Presses:- Waterless offset presses do not use dampening solution to keep the plate's non-image area free of ink. These presses function because the plate's non-image area consists of a layer of silicon that repels ink. Direct imaging (digital) offset presses are waterless, with no dampening system.

Digital Offset Presses:- Conventional offset presses are not linked directly to the prepress function. Plates are imaged away from the press and then carried to it. But digital offset presses use direct imaging (digital) in which blank plates are mounted on to the press and then imaged by digital-driven lasers.

Working principle of an offset press

Offset printing is a planographic printing process in which the image area and the non image area are on a same plane in the image carrier. This process works under the principle oil and water repels each other. It was invented by a German named Alois Senefelder in 1798. In 1903 Ira Washington Rubel from New Jersey developed an offset press design. On Rubel's new press design, the inked plate transferred the image to a rubber covered cylinder, called the blanket cylinder, which then transferred the image to the paper.

Operating Units of an Offset machine

All presses are composed of four basic units - feeder unit, registration unit, printing unit and delivery unit.

Feeder Unit

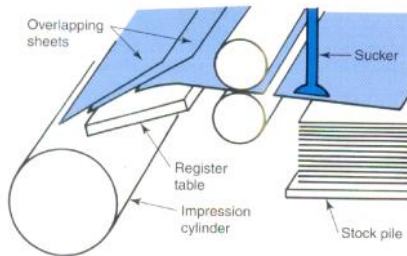
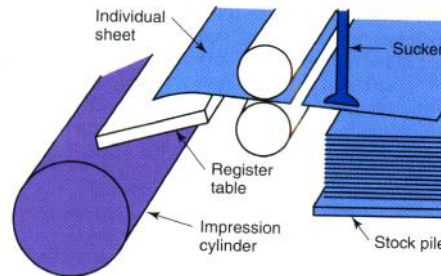
The feeding system is the mechanism that sends the substrate into the press. The feeder unit of a sheet-fed offset must separate the top sheet of paper from the infeed pile, pick it up and deliver it to the registration unit. Only one sheet can be fed at a time and each must reach the registration unit at a precise movement to be registered and sent to the printing unit.

Types of feeding systems

There are two types of feeding systems: successive or single sheet feeding system and continuous or stream feeding system.

Successive or single sheet feeding:-

The most common type of mechanical feeding is successive sheet feeding system. In this system the feeder unit picks up one sheet each time the printing units prints one sheet.



Continuous feeding or stream feeding:- In stream feeder the sheets overlap on the registration board and the rate of sheet movement is significantly slower. Registration is more accurate in stream feeding.

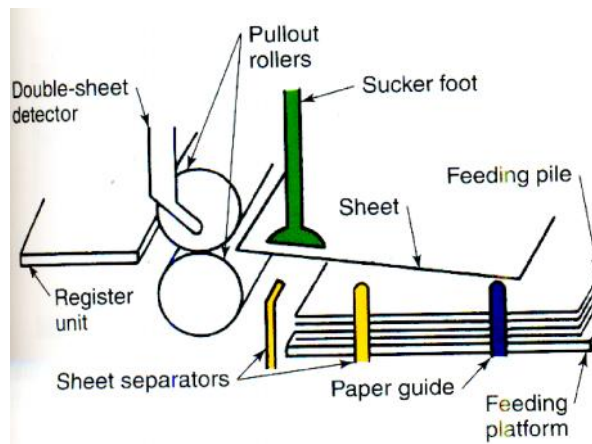
Parts of feeding unit

Parts of feeding unit are pile feeder, pile board, pile height governor, sucker, sheet separator fingers, sheet separation blower.

Pile feeder :- is a mechanism used to lift individual sheets from the pile and feed them into the press.

Pile board :- It is a platform in the feeder of a sheet fed press on which the pile of paper sits.

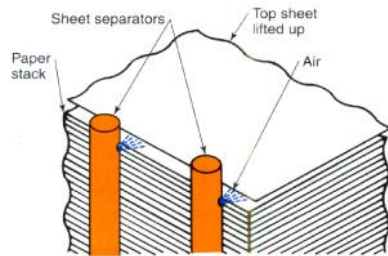
Pile height governor :- the device used to control the speed of elevation of the pile table.



Sucker foot:- It is the element used in the feeding unit to pick up individual sheets and place them into the registration unit. They are of two types- lifting suckers and forwarding suckers.

Sheet separator fingers :- They are springy steel fingers extending over the lead edge of the pile of paper in the feeder. Sheet separators hold down the

side edge of the top sheet, as the front blowers separate the sheet from the stack.



Sheet separation Blowers :- They are air producing device that separates the top most sheet from the rest of the pile in the feeding system.

In the feeding unit paper is stacked on the pile board. The pile must be positioned in correct relationship with the settings of the register and insertion device. An air blast is used to separate the top most press sheet from the rest of the pile. The blast can be adjusted for papers of different weight. Heavy and coated papers require stronger air blast than light and uncoated papers. The air blast must be strong enough to float the topmost piece of paper above the pile at a specified height below the sucker feet. The pile table automatically raises and maintain the correct feeding height as sheets are removed from the top. The sucker feet grab the floating top sheet and send it down the registration board where the registration unit takes over.

Registration Unit

Functions of Registration unit

Registration is the process of controlling and directing the sheets as it enters the printing unit. The goal of registration is to ensure absolute consistency of image positions on every sheet printed.

Parts of Registration unit

Double sheet detector, Registration board, front lay, side lay, conveyor tape, running in wheels, two point guide system, three point guide system, transfer cylinder system.

Double sheet detector :- It is a control device that prevents more than one sheet of paper from entering the press. Double sheet detectors sense the paper thickness. When the sensor detects excess thickness, indicating multiple sheets, the feeding of paper automatically stops.

Registration board :- It is a platform that accepts a sheet from the feeder unit and inserts it in register, ready for print.

Front lay:- It is a metal tab or plate attached to the front end of the feedboard on a sheet-fed printing press that stops the sheet of paper and holds it on the feedboard while the side lay moves the sheet into position.

Side lay:- It is a device attached to the feedboard that aids in the lateral positioning of a sheet of paper before a sheet is transferred into the printing unit. Side lays are of two types- push type & pull type. Pull type side lays are more accurate than push types.

Conveyor belts:- Endless belts which carry the paper to the front lay (head stop).

Running in wheels :- The sheets picked up by the suckers are forwarded to the registration unit by the running in wheels.

Press register methods

The registration table carries each sheet using the conveyor belts to the front stop where paper is aligned square with the printing system with the help of side lay, ready to be captured by the grippers of the impression cylinders.

There are three press register methods- the three point guide system, the swing feed system and the feed-roll system.

Three point guide system :- In the three point guide system the sheet is forwarded to the front guides which may be two or four in number. While the sheet is held against the front guides a side guiding mechanism pushes or pulls the sheet into proper side alignment until the impression cylinder grippers take hold of it. At this time the front guides are lifted out of the sheets path of travel. As soon as the entire sheet clears the feedboard the guides drop back into position to align the next sheet.

Swing feed system :- In this system the sheet is moved forward down the feedboard and got to rest against front guides. The side guides then aligns the sheet. After being properly guided the sheet is picked up by a set of grippers usually mounted over the feedboard. The front guide moves out of the way and the arm swings forward carrying the sheets into the gripper on the impression cylinder.

Feed-roll system:- In this system the sheet is moved down the feedboard, positioned against stops and side guides. While the sheet is at rest, it is firmly gripped in its position by being pinched between upper and lower feed rolls or cams. At a precise movement the front guides move out of the way, and the feed rolls start rotating to drive the sheet forward and into the grippers on the impression cylinder.

Printing Unit

The printing unit places a water solution and ink on the plate, transfers the image on to the paper and delivers the paper to the delivery unit. The printing plate must be adjusted so that the proper amount of ink and water solution is deposited on the printing plate so that the image is transferred accurately, evenly and consistently to the printing paper. The printing unit of an offset press consists of cylinder system, the dampening system and the inking system.

Cylinder system:- The lithographic press consists of a group of cylinders that transfer images from the printing plate to the substrate. The components of a cylinder system are the plate cylinder, the blanket cylinder and the impression cylinder.

Cylinder structure:- The components of a cylinder includes the body, bearers, bearings, clamps and a gear that drives the cylinder.

Cylinder body:- is made up of steel or cast iron. Normally it is coated with chromium to prevent rusting. It should have perfectly even surface. Body of a press cylinder has two parts namely cylinder gap and cylinder bearer. The cylinders have some gap on its surface where the clamping mechanism is attached. It is called the cylinder gap or depression gap. The narrow metal band at both ends of press cylinder used to allow packing and easy alignment is called the bearer. The height of the bearer is always higher than the cylinder body to accommodate plate. The difference between the radius of the cylinders bearers and the radius of the cylinders themselves is called undercut. The cylinders have a series of clamps in the depression gap to hold the plate or blanket.

Gutter:- is the small gap between the bearer and the cylinder body. It prevents foreign bodies like grease and other lubricants coming into contact with plate and blanket surface.

Drive gears:- are gears that make the cylinders rotate.

Cylinders

Plate cylinder: It holds the printing plate on the press, receives water on the non image area from the dampening system and ink on the image area from the inking system and transfers the image to the intermediate blanket on the blanket cylinder. This cylinder brings the inked plate image into contact with the blanket cylinder.

Blanket cylinder:- It is located between the plate and the impression cylinders. This cylinder holds the rubber blanket, a synthetic rubber mat that accepts the

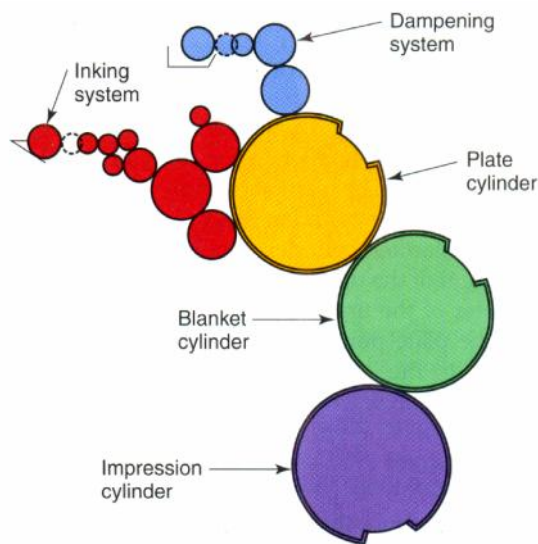
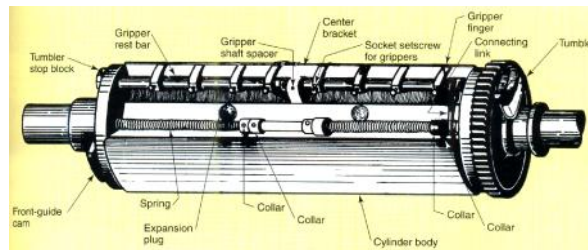


image from the plate cylinder and transfers or offsets it to the substrate with the help of the impression cylinder.

Impression cylinder:- The impression cylinder carries the paper through the printing unit, and presses it against the inked blanket where the image is transferred to the paper. This cylinder uses a set of grippers to grab the lead edge of the press sheet when the sheet reaches the end of the feed board. The paper is drawn

around the impression cylinder and forced against the blanket to make the impression. The grippers then open to release the press sheet to the delivery unit or to the next printing unit.



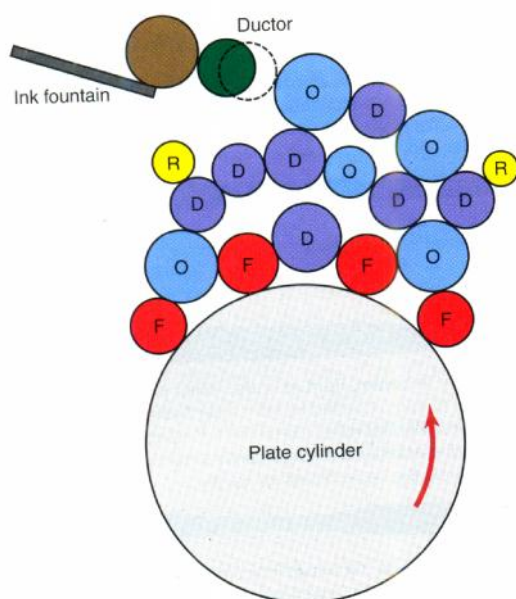
Grippers are the row of mechanical fingers attached to the impression cylinder that grabs the sheet of paper and feed it to the printing press.

Inking system

The goal of an inking system is to place a uniform layer of ink across every dimension of the printing plate. All lithographic inking system are made up of three main sections. Ink fountain and fountain rollers, ink distribution rollers and ink form rollers.

Ink fountain stores ink in a reservoir and fills small quantity of ink to the rest of inking system from the fountain roller. The ink distribution rollers receives ink and work it into a semi liquid state that is uniformly delivered to the ink form rollers. A thin layer of ink is then transferred to the image portion of the lithographic plate by the ink form rollers.

The ink fountain holds a pool of ink and controls the amount of ink that enters the inking system. The most common type of fountain consists of a metal



blade that is held in place near the fountain roller. The gap between the blade and the fountain roller can be controlled by adjusting screw keys to vary the amount of ink on the fountain roller. Printers adjust the keys in or out as the fountain roller turns to obtain the desired quantity of ink.

Ink agitator :- Ink is supplied to the system by an ink fountain. On large presses and ink agitator may be used to help maintain a constant ink flow. An agitator is a revolving device that moves along the

fountain and stirs the ink to keep it at the same flow level.

Ductor roller :- The ductor roller is the intermediate roller between the fountain roller and the distribution roller. Ductor roller is a movable roller that flops back and forth between the ink fountain roller and an ink distribution roller. As the ductor roller contacts the fountain roller, both turn and the ductor is inked. The ductor then swings forward to contact a distribution roller and transfers ink to it. The rate of rotation of the ink fountain rollers and the gap between the fountain blade and the fountain roller controls the amount of ink added to the distributing system.

Form rollers:- The rollers that are actually in contact with plate are called form rollers. They ink the plate.

Distribution rollers:- Distribution rollers spread the ink out to a uniform layer before it is placed on the plate. The greater the number of distribution rollers the more accurate the control of ink uniformity. There are generally two types of distribution rollers. Rotating distribution roller and oscillating distribution roller. Rotating distribution rollers rotates in one direction. Oscillating distribution rollers rotates and also move from side to side.

Fountain roller:- Fountain roller is the roller that is placed inside the ink fountain. It transfers ink from the fountain to the ductor roller.

Dampening system

A layer of moisture must be placed over the non image area before the plate is inked. The dampening system accomplishes this by moistening the plate consistently through out the press run. The fountain roller rotates in a pan containing the fountain solution. It transfers a thin film of fountain solution either to the ductor roller or directly to the form rollers.

Offset press dampening systems are classified into three types - Intermittent, Continuous and Integrated.

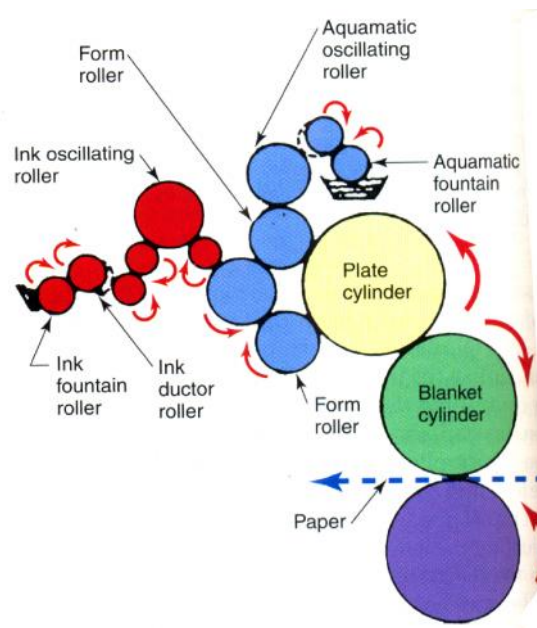
Intermittent system (Conventional dampening system) :- It is similar in design to the inking system on an offset press. The system uses oscillator rollers, form rollers, a ductor roller and a fountain roller. The dampening system uses fewer rollers than the inking system does because fountain solution is more fluid than the ink and does not need to be worked to the same degree.

A common problem with an intermittent system is their inability to quickly adjust the level of solution on the plate.

Continuous dampening system:- They do not use ductor roller to transfer fountain solution from the pan. This system use a metering roller to move the solution to a transfer roller. The metering roller is usually made of or covered with rubber and serves the same purpose as the fountain roller in an intermittent system. The transfer roller is a hard chrome covered roller. The biggest advantage of using continuous system is that it allows the operator to quickly make adjustments and see immediate results. Continuous dampening system are often referred to as alcohol dampening system because alcohol was commonly used in the fountain solution.

Integrated dampening system:- This type, of dampening system link the dampening rollers and the inking rollers to the ink fountain. The fountain solution and the ink are fed to the plate from the same set of form rollers. The fountain solution is distributed, not only to the rollers in the dampening system but also to sum of the ink rollers. Since the fountain solution repels the ink it can ride on the ink to the plate. This type of system is also referred to as combined dampening system or combination dampening system. Improper formulation of fountain solution in the system may cause emusification problems.

Alcohol dampening system:- Alcohol dampening system recirculate the fountain solution there by making it possible to maintain pH consistency in



the fountain solution. This system also assist the press operator in maintaining proper fountain solution level in the fountain pan. The entire fountain system generally runs more cleanly than a conventional dampening unit does.

Advantages of alcohol dampening

Using alcohol eliminates the problem of too warm a solution during hot weather. Alcohol lowers the surface tension of water, allowing to be fed to the plate. Use of alcohol causes faster evaporation of moisture from the offset plate and ink rollers resulting in less ink emulsification and faster drying of printed sheets.

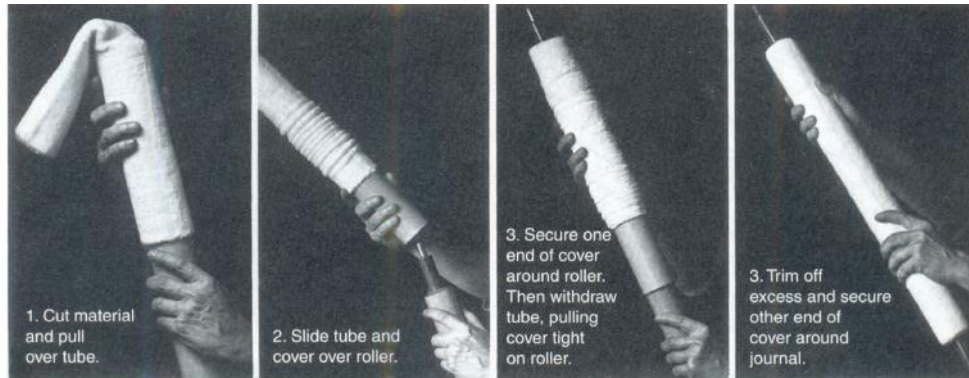
Roller and roller covers

The dampening covers are either solid metal, rubber or cloth-covered rubber. Fountain roller are usually solid metal, while ductor and dampener form rollers are usually cloth covered. The dampener form and ductor rollers are covered with a cloth called Molleton cloth. Molleton covers are available ready cutting tubular or wrap around strip form as well as in continuous tubular form.

Cover installation steps

- 1) Remove the old cover carefully so that rollers are not damaged
- 2) Clean the rollers with soap and water. Use solvents to remove ink built up.

- 3) Slide the new cover over the roller.
- 4) Tie both ends of the sleeve.
- 5) Wet the entire molleton in a sink.
- 6) Install the roller in the press.
- 7) Run the press to let the rollers run in and smooth the surface.



Roller pressure settings

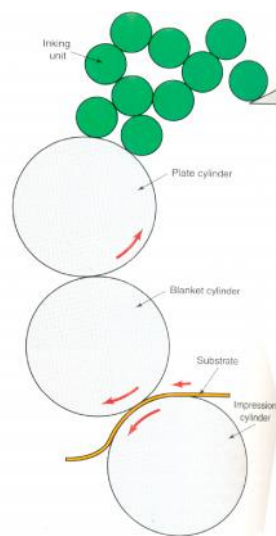
New damper covers must be set for proper pressure after they are installed. The following procedure can be used to check the dampener roller pressure setting.

- 1) Prepare the dampening system for operation. Check the dampness of the form roller. Let the dampener form roller run against the plate on the plate cylinder for a few minutes. Lift the form roller and stop the press.
- 2) When the press is stopped, place two 1" X 8" strips of 0.005" thick acetate sheet between the form rollers and the plate. Place one strip each at both the ends.

- 3) Drop the form rollers to the on position.
- 4) With one hand holding each strip, pull towards you with a slow uniform tension. There should be a slight even drag on both strips. If one strip pulls easier than the other or if there is too much or too little drag on both, adjust the roller on one end or both as a test procedure.
- 5) After pressure seems satisfactory, drop the form rollers to the plate and lift it up again. You should see a faint damp line across the entire width of the plate.

Waterless Presses:- A waterless press is an offset lithographic press system that does not use a dampening system during the printing process. The surface of a waterless plate is a layer of silicone rubber that repels ink and keeps the non-image area separate from the image area. The image area is recessed. It lies just below the plate surface and has an ink receptive photopolymer coating. The silicone plate surface serve the same function as the fountain solution in a dampening system. Waterless plates are designed from conventional lithographic presses. Plate exposure is done using vacuum frame and light sources and is developed with a water based solution than with a solvent based solution which are more safe to dispose.

Waterless plates require special inks which are thicker than conventional lithographic inks. The inking system used by waterless presses is temperature controlled. As ink is applied to the plate, the surface is designed to repel certain thickness of ink. The system must regulate the temperature of the ink to maintain correct thickness. Several rollers in the system contain hollow tubes that are filled with water to remove excess heat. Water circulate through the rollers and cools the ink as it is transferred to the plate.



Advantages of waterless presses

Waterless plates provide great image quality by producing a higher density of ink when they are offset. The procedure involved in formulating dampening solution and maintaining a dampening system are eliminated saving set up time. Waterless printing changes the image transfer system from a chemical/physical process to a mechanical process. Waterless printing system is more eco-friendly compared to the conventional offset printing method.

Delivery Unit

Delivery unit removes the printed substrate from the printing system of the press and prepares it for finishing operations. Delivery systems on sheetfed presses are designed differently from those used on web-fed presses. On a sheet-fed press, the delivery system removes sheets of paper and places them into a stack called the delivery pile. On a webfed press, the delivery system conducts a number of additional operations.

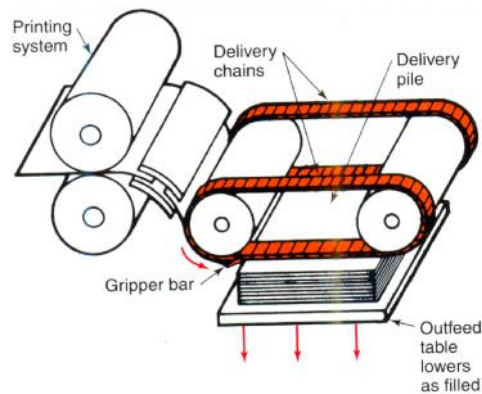
There are two common designs for sheetfed press delivery units: Gravity delivery and Chain gripper delivery.

Gravity delivery is the simpler and less dependable of the two. As the sheet leaves the printing unit, it is dropped into a delivery pile. The basic limitation is that paper cannot be delivered faster than gravity can pull it into place. Gravity delivery is usually found only on smaller presses.

Chain gripper delivery:-Most presses are equipped with delivery grippers consisting of a series of small metal fingers attached to a bar extended between two continuous delivery chains. The delivery chains are belts or chains used to transfer the printed sheet from the impression cylinder to the delivery pile.

A pair of sprockets guides and drives the delivery chains. The grippers are spaced at regular intervals along the chains so one set of grippers is receiving a sheet while another set is delivering the preceding sheet.

Spring pressure usually holds the grippers closed. As the chains carry the grippers towards the impression cylinder, they pass over a cam that forces the grippers open long enough to receive the sheet. The grippers then carry the sheet to the end of the press, where a trip cam forces the grippers to open and release the sheet to the delivery platform. The sheet comes to the delivery pile faceup, with the gripper edge towards the front of the press.



Parts of delivery unit

The delivery unit of an offset press consists of delivery chain, delivery table, delivery grippers, delivery cylinder, skeleton wheel, joggers and may contain some ancillary units like anti-set off spray.

Delivery chain:- is a belt or chain the delivery system of a press uses to transfer the printed sheet from the impression cylinder to the delivery pile.

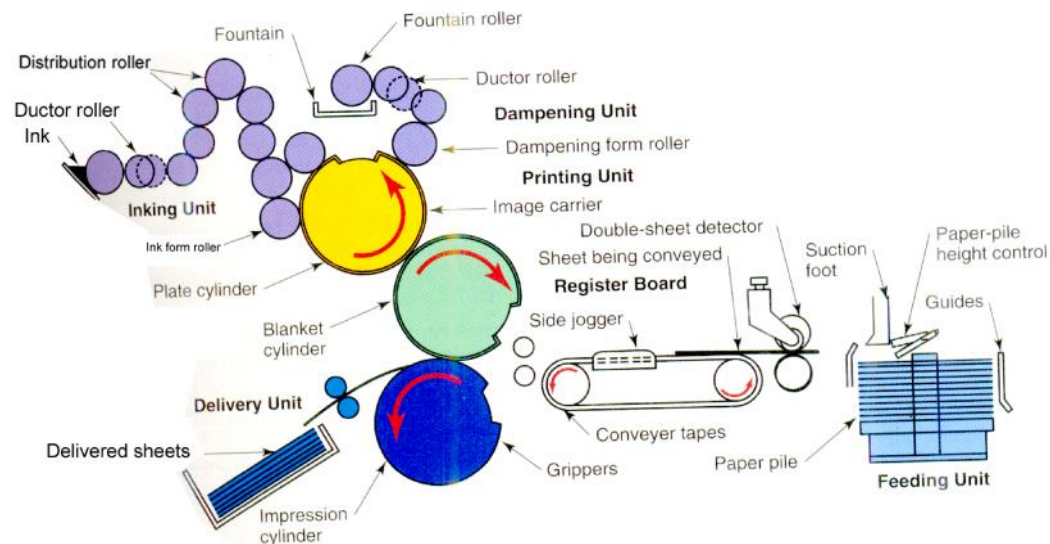
Delivery grippers:- These are small metal fingers attached to a bar extended between two continuous delivery chains.

Delivery table:- is a platform or tray on which the printed sheets are stacked.

Delivery cylinder:- It is a cylinder in the delivery unit of a press that transfers the printed sheet from impression cylinder to the delivery pile. This cylinder is usually covered with skeleton wheels.

Skeleton wheels:- It is an adjustable disc on the delivery cylinder that holds the sheet as it travels.

Joggers:- Jogging side and back guides are used to control the outfeed pile. Two stationary guides can be adjusted to the paper extremes. The jogging guides are adjusted to touch the remaining two paper sides on their innermost stroke. The delivery pile is continually touched by all four guides. This keeps the stack straight.



Four units of an Offset Machine

Ancillary units

Anti-setoff spray: The printed sheets in the delivery unit are sprayed with anti-setoff powder to avoid setoff. This powder layer is distributed by compressed air, thereby preventing the ink of the freshly printed sheets from getting too close to the reverse side of the top sheet. Anti-setoff powder are colourless

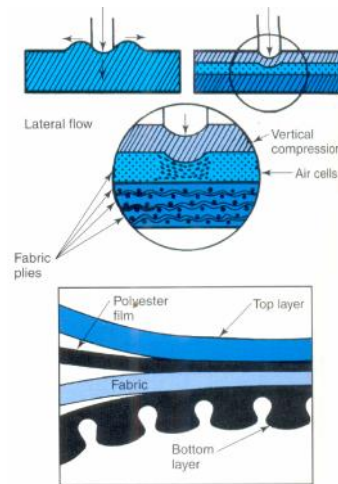
powder grain that serve as spacers ensuring oxidative drying by the inclusion of air between the sheets. The grain laying between the sheet provide air cushion between the individual sheets.

Offset Blanket

Offset blankets are formed from vulcanised rubber bonded on a fiber base. Blankets should have the ability to accept ink from the plate and to transfer it to the paper with satisfactory ink density.

Structure of a blanket

The bottom layer or the back side of the blanket is formed from rubber or synthetic materials which are specially woven to maintain the quality and strength of the blanket. They are called carcass. The backing on a blanket includes atleast one layer of soft resilient material, such as form, rubber, cork, or loose fabric fibres that gives blanket its compressible character. To make the blanket compressible a thin layer of air cells is layered between the fabric and rubber face.



Depending on the number of fabric layers on a blanket it may be classified as single ply, 2 ply, 3 ply, 4 ply, etc. The number of fabric layers equals the number of plies. Thus a 4 ply blanket would contain four fabric layers.

Two basic types of offset blankets are conventional and compressible blankets. Conventional blankets tend to bulge at the impact point. They are made without a layer of form.

Compressible blankets are designed to compress and instantly rebound to its original shape and thickness. They are the most widely used blankets because they prevent minor blanket smashes from effecting the print quality.

Under blankets:- They are underlay blankets, made of form rubber, cork or loose fabric that can be used under the blanket to improve its performance. Benefits of using underblankets are reduced downtime, sharper definition of fine images, and reduced roller and cylinder pressure that lead to reduced plate wear.

Hardness of blanket is measured in terms of shore hardness. (eg. 80°A or 80 shore A) The device used for measuring the shore hardness of a rubber blanket is shoredurometer.

Types of blanket

Blankets may be classified into the following according to their resilience: Hard blanket, Soft blanket, Medium blanket, Sandwich blanket and Special blankets.

Hard blanket:- They are having 80° A to 85°A hardness. They are used to print on matt, rough surfaced, thick coated card and other heavy coated papers.

Soft blanket:- Blankets having 60° A to 65°A are called as soft blankets. Low grade uncoated papers, polythene sheets and coated papers may be printed using soft blankets.

Medium blanket:- They are blankets made of 65° A to 70°A hardness. These blankets are used to print on super calendered or thin coated and glazed papers, maplitho, thick and thin white paper.

Sandwich blanket:- They are blankets having hardness within 70° A to 80°A. They are used for printing heavy solid jobs, blankets of 60° to 70° shore hardness should be used. Fine halftone images need 70° to 80° shore hardness because they have a better ability to transfer fine screen dots.

Special blankets:- They are special solvent resistant blankets. Vehicles and solvents of heat-set and quick-set printing inks are not suitable for ordinary blankets. They require special solvent resistant blankets.

Properties of a blanket

The face of the blanket should have no adhesive properties. The surface should be sufficiently resilient for better transference of image on the printing material. Blankets should have good receptivity to all types of lithographic inks. Blankets should not become glazed or tacky when its surface comes in contact with solvents. Blankets should have less affinity for ink than paper so that it may readily release ink on to the paper surface.

Care and Storage of blanket

- Blankets should be wrapped round the blanket cylinder properly stretched.
- Thickness of the blanket should be decided in consideration of the bearer or the pitch circumference.
- Blankets should be used with the consideration of the paper surface.
- The unrolled blankets should be laid on plain surface.
- More than one blanket may be placed face to face or back to back.
- Blanket should be prevented from exposure to sunlight, high temperature and fluorescent light sources.

- Printing blankets should not be stored near ozone sources such as electric motors, copy machines, etc.
- Blankets stored in their packing tubes should be placed in horizontal state.

Practical Activities

1. Functioning of different units of a sheet-fed offset press.
2. Identify different parts of sheet-fed offset printing machine.
3. Dampening cover fixing.
4. Identify different types of blanket.
5. Blanket fixing

Assessment Activity

1. Make a drawing of plate, blanket and impression cylinders as well as form rollers ink and dampening system in the practical record. Label these components and add arrows showing the direction of rotation.
2. Draw a schematic diagram of the inking unit of an offset press and label the different rollers in the practical record.
3. Draw a schematic diagram of Conventional dampening unit and mark its parts in the practical record.

TE Questions

1. Explain the working principle of offset.
2. What are the four units of an offset press.
3. Describe the basic features of sheet-fed offset printing machine.
3. List out different parts of a feeding unit and explain its function.
4. Small offset presses upto 11" x 17" are usually referred as _____
5. Offset presses that can print more than one colour at the same time are called _____ presses.
6. Draw the cylinder configuration of offset perfecting press.
7. Identify the functioning of waterless offset press.
8. Compare conventional and alcohol dampening system.
9. Briefly explain about the type of blankets used in an offset printing press.
10. Write your ideas about storage of blanket.

Unit - 3

OFFSET PRESS OPERATIONS

Introduction

The purpose of this unit is to deal with fundamental understandings that will enable the students to run any offset duplicator or sheet-fed press after a review of manufactures operating manual. The operating procedure for running a press include mounting the plate, achieving smooth paper feeding and delivery, controlling ink and dampening solution, adjusting the image as needed, and cleaning the press at the end of the run. This unit also provides information about leading press manufacturers. The last section of this unit deals with the factors affecting the cost of a printing job and estimation procedure.

Learning outcomes

The learner:

- understands the make ready Procedure.
- understands the working of a multi-colour sheet fed offset machine.
- understands about sequence of colours in multicolour printing.
- lists the leading manufacturers of offset machines.
- estimates the cost of production of a printing job in offset printing.

Pre-make ready checks

Before operating a press, the following activities should be done to check whether the press is made ready for printing.

- 1) Oil the press according to manufacturer's recommendation.
- 2) Clean the press of dirt, dried ink, grease and excess oil.
- 3) Check the pressure settings of all rollers and cylinders.
- 4) Examine the blankets for defects.
- 5) Examine the inking rollers for glaze.
- 6) Examine the dampener roller covers and change them if required.
- 7) Check the pH of the fountain solution.
- 8) Mix or otherwise prepare the ink for the job.
- 9) Examine the image and non image areas of the plate to be printed.

Before starting a printing job, we should check the information given in the job ticket. The information include the following:

- 1) The correct ink and colour.
- 2) Adequate fountain solution.

- 3) Correct paper stock, plus make ready and waste sheets.
- 4) Printing plates on hand.
- 5) Wash up solvents and blanket wash.
- 6) Special instructions, if any.
- 7) Finishing operations

Make ready

Make ready refers to the procedures preparing the press to print a particular job. The term make ready covers all the activities the press operator performs between beginning the job and actually running the job.

Press lubrication :- Correct press lubrication reduces wear on all moving parts and lengthens press life. Lack of lubrication, use of inferior lubricants or carelessness in the use of lubricants shortens the productive life of press. Lubricate the feeder and delivery drive chains once a week. Use gear grease compound on all gears. Use penetrating oils wherever applicable. Motors should be oiled during the weekly lubrication. Those with grease fitting require grease atleast twice a year.

Paper and Ink:- Verify the paper size supplied for the job. Make sure the grade size and quantity are correct. Make sure the press sheet grain direction is appropriate to the job. Obtain the required ink for the job.

Starting procedure

The following is the general sequence of step in setting up and running a job in an offset press.

Preparing the inking unit:- Ink rollers should be cleaned of all lint and dust before filling the ink fountain. Clean the rollers with blanket and roller wash. Remove the fountain and clean it thoroughly using roller wash.

Fill the ink fountain by applying small amounts of ink with an ink knife against the fountain roller. The fountain is equipped with a number of adjusting keys or screws. Turning these keys clockwise decrease the flow of ink and turning the key counter increase the flow of ink.

Preparing the dampening unit :- The dampening fountain and the fountain roller should be clean and free of dirt. Fill the fountain bottle with proper mixture of fountain solution. The dampener form rollers should remain off and should not contact the plate.

Start the press, allowing the rollers to pick up moisture. Operate the fountain roller by hand to help the moisture along. If necessary you can use sponge to drip a little fountain solution on the oscillating roller and dampener ductor roller. Stop the press turn the hand wheel to bring the water ductor roller into

contact with the fountain roller. Turn the fountain roller knob by hand to transfer fountain roller solution from the water fountain roller to the ductor roller. When the form rollers are sufficiently damped stop the press, check the dampeners on the form roller by touching it with your hands. Be sure the ductor control lever is on. The dampening unit is now ready for use.

Attaching the plate

Always be sure the plate cylinder is clean and dry before attaching the plate. Attach the gripper edge of the plate to the plate clamp. Hold the tail of the plate square and tight with your right hand. Turn the handwheel clockwise until the tail clamp is in position for attaching the plate. Hold the plate with your left hand and bring the tail clamp up to position with your right hand. Attach the plate to plate clamp. Tighten the plate clamp by turning the plate clamp tightening dial clockwise.

Semi-auto plate loading:- In semi-auto plate loading the operator have to lift the guard and put the lead edge of the plate into the clamp, then hit a button and it does the rest.

Auto plate loading:- In autoplate loading, automatic plate changing can be done, enabling the plate for the next product to be loaded while the press is running. The full sequence of old plate removal and new plate loading requires less than 30 seconds. This technology has a dramatic impact on labour requirements, make ready waste and press uptime.

Feeding the paper

Fanning the press sheets - Begin the paper feeding process by fanning the pile to remove any static electricity that might be holding individual sheets together.



Adding paper to the feeder section:- Place the pile in the

feeding section of the press slightly off center. Push the pile forward so that it is squarely seated against the front plate of the feeder.

Using wedges to level the paper:- The top of the paper pile must be perfectly level and parallel to the registration board. If the stock stacks insert wedges at several points into the pile to make the top surface level.

Adjusting the pile height:- Adjust the pile height below the feeding mechanism (Sucker Feet). Feeding problems will result if pile height is not properly set.

Adjusting the air blast:- The purpose of air blast is to float the top most sheet above the rest of the pile on a blanket of air. The amount of airblast needed will vary depending on the weight and size of the paper sheet.

Adjusting the registration system

Positioning the pull in rollers and double sheet detector:- Before allowing the feeder mechanism to send a sheet to the registration units, the pull in wheels (running wheels) and the double sheet detector must be set. Adjust the pull-in-wheels to a uniform pressure so that each sheet is pulled squarely from the feeder on to the registration board. Double sheet detectors cause the press to stop when a double is detected. Set the device to pass the thickness of one sheet and trip the press if more than one sheet is fed.

Setting the register board and sheet control:- Next allow the press to feed a sheet into the registration unit and to stop if in contact with the head stop. Line up the conveyor belts, straps or skid rollers to the sheet size. Adjust the pull guide to push or pull the sheet. Inch the sheet into the grippers that pull it between the impression cylinder and the blanket cylinder and allow it to transfer to the delivery system.

Positioning the image on the paper:- The image must be positioned squarely on the paper by adjusting the control knob of the stop bar. This stop bar can be tilted in either direction. Moving the stop bar eliminates the need of adjusting the plate on the plate cylinder.

Setting the gripper bite control:- Small vertical movement of image can be made by moving the paper stop bar forward or backward allowing a larger or smaller gripper bite. Large vertical movements of the image on the paper are made by moving the plate cylinder.

Adjusting the delivery unit:- Move the sheets to delivery units and adjust the delivery side table guides before the sheet is released from the chain grippers. Allow the sheets to drop on to the delivery table and position the table and jiggers.

Checking the entire system:- In order to check the entire system start the machine and allow paper to pass from feeder to delivery. The sheet should be smoothly and consistently fed on the registration board. Each sheet should be uniformly registered and transferred to the printing unit. The delivery system should remove each sheet and stack a perfect pile on the outfeed table.

Feeding the test sheet:- A small quantity of make ready sheet must be placed on top of the press sheet pile. Make ready sheets are sheets of same weight and surface finish as the final sheets that are used for initial press setup. These make ready sheets should be run through the press to determine if any adjustments are required. The following steps should be considered while feeding the test sheets.

1. Moisten the plate with fountain solution using a cotton pad.
2. Start the press.
3. Lower the dampening form roller to the plate.
4. Allow the press to run for some time while checking the plate for dampness.
5. Lower the ink form rollers to the plate cylinder.
6. Start the vacuum and blower motor.
7. Set the press on impression and run a sheet of paper.
8. Turn off the impression and raise the ink form rollers.
9. Stop the machine.
10. Check the image position and make necessary adjustments to achieve position, ink water balance and desired ink coverage.

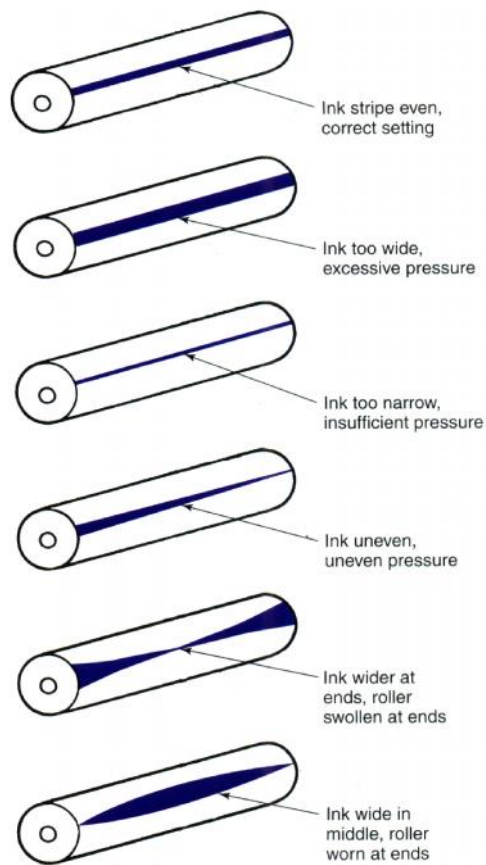
Checking the test sheets:- Inspect the test sheet carefully. The image on the paper should be clear, well inked and free from background tone. Check for scum which indicates an excessive amount of ink or insufficient amount of dampening solution. The ideal ink-water balance occurs when each printed sheet takes exactly the same amount of ink and water while being metered to the plate.

Check the position of the image:- These check should include lateral (left to right) and vertical (up and down) position.

Cylinder and roller pressure

There are several pressure checks that must be made to cylinders and rollers on a daily basis. These checks should also be made whenever rollers, roller coverings, blankets, plate thicknesses, and paper thicknesses are changed. The sequence of pressure checks is given below:

- 1) Check dampener form roller-to-plate pressure.
- 2) Check ink form roller-to-plate pressure.
- 3) Check plate cylinder-to-blanket cylinder pressure.
- 4) Check impression adjustment (squeeze).



Make sure you have properly installed and gummed the plate on the press. Place the dampener form rollers in the off position. Place the ink form rollers in the on position and allow the gummed plate to ink up over the entire surface. Stop the press and place the ink roller in off position. Allow the plate cylinder to come into contact with the blanket cylinder. Take the plate cylinder out of contact. Do this in several different locations on the blanket. You should have a uniform ink-band line 3.2 mm to 4.8 mm wide. If an adjustment is required correct the parallel first and then the overall press adjustments.

Multi colour printing

Most offset lithographic presses can be used to produce quality process colour work, if good separations, plates, paper, ink and skilled operators are available. Multicolour sheetfed presses operate in the same manner as single colour sheetfed presses. But they are equipped with two or more colour printing units arranged in-line (one following the other). Each printing unit is capable of delivering a single colour of ink to the press sheet. Most multicolour presses are designed with two, four, or six printing units. Two colour presses are ideal for jobs that require spot colour such as a page of text in which the text is printed in one colour and the display type or graphic elements (rules, boxes, decorative borders, or illustrations) are printed in another colour. Four colour presses are designed especially for four-colour process printing. A five- or six-colour presses increase printing possibilities even further by allowing a sheet to be printed with four process colours, followed by a flat or match colour, or a varnish.

The primary advantage of a multi colour press is that more than one colour can be printed in a single pass through the press. Without a multi colour press, the press sheet would have to be printed with one colour, then replaced on the infeed table and run through the press again for each additional colour required. Not only is this a time-consuming operation, but it can lead to mis-register problems. Paper is not dimensionally stable. When passed through the press, each piece of paper is subjected to both ink and water. Moisture from the dampening system tends to make the paper stretch, then shrink as it dries. When a single-colour press is used for a multi-colour job, some time will elapse before the paper is put through the press for the next colour. During this time, the paper may shrink, stretch, or warp slightly owing to humidity and other environmental conditions in the printing plant. The overall effect is that on the second pass through the press, the paper is not exactly the same size as it was on the first pass through the press. This makes critical registration more difficult and sometimes impossible. A multi-colour press can reduce this problem.

One additional advantage of a multi-colour press is that the press operator can judge the quality of the printed sheet immediately as it comes off the press, and he can make press adjustments based on this evaluation. When printing process colour, all four colours must be printed with the correct press settings if the colours on the final job are to be correct. When a single-colour press is used to print process colour, improper press adjustments during the printing of the first colour may only be discovered as the fourth colour is being printed. By this time, all of the sheets have been printed with three colours and it is too late to make any corrections. The whole job will have to be scrapped and reprinted.

Sequence of colours

Process colour involves overprinting of four separate images. During printing the sequence of colours can vary depending on the type of ink, paper, or press or on the preference of the operator. There are several common sequences. The sequence of cyan, then magenta, yellow and finally black is often used. Yellow, magenta, cyan and black is another frequent colour order. If cyan is first printed on the sheet, details will usually be carried across the sheet wherever the final image appear and it is relatively easy to fit all colours after cyan into their proper position. One disadvantage of using cyan as first colour is with the quality of ink laid down on the first pass through the press. All following colours will tend to dry slowly because the paper has already absorbed

ink over much of its area. The paper become more ink saturated with each added colour, adhesion can build up between the sheet and blanket.

The ink printed last has some extra effect on the image. Hence for a sunset scene magenta ink must printed last. In the same way for a sea scape, the cyan may be printed last. The modern process inks print transparent ink film and hence may be printed in any order. If opaque inks are used it must be printed first.

Leading Offset machine manufacturers

International

Heidelberg (Germany)
Komori (Japan)
Mitsubishi (Japan)
Ryobi (Japan)
Fuji (Japan)
AB Dick (US)

Indian

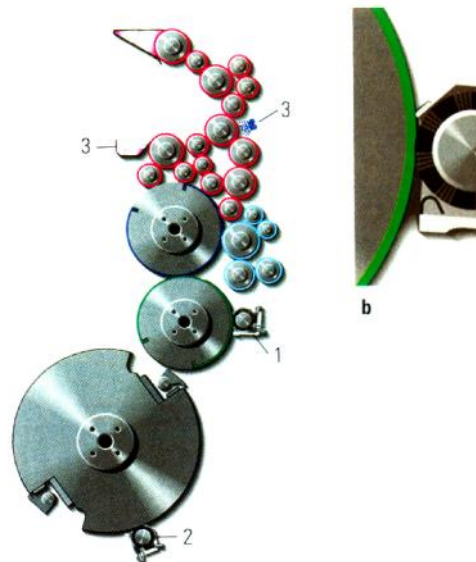
HMT
Manugraph
Orient
Optima
Autoprint

Automation in Print Production

The make ready operations in offset printing include ink changing, cleaning, sheet size and sheet travel changes, plate change, ink feed pre-setting, colour register and ink feed setting. A pure manually operated machine needs 60 to 90 minutes of make ready for a four colour job. An offset machine assisted by automation has reduced this time to about 15 to 20 minutes. Automation has also lead to drastic reduction in waste sheets. Here we will discuss a few automated operations developed by manufacturers of offset machines.

Automatic Wash-up Procedures :-

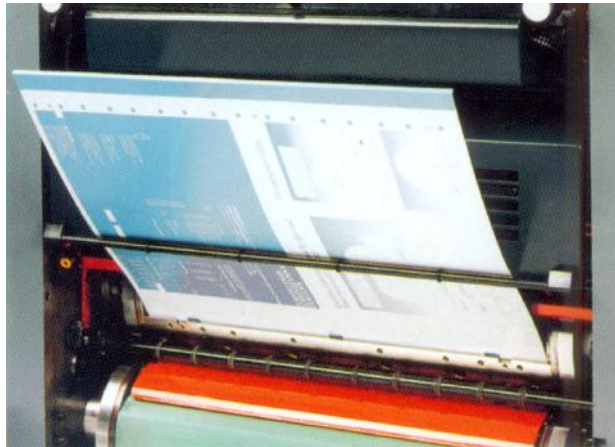
In press with automated wash-up device the blanket cylinder, the impression cylinder and the inking unit can be washed automatically with a single wash-up device installed. The cleaning device is covered with a reel washing cloth and liquid for cleaning operation.



Automated washing equipment with cleaning brush roll
a. Printing unit with washing equipment for blanket cylinder (1),
impression cylinder (2) and inking unit (3)
b. Blanket wash-up device

The device can be positioned to the blanket or impression cylinder. The cloth width will be equal to the width of the printing unit. The cleaning liquid is supplied in accordance with the degree of soiling and is sprayed on to surface by a row of nozzles. The cloth will squeeze through the cylinder and clean it. Ink cleaning unit is also equipped with a special spraying device. Located opposite to the spraying device there is an ink trough which is used to squeeze off the ink on the roller.

Automatic Plate changing: When mounting a set of plate for multicolor jobs, it is essential that the printing plates should be clamped in accurate position on the plate cylinder. This is achieved by means of punching register holes on the printing plates and suitable guide system. This is done with the help of a plate punching device in the press room. In automated plate changing system the plate is placed ready for mounting on the plate cylinder. The plates of the earlier job will be ejected automatically which is followed by the automatic feeding clamping process of the plate for the new job.



Major advantages of automated plate changing system are that

- no manual clamping of the plate is required,
- no operator related error will occur and
- plates change over can take place on all printing unit at the same time.

Estimation procedure in offset printing

Estimation is a complex process of predicting the cost of a job based on client submitted specification which includes the desired quantity, dimension, type of paper, the number of ink colours, along with many other factors pertaining to the job.

For example, estimation factors for the production of 500 business cards are the time spend in pre-press for preparing the digital file and the plate, time spend in the press for printing, for cutting the individual card and the time spend for packing the finished card in addition to the material cost, labour and energy cost.

Specification (Spec) :- A typical spec includes the quantity to be printed, the dimension of the job, the type of paper or other substrates to be printed, the number of inks and their colour, the number of folds, the method of binding, the method of packing and other factors that influence the cost which are explained below.

Business cost can be grouped into three categories- the material cost, the labour cost and the fixed costs.

The material cost is the price paid for items that are consumed for a job to be printed such as paper, ink and packaging materials. The labour cost is the 'people costs' involved in operating a business which includes hourly wages, salaries and benefits for employees. The fixed cost is the business expenses that remain constant regardless of the volume of work in the shop which includes rent, electricity charges, telephone charges, cost of advertisements, office supplies, and the cost of the machineries and equipment needed to run the press.

Calculating production cost

Printing estimate or quotation is an offer to print a particular job for a specified price. If the customer accepts the estimate it becomes a contract that is binding for both printer and the customer. Accurate printing estimate depends upon precise costing information which includes the hourly running of the firm. It is a combination of labour costs and overheads. Printing cost is calculated on the basis of the time required to perform a particular operation or the amount of output that can be expected. It includes the time to prepare the press, time for running 1000 press sheets and the time to wash up the ink and gum the plate.

Thus for example, if a machine requires 15 minutes to print 1000 press sheets, 30 minutes of make ready time and 30 minutes of wash up time equals 1¼ hours of total press time. If hourly charge of the cost center is Rs.100/-, then the production cost of the above center will be $100 \times 1.25 = \text{Rs. } 125/-$

Pre-press cost:- It is the time for preparing a digital output file for each plate.

Paper cost:- The quantity of paper required for completing a particular job and its cost.

Plate cost:- It depends on the number of colours and number of pages of a job

Binding and finishing:- It includes the cost for operating the bindery machines and the materials for it.

Job ticket / work order

A job ticket is an electronic form or a paper form used to track costs for labor, material and press time of a given job. It includes the spec, details of the production plan, needed materials, notes to the production employees and a section where production time are recorded. This ticket moves with the job through production and communicates the client's spec to production person. The job ticket can be a sheet of paper or an envelope or can be a part of an electronic file that can be accessed by the computer throughout the production plant.

Practical Activities

1. Perform paper feeding steps
2. Control the registration
3. Plate loading
4. Setting of Inking and dampening units
5. Setting of delivery unit
6. Estimation for a printing job.

Assessment Activity**Calculation**

1. Calculate the press cost to print 18000 posters of 11'x17" size printed in two colours on one side on 100 GSM art paper which costs Rs. 2500 per ream of 23" x 18" basic sheet size. The print area of the machine is 24" x 18.5". (Assume cost for one exposed plate is Rs 350 and Printing cost for 1000 impressions for one colour is Rs. 250).

TE Questions

1. Discuss the steps and procedures for setting up the paper feed on an offset press.
2. Explain how printing unit is prepared, including adjustments for ink and water for both direct and indirect dampening systems.
3. The part of the ink fountain that can be adjusted to allow more or less ink flow are _____
4. True or false? A register unit is a mechanism that aligns the paper for printing.

Unit - 4

WEB OFFSET PRESS

Introduction

Web offset presses feed from roll or web of paper instead of individual sheet. The term web-fed is commonly used to distinguish these presses from sheet fed presses. They are extremely fast. For this reason they are typically used for long run works. Large daily newspapers are printed on web press. An advantage of web press is that finishing operations can be performed inline. A variety of finishing operations like folding can be incorporated into the press run. Web presses produce medium run newspapers, magazines, business forms, mail order catalogues, gift wrappings, books, inserts, and all type of commercial printing.

Learning outcomes

The learner:

- categorises web offset presses based on its design.
- understands the operation of a web offset machine.
- understands the Inline finishing methods in a web offset machine.
- identifies different types of printing papers used in a web offset press.
- understands the working of a press console.

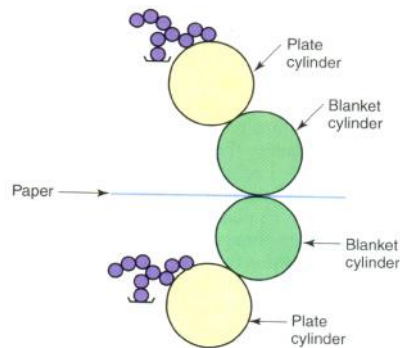
Web offset press designs

There are mainly four types of web offset presses.

1. Perfecting blanket to blanket
2. Inline presses
3. Stack / Tower Presses
4. Common Impression Cylinder (CIC) presses (Satellite units)

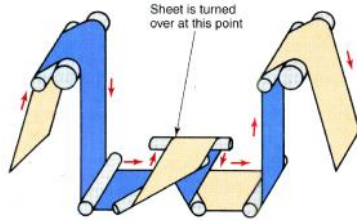
1. Perfecting blanket to blanket :- Presses printing on both sides of the paper at the same time are known as perfecting presses or perfectors.

A perfecting blanket to blanket web offset press does not have impression cylinder. Instead, the blanket cylinder of one unit serves as the impression cylinder for the other units, and vice versa. Each printing unit has two plate cylinders and two blanket cylinders. The paper is printed on both sides at the same time as it passes between the two blanket cylinders.



Each printing unit has an upper and lower inking and dampening unit. Ink from these fountains are adjustable through a series of fountain keys. This design is commonly used in newspaper and publishing industry.

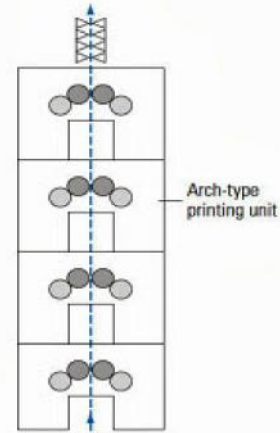
2. Inline presses :- Each printing unit of an inline web-offset press have its



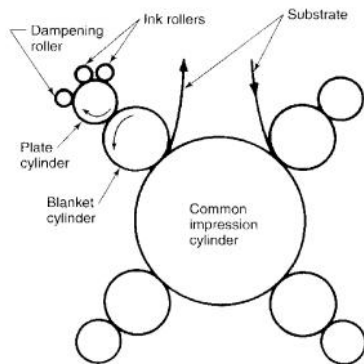
own plate, blanket, and impression cylinder and each unit prints one colour on one side of the web. To print on the reverse side the web of paper must be turned to 180 degrees between printing units by means of turner bars that expose the unprinted side of the web to the remaining units. Turner bars are also referred to as angle

bars. They are metal bars placed horizontal at a 45 degree angle to the feed direction of a printing press used to turn the moving web to flip over allowing it to be printed on the reverse side. This press design is commonly used for printing business forms.

3. Stack / Tower Presses :- They are also called vertical blanket to blanket press. In this type of web-offset all the units are designed in such a way that two blanket cylinders are arranged on top of one another with the web guided between them in a horizontal direction. The plate cylinders, the inking units and the dampening units belonging to each printing units are arranged at the top and bottom respectively. Four colour printing on both sides is produced by arranging four such blanket to blanket units in a sequence.



4. Common Impression Cylinder (CIC) presses



(Satellite units):- This type of offset has several plate cylinders positioned around a single large-diameter common impression cylinder. This large cylinder supports the substrate as it contacts a series of adjacent plate cylinders, which lay down successive colors. Central impression presses can have anywhere from two to eight printing units, with four being the most common. The major advantage of this press is the ability to hold excellent register.

Web operations

Paper is fed into the press from large rolls on a roll stand, replacing the pile feeder on a sheet fed. Roll stand is a stand used with web presses to hold one

or more paper rolls and feed each in turn with consistent and controlled tension into the printing unit of the press. When the roll begins to run out a new roll can be spliced on to the old, using an automatic splicer. Splicer is a machine that joints the end of two webs of paper to make a continuous roll without stopping the press.

The paper is threaded into the press while the press continues to run at full speed. Large festoons are used to unwind the paper. Festoon is a paper storage device that unwinds paper to keep the press running at the same speed while the splice is made and the new roll accelerates to press speed. This device also gives the web a long lead time into the press.

To run a continuous web of paper at high speed between numerous rollers and cylinders, it is necessary to control the tension of the web precisely. Tension control device regulates the amount of pull needed to keep the paper from having slack.

Web guide controls the side-to-side register of the web as it passes through the press, just as a side guide exercises this control on sheet fed presses.

Drier and Chill rollers:- Modern web offset printing uses heat set inks, inks that require the application of high temperatures to dry. As a result, web presses that utilize such inks need a dryer and chill rolls attached after the last printing section.

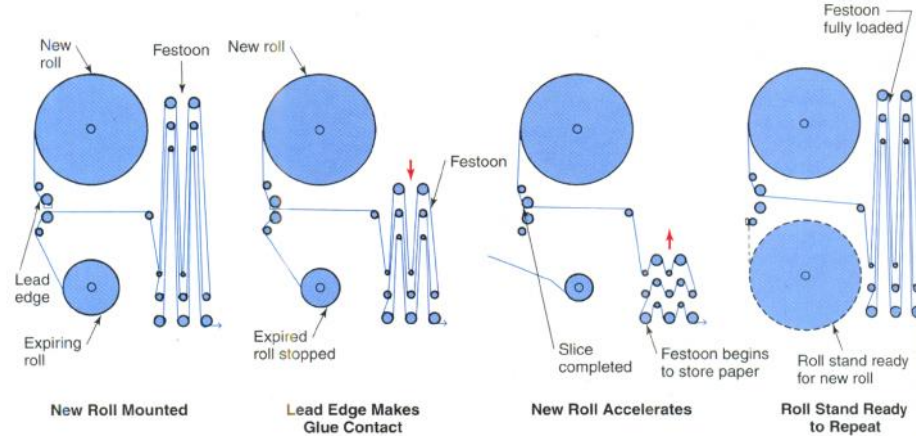
Most of the web offset printing machines have a drying chamber as an extra attachment. Some machines have a device for blowing hot air on the printed web for setting and drying the ink.

After passing the printed web through the heating chamber it is necessary to cool it. The surface of the web, structure of the fibres and the newly printed ink density are affected when it passes through the heating chamber. All these factors of the web become normal when it passes through the chilling unit.

There are two large cylinders for chilling the web which are kept away from each other. One side of the web passes in contact with one cylinder and the other side with the other cylinder. Droplets of water are formed on the surface of chilling cylinders. Chilled droplets of water vapour normalize the heated web by this process.

Flying pasters (Splicers):- A unique mechanism for bringing a new roll of paper into the feed cycle without stopping the press is called a flying paster or a splicer. As the main feeding roll nears its end, the roll stand is rotated to bring the next full roll of paper into running position without slowing the running speed of the press. Double sided tape is applied on the leading edge of the new roll. The full roll is then moved into contact with the running roll of paper and the taped edge of full roll is pressed against and immediately adheres to the running

roll. The paper from the depleted roll is cut off and the roll is brought to a stop. The new roll begins to feed the press at normal running speed.



Zero speed paster:- It is a device in the infeed section of a web press that splices a fresh roll to an expiring roll by stopping the expiring roll briefly but not stopping the press.

Web break detectors:- A web break detector is a device that automatically detects the site of a web break and immediately shutdown the press. The detector also prevents any free paper from whipping back and wrapping around the cylinders. Five main causes of web break are:

- wet spot on web,
- edge cuts,
- felt hair, calender and fiber cuts,
- tension control malfunctions and
- humidity problems.

Image alignment and register:- There is a number of printing adjustments that can be made to place the printed images correctly on the paper web and achieve register in backup with other colours. The plate cylinder can be angled, moved laterally or be packed. The entire printing unit can be advanced or retarded and check the back to back register with the opposite plate image. The operator can check the image quality and register on one or both sides of the web while the press is running.

Ink drying systems:- Heat-set inks are most commonly used inks in web offset printing. The composition of heat-set inks requires the use of heat, for drying and chilling or cold setting to bond the pigments to the paper. Web-offset presses using heat-set inks must be fitted with an exhaust system to eliminate solvent vapours from the driers.

Non-heat set inks do not require the use of heat from the driers. They are used on highly absorbent uncoated papers. Radiation curing inks, UV curing inks and thermal curing inks are also used in web-offset presses.

Filtration system:- Filtration and ventilation systems are commonly found in press areas to overcome ink misting and flying. A spray, fog or mist of ink is visible in the air as a result of ink misting and flying. Ink mist suppressors are used to overcome this. They are typically electrically charged devices that repel the charged ink back to the ink rollers. Electrical grounding of the press and air conditioning the press room helps to remove ink mist from the air.

Dampening system:- Most web offset presses use either conventional or continuous dampening system. Some web offset presses are capable of short run waterless printing.

Inline finishing

Combination folding:- Most web presses are equipped with one or more folders which fold work into signatures as the web leaves the press. There are three basic types of folders- former folder, jaw folder and chopper folder. All three folding devices are often incorporated to form a combination folder. A former folder folds the web by pulling it over a triangular shaped former board. This action makes to fold the web along its length. Additional folds are after former folder are made with jaw and chopper folders. A jaw folder folds the web across its width by allowing it to travel around a cylinder equipped with a tucker blade which forces the paper into a jaw on an opposing cylinder. In chopper folder, each signature is forced between two rotating fold rollers that makes the final fold.

Inline stitching:- It is the last but one operation of the delivery unit. When all the sections of the printed web have been gathered, the book or the magazine is stitched with its cover. Generally two or three stitches are sufficient for book of any size.

Single knife rotary trimmer:- Cutting is the last operation of the delivery unit. Here, each book is trimmed at the edges. The sequence of trimming is fore-edge, tail and finally the head. Single knife rotary trimmers are designed for accurate clean cut, high speed trimming of the press products.

Three knife trimmer:- Three knife trimmers use two parallel knives and one right angle knife to trim three sides of the printed publication inline.

Numbering tower:- This part is designed for sequential numbering on one side of the web or both sides of the web simultaneously. It is used for numbering coupons, newspaper inserts, security products, lottery products and direct mailing pieces.

Pattern perforators:- This operation scores, slits and perforates any desired pattern inline without tying up a printing unit.

Pattern gluer:- This gluer prints glue inline for the production of envelopes, return post cards, lottery and game-card products and spot gluing in trim areas for binding assistance.

Web offset printing papers

Good quality paper is essential for web offset. Cleanliness and uniformity of moisture content, thickness, substance weight and finish over the entire paper surface are critical. The ink receptivity of the paper should be highly compatible to the quick drying quality of the ink. The paper rolls must possess no weak areas and must be able to withstand the greater stress the press equipment impose. The rolls should arrive well protected and wound to proper tension on well constructed cores of suitable diameter.

Press console

Press console provide electronic control for register and image quality on the moving web. Information such as web side lay, register, colour consistancy etc. are computer controlled. Press adjustments can be made on the fly (as the press is running at printing speed). Setting of each printing unit or couple, such as ink and dampening settings and horizontal and vertical register can be made directly from the console. The press operator monitors the console and make adjustments by adjusting the switches on the console, which in turn causes the appropriate adjustments on the press itself. Many presses have automatic blanket washing units that are controlled by the press console. Console reduces wastage of paper and the amount of press down time. Console also reduces the number of people required to operate the press.

Assessment Activities

Field visit

Student should visit a reputed web offset press.

Record

Draw a schematic diagram of web-offset machine and mark its parts.

TE Questions

1. Identify other operations besides printing done on a web press system.
2. Perfecting blanket-to-blanket web presses use two _____ cylinders and two _____ cylinders.
3. Describe the construction and operation of common impression cylinder presses.
4. Explain a web press operation in detail.
5. Compare zero splicers and flying splicers.
6. Explain the function of driers and chill rolls in a web offset press.
7. Briefly explain about press console.

Unit - 5

PRESS MAINTENANCE AND TROUBLESHOOTING

Introduction

During offset press operation, when a problem arise the operators skill set includes the ability to examine the problem and methodically identify the cause- poor paper, excessive dampening solution, inadequate roller pressure, etc. What ever the cause the operator is counted on to systematically isolate and eliminate it. At this point the students learn about basic press maintenance methods and trouble shooting techniques.

Learning Outcomes

The learner:

- identifies paper problems and suggest remedies
- identifies Ink problems and suggest remedies
- identifies printing problems and suggest remedies
- identifies problems due to blanket and rollers and suggest remedies
- identifies problems due to incorrect cylinder pressure and suggest remedies
- understands the importance of preventive maintenance
- demonstrates cleaning and caring the press
- understands the importance of Quality Control Devices in quality printing

Printing problems may arise due to situations involving the substrate, the ink or the press- or any combination of the three.

Paper problems

Electrostatic Charge on Paper

Printing sheets stick together because they are electrostatically charged. As a result, several sheets are simultaneously sucked in from the stack, stopping up the feeder. Static electricity arises from either an electron deficit (positive charge) or an excess of electrons (negative charge) on the surface of the paper. An electrostatic charge is especially likely to occur when paper that is too dry is processed under conditions of low atmospheric humidity.

Remedies:

The moisture content of paper should range between 45% and 55%. The electrical conductivity of paper, and consequently electrical run off, increases with increasing moisture content

- Working spaces should be air-conditioned or humidified at a 50% to 55% level of relative humidity.

- Antistatic equipment such as discharge electrodes and ionic blowers reduce electrostatic charge; ionization equipment raises the surrounding air's electronic conductivity, thereby preventing the build up of static charge

Crease Formation

If paper is stored under the wrong climatic conditions, does not lie flat on the pile, has wavy or tight edges or has developed a static charge, it may become creased during printing.

Incorrect settings on the sheet-feeder or during paper transfer may also lead to the formation of creases. In order to ensure that the printing stock lies flat during the printing process, it should be kept properly air-conditioned during storage and transport. Paper is very sensitive to fluctuations in humidity. This is why one must be careful to maintain atmospheric humidity and temperature at constant levels during storage. The temperature should be kept constant between 20°C and 22°C (68°F and 71.6°F).

Creases may also develop due to incorrect machine settings - most likely on the sheet-feeder, incorrectly set or jamming front lays, side lays that draw with too much force, a hold-down device that has been set too tightly, or an air-blast that is too strong. An incorrect air-pressure setting at the point of sheet transfer may also contribute to the formation of creases. Poorly functioning or dirty grippers, which warp the sheet, as well as a printing pressure between the rubber and the impression cylinder that is set too high, or is uneven are also the reasons for crease formation.

Remedies:

- Employ printing stock that is good and flat.
- Inspect the front lays and side lays.
- Do not set the hold-down device too tightly.
- Reduce the air-blast on the sheet-feeder.
- Optimize the air-pressure adjustments at the point of sheet transfer.
- Inspect, clean, and adjust the grippers as needed.

Picking

Picking occurs when small particles are torn out of the surface of the paper during the printing process. It becomes necessary to wash the blankets more frequently, and print quality is adversely affected. Inadequate gluing, or the poor anchoring of the coating material on the paper's surface may cause picking. Other causes of picking are excess ink tack, excess blanket-to-impression cylinder pressure and tacky blanket surface.

Remedies:

- Reduce the ink tack.

- Allow the machine to run on standard working condition.
- Repack blanket or reduce cylinder pressure.
- Use a quick release blanket.
- Use better quality paper.

Ink problems

Emulsification

Emulsification is the mixing up of ink and dampening solution. In this process, dampening solution is distributed evenly throughout the ink in small droplets. Too large a proportion of dampening solution in the printing ink, or too low a pH-value causes emulsification. Emulsified printing inks will increase drying times, as well as increasing the risk of deposits.

Remedies:

- Set the ink and dampening balance correctly, and check on it continuously throughout the printing process.
- In case of emulsified ink, wash the rollers.
- Check the dampening solution, and change it regularly (the ideal dampening solution has a pH-value from 4.5 to 5.5, and a temperature from 10°C to 15°C (50°F to 59°F)).

Slow ink drying

It is a condition that occurs when ink fails to cure quickly, delaying multicolour printing runs. This may lead to the rubbing off color of the print during post press or during transport. Causes for slow drying are

- Fountain solution too acidic
- Insufficient amount of ink driers
- Wrong ink used with paper
- Low temperature in press room

Remedies: Check the pH of fountain solution, add driers to the ink, use ink that is appropriate for the paper and raise the press room temperature to improve drying ability.

Chalking

It is a condition in which dried ink gets easily rubbed off or is missing from the sheet. Major causes of chalking are:

- Insufficient amount of ink driers
- Ink absorbed by the paper before setting properly
- Wrong ink used with paper

Remedies:- Add driers as suggested by the manufacturer, add gum or binding agents to control absorption and overprint paper with varnish.

Hickies

It is a condition in which ink spots surrounds a white background. It is caused by small particles of dried ink, dust or paper dust getting attached to the plate or blanket.

Remedies:- Clean the press and remove all dried ink from the fountain and roller, check feeding pile for loose edges.

Piling

A buildup of ink on the ink rollers, plate or blanket. Causes are:

- Ink too stiff or tacky
- Emulsified ink
- Improperly ground ink
- Improperly packed blanket

Remedies:- Reduce tack by adding reducing compound, clean-up press and use proper balance of ink and fountain solution, re-formulate ink and re-pack blanket.

Printing problems

Blinding

The image area of the plate will not accept ink. Major causes are:

- Excess gum in fountain solution
- Fountain solution too acidic
- Excess plate-blanket pressure
- Glazed rollers
- Improper ink tack
- Contamination of plate during plate making

Remedies:- Check the pH of the dampening solution, check the roller pressure with cylinder packing and blanket packing, deglaze or replace rollers, reformulate ink to match the stock, clean and rinse plate and re-gum surface.

Ghosting

It is a condition that occurs when solid images print unevenly or a faint second image appears next to the original. Major causes for ghosting are:

- Glazed or hardened ink rollers
- Excess fountain rollers
- Embossed or engraved blankets

Remedies:- Clean and replace rollers, adjust balance of ink and fountain solution, replace blanket

Mis-registration

Two overprinted images or colour elements do not align when printed. Major causes are:

- Excess ink tack
- Curled or wrinkled paper stock
- Printing pressure stretch paper stock
- Image improperly positioned on plate
- Plate mounted improperly
- Loose blanket

Remedies:- Reduce tack, humidity of pressroom, adjust cylinder pressure, remake plate with image in register, reposition plate on plate cylinder, reattach blanket

Mottling

Uneven amount of ink in the solid portion of the image causing printed sheets to appear cloudy. Major causes are:

- Failure of ink to be absorbed uniformly by paper.
- Excess fountain solution.
- Ink not resistant to water.

Remedies:- Formulate ink to the grade of paper, adjust ink water balance, add varnish to increase tack.

Plateware

It is the gradual disappearance of the image areas from the plate surface. Major causes are:

- Excess form roller pressure.
- Excess pressure between plate and blanket.
- Fountain solution too acidic.
- Insufficient amount of ink.
- Dried gum on the plate.

Remedies:- Check for roller pressure, pressure by inking plate, check pH of fountain solution, clean the plate with water and solvents, clean blanket.

Scum

Buildup of ink film on non image areas of the plate. Causes are:

- Too soft ink.
- Excess use of ink.
- Sensitized non image areas of plate.

- Incorrect fountain solution.
- Glazed blankets.
- Dirty dampening rollers.
- Excessive printing pressure.
- Glazed and dirty ink rollers.

Remedies:- Add varnish to increase tack, adjust ink water balance, remake plate, check pH of fountain solution, clean or replace blankets or rollers, reduce plate-to-blanket and blanket-to-impression cylinder pressure.

Setoff

The transfer of ink from one sheet to the back of another on a delivery pile. Causes are:

- Too much ink carried to paper.
- Excess acid in fountain solution.
- Insufficient amount of ink drier.
- Improper ink for stock.
- Delivery pile too high.

Remedies:- Check pH of the fountain solution, add dryers to ink, change ink to match the stock, reduce pile height.

Slurring

An unwanted accumulation of halftone dots that result in a smeared image. Causes are:

- Excessive pressure between plate and blanket.
- Excess ink coated on paper.
- Piling of ink on paper.
- Loose fitting plate on cylinder.

Remedies:- Reduce impression cylinder pressure, reduce ink feed, use moisture-resistant stock, re-attach plate, add reducing varnish to ink.

Tinting

Unwanted colour tint in background of image, commonly caused by imulsification of ink in the fountain solution. Causes are:

- Ink fails to repel water.
- Improper fountain solution pH.
- Improper ink-water balance.
- Plate not properly desensitized.

Remedies:- Add varnish to increase tack, check the pH of fountain solution, prepare new plate.

Blanket and Roller Problems

Glazing

The ink system rollers and the blankets get shiny and hard and as a result it loses its ability to absorb ink. Causes are:

- Improper cleaning of blanket and rollers.
- Excess use of solvents.
- Over exposure to UV light sources.

Remedies:- Clean the surface with deglazing compounds

Swelling

This defect takes place in the blanket due to the use of unsuitable chemicals. This results in loss of image sharpness.

Remedies:- Remove excess swell of the blanket by reducing the packing, blanket wash should be used which dries faster.

Paper sticking

Sometimes the paper is picked up by the image and non image areas of the blanket. Causes are:

- Use of strong solvent in the blanket wash.
- The driers of previous ink may have been oxidised and created tackiness in the blanket surface.

Remedies:- Use mild blanket washes, use blanket lacquer to remove tackiness of blanket, apply pumic powder and keep the blanket to rest for some time.

Preventive maintenance

The use of proper setup procedures, proper ink formulation, and quality offset paper as well as proper cleanup procedures, increase the production and maintain printing quality. The following items should receive careful attention when preparing to run a job on the press.

- Oil the press periodically.
- Check for lubrication points and examine the belt and pulley systems.
- Chains of infeed and outfeed tables needed to be greased and free from paper pieces and dirt.
- Oil reservoirs of vacuum pumps should be kept filled. The pump itself should be flushed out several times a year.
- All rollers and cylinder bearings must be lubricated on daily basis.
- A consistent maintenance schedule is essential.

Cleaning and caring the press

The most common procedure is to give the entire printing unit a thorough cleaning at the end of each work day. Before the inking system is cleaned the

water fountain is generally drained. A tube leading from the water fountain is used for this purpose. For ink clean up a doctor blade is attached against the ink roller. The wash up solution is applied while the press is running, the ink dissolves and passes across the doctor blade into a sludge tray.

First remove as much as ink as possible from the ink fountain. Next, remove the ink fountain and clean it with ink solvent. While the press is turned off, attach the doctor blade against the ink roller. Then start the press and apply wash up solution to one side of the distribution rollers until half the system becomes clean and dry. Then apply the solvent to the remaining inked portion. The solvent will dissolve the ink and will be washed into a sludge tray.

Quality control in Offset

The running of an offset press involves many adjustments of various components of the press, especially when setting the press up for the job to be printed and monitoring it during the print run. Quality control in printing mainly involves setting the different printing units for ink feed and colour register. Then the dampening units, paper feed, air blast, suction, air powder spray device and driers have to be set. Machinery has also to be cleaned and washed.

A long make ready time and a number of operators and high paper wastage is required for doing this work in a high speed multi colour press with numerous attachments such as folders, dryers and finishing equipments.

Central control consoles, with control for setting the main press function remotely and remote control measuring systems has made the quality control and press monitoring simple.

Remote control press console: This is a remote control system attached to offset machine that helps the operator to set up press functions such as ink feed, colour register, dampening unit setting, blowers and suction control with the aid of computers.

A press remote console has two parts- an illuminating system equipped with a special light source and a unit with display screen and input function keys.

In the first unit the operator can compare



the sample taken from the run visually with the master proof. The function keys of the control console corresponds to the ink zone of the printing unit, which the operator can use to adjust the ink zone opening in individual printing unit and to correct the colour with the master proof. The console has another set of function keys that are used to set the ink register. The position of the individual plate cylinders can be adjusted in circumference and lateral direction in series of small steps. Some control console has the facility for downloading job data such as colour settings from storage media. Sophisticated control console systems can control the operations of dampening unit and air suction and air blower.

Plate Image Scanners: They are used for colour pre-setting operations. They scan a plate to see how much ink it require and the data is then input into the control console for remote adjustments of ink zone opening. Control console also include measuring devices for color, register and match. Colour measurement and control are done with the help of measuring devices like densitometer



and colourimeter attached to the console. Register measurement and control is done with the aid of optical magnifying glass attached to the control console.

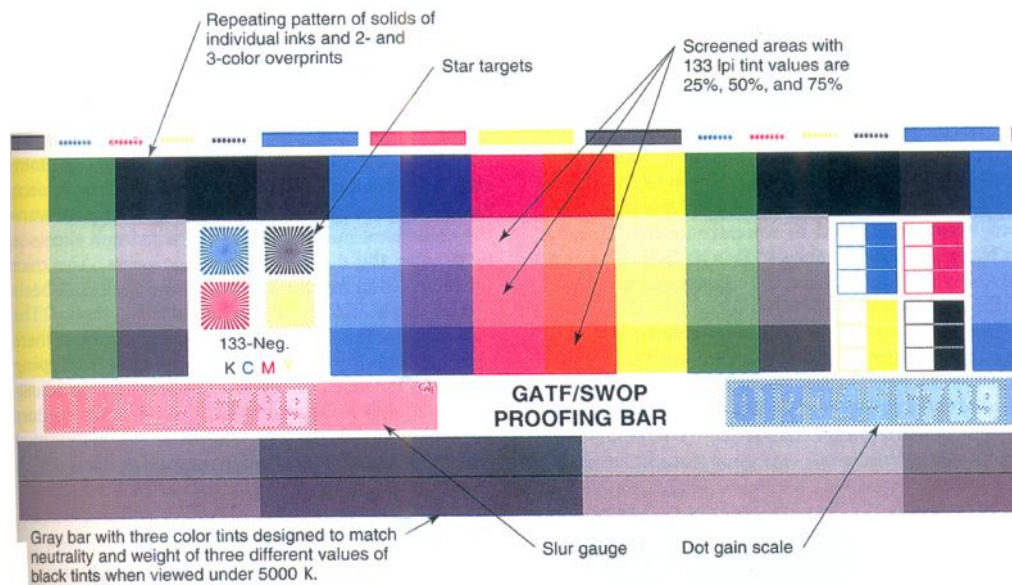
Quality Control Devices

They are devices which are stripped, plated and printed in an off-image area of the press. Under magnification, these images can aid the press operator in determining overall press sheet image quality and in making press adjustments. Most of the devices have been developed by the Graphic Arts Technical Foundation (GATF), which is an American organisation at who are at the forefront of researches and developments in graphic arts.

Colour Bar : A colour bar is a strip of colours printed in the trim area of a press sheet. This strip usually consists of overprints of two- and three-colour solids and tints. Press operators can monitor uniform ink distribution across the press sheet by measuring the density of CMYK patches. A colour bar is also used to monitor printing variables such as trapping, ink density, dot gain and print contrast.

Star Target: Star targets are circular patterns of lines primarily used to detect dot gain, slur, and dot doubling. Dot gain is the enlargement of printed dot due to excessive ink film or pressure between cylinders. Slur is a stretching of half tone dots caused by a slippage of the cylinders. Dot doubling is the printing of the same dots twice.

Dot Gain scale : It is a quality control device used to indicate dot reproduction of half tones and process colours. This scale consists of series of numbers (zero through nine) that are finely screened and graduated from light to dark. As dot gain increases, the numbers become more visible.



Gray Balance Patch : Gray balance is measured by overprinting screen tints of three process colours to see if they produce a gray balance patch of neutral gray. If gray balance is not achieved the patch will have a tint. The midtone percentage for a gray balance patch is 50% cyan and 40% of magenta and yellow.

Register marks : They are designs or shapes placed in the non-image areas of negatives, positives, colour separations and plates to ensure correct register. Register marks help the press operators to align one colour over another in perfect register. Register marks can either be purchased commercially as pre-printed transparent materials or they can be created by drawing.

Densitometer: Densitometer is a colour measurement device that computes the light-stopping or light absorption ability of an image or surface material. It computes density or darkness of an image.

Spectrophotometer: It is the most accurate type of colour measurement device. A spectrophotometer measures light intensity and different colours or wavelengths of colours. Most of the spectrophotometers used in printing industry are limited to reading light waves in the visible spectrum.

Colourimeter: It is a colour measurement device that measures and compares the hue, purity and brightness of colours in a way that models vision.

Spectrodensitometer:- It is a colour measurement device that serves all the functions of spectrophotometer, densitometer and colourimeter in a single instrument. This single instrument measures colour values and optical density.

Magnifying glass: Magnifying glass or linen tester is used to view dots of any size. They are also used to check whether the register marks are aligned accurately in positions.

Colour viewer: A colour viewer is used to check halftone dot size and paper texture.

Practical Assessment

1. Identify different paper problems, printing problems, blanket problems and ink problem and provide the solutions for each.
2. Press maintenance and clean up procedure.
3. Handling of different quality control devices.

Assessment Activities/ Seminar

1. Different quality control devices and its applications.

TE Questions

1. A problem called _____ occurs when a printed sheet picks up an image on its reverse side from the sheet below it in the delivery pile.
2. List out any two printing and blanket problems and its remedies.
3. Why is static electricity a problem in the press room? How can it be reduced or eliminated ?
4. What are the different quality control devices used in a printing press?

Unit - 6

FLEXO AND GRAVURE

Introduction

This unit introduces two printing processes which are being increasingly important in the printing industry. Flexography, the first process we will discuss, has long been a significant relief process used in packaging industry. Gravure, the second process is an intaglio printing process which is widely used for high quality long run jobs and for security printing purposes.

Learning Outcomes

The learner:

- understands the process of flexography.
- lists out the advantages of flexography.
- identifies the basic units of a flexo printing machine.
- classifies flexographic plates.
- demonstrates plate making process in flexography.
- categorises different types of flexo press.
- lists out various types of ink & substrate used in flexography.
- understands the process of gravure printing.
- lists out the advantages and disadvantages of gravure printing process.
- understands the working of the printing unit of a gravure press.
- understands the methods of preparation of gravure cylinders.
- discusses the different types of ink and substrates used in gravure process.
- understands the importance and advantages of security printing.

Flexography - Introduction

Flexography is a method of direct rotary printing that uses flexible relief image printing plates that are made of rubber or photopolymer material. Flexography was originally known as aniline printing because of aniline dyes used to colour the ink. But these aniline dyes and their harsh solvents left an odour on the product and came to be considered toxic. Later they were banned from using on food packaging. In 1950s, chemists developed water-based inks using low solvents.

Flexography satisfies the demand for high quality printing on packaging products. Corrugated boxes are the largest market for flexography. They are also used to print on candy wrappers, shopping bags, milk cartons, cereal boxes, gift wrappers, wall papers and many other goods.

Advantages

- Flexography can be used for printing on a variety of absorbent and non absorbent substrates.
- Prints on the reverse side of transparent films.
- Rubber or photopolymer image carrier can be used for printing millions of impressions.
- Allows continuous pattern printing.
- Water soluble inks can be used and hence ecofriendly.
- Since it uses fast drying solvents the process is ideal for printing on polyethene, the material used for plastic grocery bags and similar products.
- Printing plate cylinders can be taken out of the press so that it can be mounted and proofed as a pre-press operation.

Basic units

A flexographic press consists of three major units- the infeed, printing and outfeed unit. Majority of flexographic printing is done on roll-fed materials.

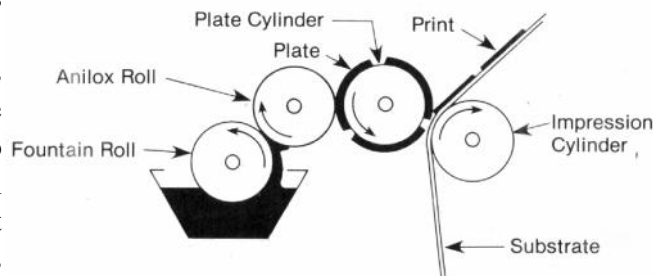
Infeed unit and unwinding unit

Majority of flexographic printing is done on rollfed materials such as film, foil, laminates used for food, medical and sanitary packages. The infeed system consists of a roll stand with tensioning devices, dancer roller and brake to control the web tension. Sheet-fed flexo is also possible for printing of thicker materials such as corrugated board. Sheet-fed flexo infeed system are designed to feed heavier stock.

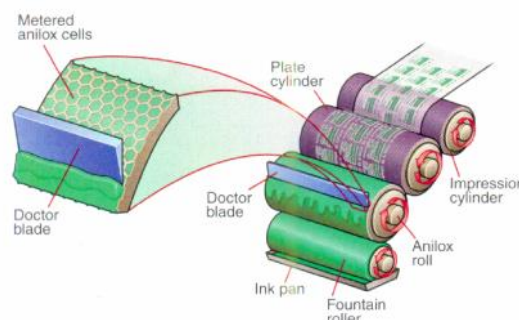
Printing unit

In a flexographic printing unit, the ink fountain holds the ink. The fountain rollers are made of soft or hard rubber and transfer the ink to the next roller in the chain, the anilox roller. Anilox rollers are metal or ceramic roll engraved with cells that carry ink to the plate cylinder.

There are two types of inking system- three roller system and two roller system. A three roller inking system consists of an ink fountain roller, typically made up of rubber, which passes ink to the anilox roller. The fountain roller moves at a slower speed than the anilox roller. This helps to remove excess ink from the anilox roller. This act of removing excess ink is called 'doctoring'.



In two roller system the anilox roller turns directly in the ink fountain and a doctor blade is used to remove excess ink from the anilox roller. The doctor blade is a thin metal blade which is angled to the anilox roller and cleans excess of ink from the non-cell areas of the anilox roller. It helps to produce excellent and even inking of the cells in the anilox roller.



The image carrying plate is mounted on the plate cylinder and is made of rubber or photopolymer. The anilox roller inks the relief image plate with a continuous metered supply of ink. The substrate is fed under controlled tension against the impression cylinder. The fast drying ink prints on the absorbent or non absorbent substrate and dries instantly. The recent improvement in the flexographic inking system is an enclosed dual doctor blade system.

The plate cylinder is designed to hold the flexible flexographic plates through an adhesive. Flexographic plate size varies with the job to be printed. Several repeat images are printed in succession from several plates mounted on the same cylinder. Thus the size of the plate cylinder is chosen to match the repeated image size i.e., if the image to be printed is 6", a 12" plate can be used to print two repeated images. Because the plate cylinder must be changed to match the plate, the anilox roller must also match the job. Flexo presses are designed so that the plate cylinder and ink train can be removed easily and installed as a unit in the press, each time a new job is run.

Outfeed unit

Outfeed unit consists of a rewinder which rewinds the substrate into a roll for later processing. Some flexo presses are designed in-line with the manufacturing production line so that printing and packaging can be done as one continuous operation.

Flexographic plates

Flexographic presses use flexible plates with raised images, much like letterpress image carriers. It can be made of molded rubber or photopolymer materials and through laser imaging.

The major disadvantage of rubber plates is that they are more costly than photopolymer plates.

Plate making process

There are mainly four types of flexographic plates. They are molded rubber plates, photopolymer plates, sheet photopolymer plates and liquid photopolymer plates.

Molded rubber plates or rubber stereo plates:- Molded rubber plates are created in a multi step process. A sheet of metal alloy coated with a light sensitive emulsion is placed in a specially designed vacuum frame. The emulsion is not only light-sensitive, it is also an acid resist. A negative of the job is placed over the coated sheet and light is passed through the negative. Where light strikes the emulsion, the acid resist is hardened. During processing, the unhardened resist in the non-image areas is washed away, leaving hardened resist only on the image areas. The metal sheet is then etched, which lowers the non image areas, leaving the image areas raised. The remaining resist is washed off. The completed engraving is then moved to a molding press where a matrix (mold) of the engraving is made by pressing matrix material against the engraving with controlled heat and pressure. The matrix material sinks into the metal engraving to form a mold. The rubber plate is made from the matrix by pressing a rubber sheet into the matrix again under controlled heat and pressure. The thickness selected depends on the job to be printed.

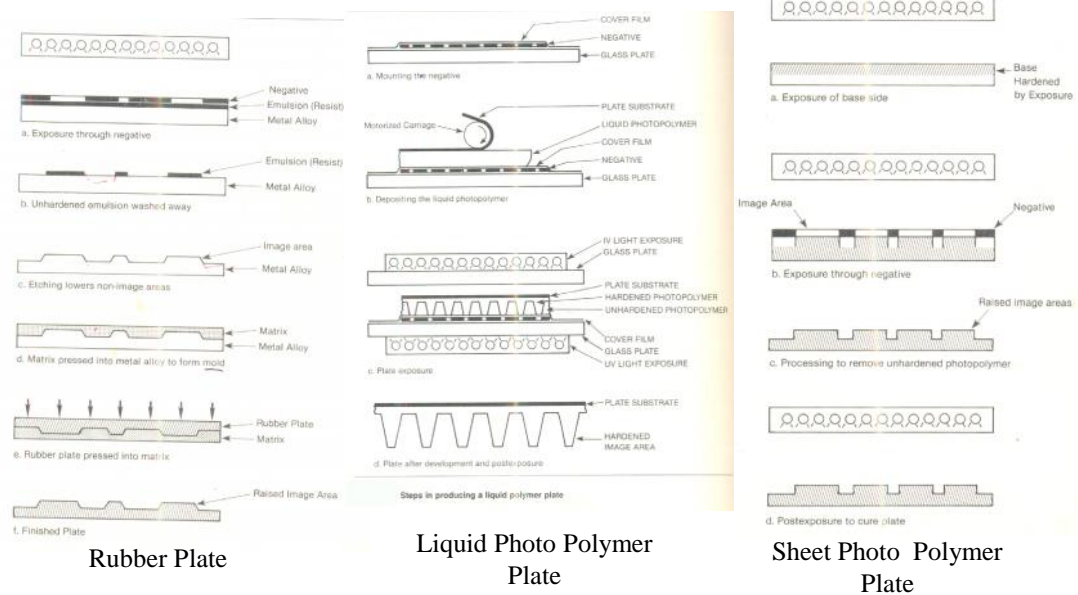
Photopolymer plates:- These plates are made from light sensitive polymers which are hardened by ultra-violet light. Photopolymer plates are made from both sheet and liquid materials.

Sheet photopolymer plates:- The plates are cut to the required size and placed in an ultraviolet light exposure unit. One side of the plate is completely exposed to uv light to harden or “cure” the base of the plate. The plate is then turned over, a negative of the job is mounted over the uncured side, and the plate is again exposed to UV light, which hardens the plate in the image areas. The plate is then processed to remove the unhardened photopolymer from the non-image areas thus lowering the plate surface in the non-image areas. After processing, the plate is dried and given a post exposure of UV light to cure the whole plate.

Liquid photopolymer plates:- These plates are made in a special UV light exposure unit. In this process, a clear plastic protective cover film is mounted over a negative transparency which is placed emulsion-side up on the exposure unit. A layer of liquid photopolymer is then deposited over the transparency and the cover film. A substrate sheet, which is specially coated on one side to bond with the liquid photopolymer and to serve as the back of the plate after exposure is placed over the liquid.

Exposure is made first on the substrate side of the plate. This exposure hardens a thin base layer of the liquid photopolymer and causes it to adhere to the plate

substrate. A second exposure through the negative forms the image on the plate. As with the sheet materials, the image areas are hardened by this exposure. The non-image areas remain liquid. Processing removes unwanted liquid in the non-image areas, leaving raised image areas. A post exposure is then made to cure the whole plate.



Computer-to-plate processing transfers images directly from the computer to the plate, thus eliminating film. Some photopolymer plates can be directly imaged by Lasers. In recent years, laser engraved rubber cylinders have been used to print wall paper and other continuous pattern jobs.

Press types

There are three types of flexographic machine configurations: Stack press, Central Impression Cylinder (CIC) and Inline presses. Stack presses are the first type of flexographic presses. In this type of press, the moving web is unsupported between the printing stations which causes register problems. Unstretchable substrates such as thick paper or heavier gauge plastics are better suited for this configuration.

In CIC presses, the web travels from one print station to the next around a central drum. The moving web is supported between stations, so the press is ideal for stretchable films needing close register. CIC presses print on one side only.

Inline flexographic press has separate print stations placed in a straight line. Each station has its own driers. Two sides can be printed in one pass with the aid of turner bar. These presses are used to print linear board for corrugated boxes before corrugation takes place. They are also suitable for printing narrow web labels and forms that are 6" to 18" wide.

Flexo Makeready

Printing cylinders are completely round and are removable. After the plates are mounted on to the cylinders, the cylinders are brought to the press in the proper station. Required aniloxes are installed. Ink is fed in each station. Press adjustments are made and the job begins to print. Registration is achieved by moving cylinders into a timed position.

Flexographic ink & substrates

Flexographic inks used are more fluid and free flowing than lithographic inks and are less viscous.

Three type of flexographic inks are widely used in the industry- alcohol based inks, polyamide inks, and water based inks.

Alcohol based inks come in full range of dyes. Pigmented inks are also available.

Polyamide inks are solvent type inks requiring alcohol and acetates to dissolve their resins. They successfully print on any substrate including absorbent and non absorbent plastics. Both alcohol based and polyamide inks emit Volatile Organic Compound (VOC), which are toxic substance that evaporates into the atmosphere, contributing to smog and causing health concerns.

Water based inks are more eco friendly but do not adhere to some substrate as solvent inks.

Gravure Printing - Introduction

Gravure is an intaglio printing process in which the ink is transferred from a sunken surface. Several important characteristics makes gravure an ideal process for jobs requiring high quality and extremely long press runs. Currency notes, postage stamps and stock certificates are some of the products printed by this process.

Advantages and disadvantages

Main advantage of gravure process is its simplicity. Gravure presses can run at high speed. It is a direct printing process that does not have to contend with ink and water balance. Gravure is capable of consistent high quality reproduction at a low cost on extremely long press runs. The long life of gravure cylinder sustains high quality reproduction. Ink used for gravure printing dry fast.

The main disadvantage of gravure is the length of time required to prepare the printing cylinder. If an engraved cylinder is damaged during production the entire cylinder or set of cylinders have to be re-engraved which is a costly operation.

Gravure printing unit

Gravure printing unit comprises of the printing cylinder running in a trough of ink, a rubber immersed roller and a doctor blade to remove excess ink from the surface of the cylinder.

Printing cylinder :- are generally one piece continuous cylinder containing recessed screened image which has been produced either by etching or engraving. The cylinders are designed to easily removable for quick change over and to enable the cylinders to be proofed, prior to printing and whenever necessary, stored for future use. At each unit the cylinder is immersed in the ink fountain. As the cylinder turns, its tiny ink cells get filled with ink.

Impression cylinder :- An impression cylinder which is made up of rubber, neoprene or other synthetic products usually applies pressure to transfer the ink to the substrate.

Ink duct :- It is a part of complete circulating system where ink is pumped to the tray from a bulk supply and surplus ink returned filtered and adjusted for solvent balance, then repumped to the cylinder. The entire system should be enclosed as far as possible to ensure cleanliness of the ink and to avoid evaporation.

Doctor blade :- It is a thick blade made of stainless steel or plastic set at twenty degree angle with the cylinder. Doctor blade is prepared to ride on the surface of the printing cylinder and remove surplus ink without damaging the surface of the printing image.

Electrostatic assist :- To improve the ink transfer to the substrate especially when the surface is hard or has poor ink receptivity a power source feeds electrical charges between the impression roller and the printing cylinder which create a force that helps to release ink from the etched cells. This process is called electrostatic assist.

Cylinder preparation methods

Transferring the image to the cylinder is accomplished using electromechanical engraving and laser beam engraving methods.

Electromechanical method :- Direct digital electromechanical engraving produces the most reliable cylinders for the press. In this method the cylinder is prepared using scanned data to drive an engraving machine. The scanner and the engraver are electronically linked. The scanner reads the original copy and converts it to electronic pulses and transfer it to the engraver. The engraver prompts a diamond stylus cutting tool or a laser device to form tiny wells on the image carrier surface.

Laser beam engraving :- In laser beam engraving the cylinders are coated with plastic and the laser functions as a cutting tool. The laser vaporizes the plastic to form the cells. Zinc is more suitable metal base for laser engraving. This technology is more used in publication and packaging gravure markets. Major advantages of laser imaging methods are quick imaging, repeatability, significant ink saving and greater stability.

Ink and substrates

Gravure inks are thinner than those inks used in other printing processes. Viscosity is also much lower than most inks. Solvent based inks are highly volatile.

Gravure printing is done on a wide variety of substrates including inexpensive paper stocks. Packaging and special products typically use substrates such as film, cellophane, cloth, plastic, and corrugated board. Gravure press also runs newsprint stock and coated stocks for publication work.

Security Printing

Introduction to security printing

Security printing is used in areas such as currency notes, stamps, credit cards, cheques, postal orders and many type of top secret government informations. Gravure and offset are the most commonly used security printing methods.

Three main concerns of security printing are:

1. To secure confidentiality of documents.
2. To ensure authenticity of documents and make them readily identifiable.
3. To make copying, duplicating and forgery of the documents as difficult as possible.

Security features

Major features in security printing are watermark, security thread, latent image, microprinting, colour-shifting ink, see through register, etc.

Water mark:- Faint images that are part of paper that are visible from both sides of the paper are water marks. In currency notes watermarks include portraits of historical figure and numerical value of currency.

Security threads:- They are plastic strip partly visible and partly embedded in the paper that displays value of the bill. Depending on the denomination, security thread glow orange, green, or yellow when held under UV light.

Guilloches:- They are printed backgrounds consisting of elaborately interwoven regular wave or arch shaped lines which are produced according to certain

mathematical laws. They may have *shine through effect* that create complete picture from sections on the front and on the reverse side of the bank note.

Microprinting:- Tiny characters, words, or phrases printed which are usually not visible to the naked eyes. Microprinting is difficult to be reproduced by counterfeiters.

Colour shifting:- Images or numbers printed that change from copper to green when viewed in different angles. This effect is created by adding metallic flakes to the ink.

Security ink

Security printing ink can be divided into two categories: Anti-duplication security inks and Anti-alteration security inks.

Anti-duplication security inks:- are designed to prevent unauthorised copying or duplication of documents. They provide usually covert features for authentication such as UV fluorescence or reactivity to heat, metal, UV, IR light etc. These features cannot be duplicated digitally or by photocopying.

Anti-alteration security inks:- These inks provide indications of tampering such as discolouration upon exposure to water or chemicals, or destruction of the background upon erasure.

Numbering with MICR ink:- MICR or magnetic ink character recognition inks contain ferro magnetic particles and they are machine readable which provide an excellent method for machine processing of large number of cheques or bank notes and at the same time as a counterfeit deterrent.

Security paper:- The major distinguishing paper attributes for security printing is the fact that they contain a mixture of multiple overt (public security features that are visible with unaided eye - eg: watermark, security thread), covert (feature that are not easily visible - eg: paper fluorescence) and forensic features (requiring advanced knowledge and special instrumentation for verification).

Currency printing :- Bank notes are printed on specially tough rag based paper produced under conditions of high security. It contains its own water marks which are different in design and position for each denomination. Some bank notes comprises more than one layer of paper which enables metal or plastic strips and other devices to be incorporated. To aid identification and avoid forgery complicated line patterns, microimages, or secret patterns are also included.

Cheque printing:- In cheque the number and other coded informations are printed with an ink containing minute ferrous particles which can be detected by a Magnetic Ink Character Recognition system(MICR).

Holograms :- Holography is a process that creates the illusion of three dimensionality on a two dimensional surface. Today any image or model can be transferred into holographic foil. There are four holographic effects which can be captured in a foil image:

1. *Holographic patterned foil :-* They produce images of depth and a rainbow of shifting colour as the angle of view changes.
2. *Three dimensional holograms :-* 3D holograms produce 3D illusion of objects and seems to rotate in space as the angle of view changes.
3. *Multiple plane holograms :-* This type of hologram layers two to four images into separate planes creating the illusion of a 3D scene.
4. *Stereograms:-* They are sophisticated holograms of live moving models that incredibly render the illusion of a brief 3D movie on a two dimensional surface.

Barcode:- Barcode is an optical machine readable code in the form of numbers and a pattern of parallel lines of varying width printed on a commodity and used for stock control. Major use of barcode is to automate supermarkets, libraries, etc.

Barcode reader is an electronic device that can read and output printed barcodes to a computer.

QR(Quick Response) codes:- QR code is a two dimensional barcode system. They are made up of black and white squares which are generated using a code generator. Even a smartphone can be used as a QR code scanner. QR codes are now used over a wide range of applications including commercial tracking, entertainment and transport ticketing, mobile couponing and more. It can also be used in storing personal information for use by organizations.

Practical Activities

1. Preparation of flexographic rubber plate in your plate making unit.
2. Distinguish between offset, flexographic and gravure ink from the collected samples.
3. Generate a barcode for a particular item in your computer and list out its features.
4. Generate and read a QR code for an address using smart phone QR code application.

Assessment activity

1. Collect samples of plastic bags that have been printed by flexographic process colour method and check the colour register. Write your observation.
2. Select 10 major magazines and determine if any of them are printed by the gravure process.
3. Identify 5 products that have been printed by gravure process.
4. List out and compare the security features provided in different currency notes and bank cheques.
5. Collect different samples of holograms which are used in day-to-day life.
6. In your lab record draw diagrams of flexographic inking system (two roller & three roller) and mark its parts.
7. Prepare a diagrammatic representation of different steps in producing a flexographic rubber plate.
8. List out the security presses in India.

TE Questions

1. Why was flexography originally known as aniline printing?
2. What device scrapes the ink off the anilox roller?
3. Name the two main type of flexographic press configuration.
4. List out the major advantages and disadvantages of gravure printing process.
5. Name the two cylinder engraving method in gravure printing process.
6. A metal roll with engraved cell surface that carry ink to the plae cylinder in flexographic printing process is _____
7. Briefly explain about the major features in security printing.

Unit - 7

SCREEN PRINTING

Introduction

Of all the major printing processes, this porous printing process is undoubtedly the oldest, simplest and inexpensive. Modern screen printing developed in 1940's and 50's. Rapid technological advances continue to improve the process and lead to expanded market. In this unit we will discuss about this process in detail.

Learning Outcomes

The learner:

- understands the applications of screen printing
- demonstrates the screen printing process
- understands various types of screen frames and fabrics
- demonstrates the preparation of stencil for screen printing
- lists out the substrates for screen printing
- understands the automation in screen printing process
- understands the special applications of screen printing process

Screen printing is the porous printing process of forcing ink through a porous fabric and the open areas of a stencil to produce an image. Screen printing can be a very simple process, requiring only a few inexpensive tools and materials or it can be extremely complex, requiring an array of sophisticated equipment and production techniques.

Applications of Screen Printing

It can be done on a wide variety of materials including paper, metal, glass, wood etc. Images can be created using screen printing on clothing and printed circuit boards. Finished products are as diverse as a football jersey or a traffic sign.

The advantages of screen printing include:

- Images can be printed on a wide variety of substrates
- The production process is relatively easy
- Costs are low compared to other printing processes
- Images can be printed with glitter, flock, and other decorative finishes
- Screen printing can be done on substrate with any shape (flat, cylinder or irregular)

Disadvantages are:

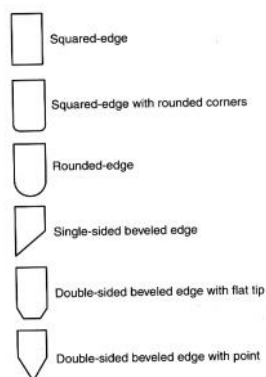
- Rate of production is slow
- Ink mileage is poor
- Details and fine-line images may be difficult to print

Screen Printing Process

First, porous fabric is stretched across the frame. Next, a stencil is adhered to the fabric, blocking out certain portions of the fabric and leaving open the desired image areas. Ink is poured on to the fabric and forced through the image areas using a rubber or plastic blade called a squeegee. The ink is deposited on a substrate below, producing an image of the cut stencil. Additional prints are made by repeating the squeegee action on new substrates.

Squeegees:- A handheld squeegee has a smooth wooden or aluminium handle and a rubber or polyurethane blade. Squeegee blades are rated by hardness, as determined by a shore durometer.

Different substrates require different blade edges. There are six squeegee blade shapes. The square-edge blade is used for flat surfaces and general-purpose printing. The squared-edge with rounded corners provide extra heavy ink deposits on flat substrates and is used when a light colour will be printed on a dark substrate. A rounded-edge blade is used primarily in textile printing where an extra-heavy ink film is required. Single beveled edge blades are used for printing on glass. The double beveled edge with flat point is used for printing on ceramics and the double beveled edged is used for printing on cylindrical objects such as bottles and containers.



Screen printing inks:- The type of ink depends upon the type of stencil being used, the substrate, and the intended product. The ink pigment and ink vehicle in screen printing must freely pass through screen fabric and create an image of acceptable density on the receiving surface. Screen inks are thinner than letterpress or lithographic inks but thicker than inks used in gravure.

Solvents:- Screen printing solvents are classified as thinners, retarders and washup solvents. Thinners are solvents added to inks to change the viscosity (thickness) of the ink. Retarders are solvents added to inks to thin the viscosity and slow the drying time. Washup solvents are used to remove ink from the screen.

Drying system:- Oven drying systems are used now instead of drying racks for faster drying times and an efficient use of floor space.

Screen frames and Fabrics

The screen frame serves several important functions. A frame:

- Provides a means of attaching fabric at the proper tension
- Provides rigidity and dimensional stability
- Resists mechanical stress and warpage

Resists chemical action and corrosion

Provides a means for register

Frame materials:- Materials used to manufacture screen frames include wood, metal alloy, steel and plastic. Wood and metal alloy are the most commonly used materials.

Wood frames:- Woodframes are constructed using screws, corrugated fasteners, dowels, and nails. Frames are continuously subject to mechanical and chemical stress and is in contact with water. Fasteners must be able to withstand the stress. Avoid metal fasteners which may cause rust and corrosion and loosen the joints.

Metal alloy frame:- Metal alloy frame provide greater rigidity and dimensional stability than wood frames. They are not susceptible to chemical attack from water but have poor resistance to acid and soda solutions.

Print size:- The maximum print size is determined by the inside dimension of a screen frame. Normally, the non-image areas should be twice the size of the image area. An ideal frame size is four times the image area.

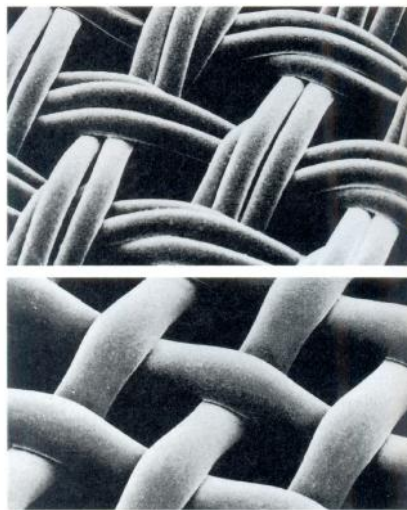
Classifying screen fabrics

Screen fabrics are classified according to filament, mesh count, strength and weave pattern.

Filament:- A filament is a single thread. It refers to the type of thread. A fabric may be either multi filament or mono filament. Multifilament means there are several strands of material per filament. Silk is an example for multi-filament strand. Multi-filament silk strands provide greater cross sectional area than monofilament strands and allow for the strong adhesion of any stencil. But silk is not dimensionally stable which means it changes shape and size with change in temperature and humidity. This makes it unsuitable for work requiring critical control of registration.

Monofilament means each filament is a single strand of filament or one thread. Nylon is an example for monofilament fabric. They provide better ink film thickness, uniformity and dimensional stability than multi-filaments. They have uniform weaves and pass pigments more easily through the mesh openings.

Mesh count:- Mesh count is the number of threads per linear inch in a fabric. The higher the mesh count, the better the reproduction of fine details. A high mesh count makes the



edges of the image smooth and sharp. As the mesh count increase, fabric strength and durability decrease.

Fabric strength:- It is directly related to the thread diameter. As the mesh count increase, thread diameter must decrease or no porous areas will exist.

Types of fabrics:- Three types of fabrics are used as screens- natural, synthetic, and metal mesh. Natural fabrics are always multi-filament. Synthetic fabrics may be either multi-filament or monofilament. Metal mesh is a monofilament. Typically it is stainless steel, but it can also be bronze, copper or brass. It is used for printing with heated inks on plastics.

Stencil preparation

Stencils can be classified into three groups: Hand cut, Tusche and glue and photographic stencils.

Hand cut stencils

Hand cut stencils are prepared by removing the printing image areas manually from some form of base or support material.

Tusche and glue stencils

It is an art process which involves drawing directly on the screen fabric with lithographic tusche (an oil based pigment) and then blocking out non-image areas with waterbased glue material.

Photographic stencils

They are generally produced by a thick, light sensitive, gelatin based emulsion that is exposed and developed either on supporting film or directly on the screen itself. Only hand cut and photographic stencils are used in commercial printing.

The primary advantage of photographic stencil is the possibility for complex and high quality line details. This method allowed the screen printers to enter the field of packaged product illustration. A colour image can be screen printed with nearly any ink on nearly any surface shape (flat, cylinder or irregular) with this process

All photographic stencil process are divided into 3 types:

Indirect, direct and direct-indirect

Indirect:- The indirect process uses a dry emulsion on a plastic support sheet. The stencil emulsion is sensitised by the manufacturer and is purchased by the printer in rolls. The stencil film is exposed through a transparent, right reading positive and is then treated with developer solution. The area that the light reaches (non-image area) harden during exposure. The remaining areas are washed away with a warm water spray to form the image area. The stencil is adhered to a clean screen while it is wet from the spray and support sheet removed after the stencil dries.

An indirect photographic stencil method involves six steps:

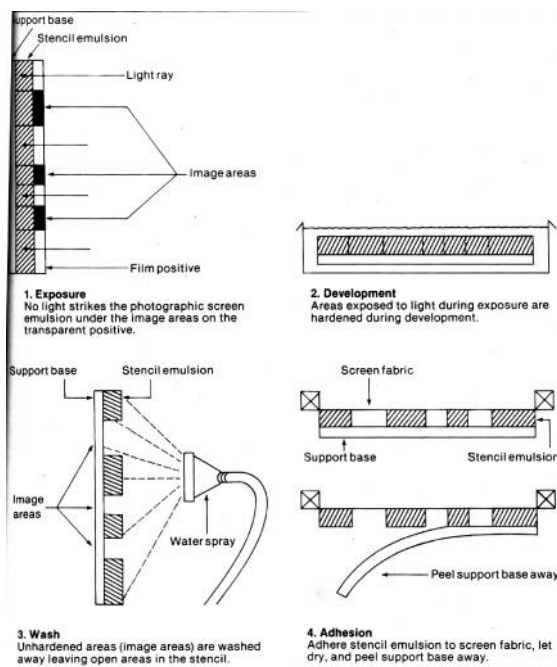
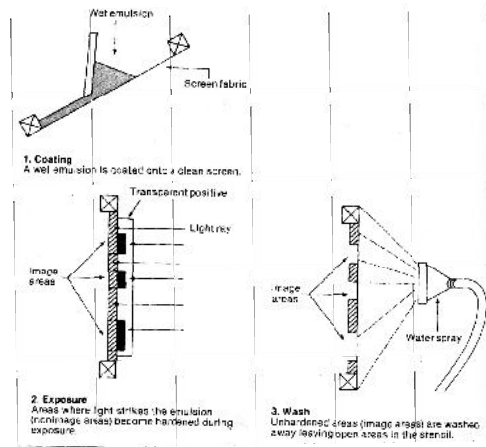
1. Exposure
2. Development
3. Washing
4. Application of stencil to the screen
5. Drying
6. Removal of the base material

Direct process:- It uses a wet emulsion that is coated directly on a screen. The emulsion is exposed through a transparent positive to harden the non-image areas. The image area is washed away with a warm water spray. When the emulsion is dry the stencil is ready to print.

Five steps in preparing the direct photographic stencil are :

1. Preparation of a sensitized emulsion
2. Application of the emulsion to the screen
3. Drying the emulsion
4. Exposure
5. Development

Direct/Indirect process:- This process combines the indirect and the direct photographic process. An unsensitized film material is placed under the stencil side of the screen on a flat table. The stencil emulsion is stored in two parts, a liquid emulsion and a sensitizer. When the two are mixed, and coated on the screen, they become light sensitive and coat through the



screen to the film support. When the emulsion is dry, the backing sheet of the stencil is removed and normal direct exposure technique is carried out.

Automation in screen printing

The basic problem with any hand operated hinged frame screen printing system is the small number of impressions that can be made per hour. Production is limited by how rapidly the printer can feed the stock, close the frame, position the squeegee, pull the impression, remove the squeegee and deliver the stock.

The development of high speed screen printing presses such as lever action hand-operated, semiautomatic and automatic units has made the screen printing process more easy and popular.

Special screen printing applications

Cylindrical screens:- They are used to print on long roll materials such as wall paper or bolt fabrics which require continuously repeating images.

Screen printing on cylindrical surfaces:- It is used to screen print on labels directly on cylindrical or conical containers such as bottles, cans, and drinking cups.

Carousal units:- It is a popular method of screening multi colour images on materials such as T-shirts. It is a wet-on-wet printing method on which printing of one colour is done directly over another without waiting the ink to dry.

Practical Activities

1. Stencil preparation using different photographic methods.
2. Prepare an invitation card using screen printing technique.
3. Identify basic shapes of squeegee blades available in your lab.
4. Identify the chemicals used in screen printing.

Assessment activities

1. Assignment on latest developments in screen printing.
2. Project work - single colour and two colour screen printing on various substrates.

TE Questions

1. What is the basic concept of screen printing?
2. What are the three type of stencil preparation method?
3. What is the primary advantage of photographic stencil?
4. What does the term wet on wet printing means?
5. What are the major types of fabrics used for stencil preparation in screen printing process?

MODULE 4

BINDING AND PACKAGING

Overview of Module 4

Once an image has been printed on a substrate, some form of binding and finishing is usually required. Binding is the process of joining together multiple pages of a printed product by various means including sewing, stapling, spiral wire and adhesives. Finishing includes various processes that enhance the final printed product. Some of the more common finishing operations include embossing, die-cutting, stamping, punching, drilling, round cornering, and padding. Laminating and coating are also considered as modern finishing operations. Packaging basically involves wrapping, strapping or boxing of various consumer products. In this module we go through various finishing operations, modern packaging operations and its application in our day to day life and also about the importance of safety, health and eco-printing. In this module we have a unit that deal with the basic engineering aspects of offset machines and a unit that gives introduction to basic engineering drawing for the students.

Unit - 1

SAFETY, HEALTH AND GREEN PRINTING

Introduction

Unsafe machines, work areas, and procedures are the cause of many accidents. Take time to inspect all equipments and work areas. When unsafe conditions exists, take immediate action to correct and eliminate them. Also manufacturers of printing supplies and equipment has to take the responsibility of developing new environmentally friendly technologies and materials. This unit acquaints the student with many issues and practices invloved in advancing safety, health and Green printing in the work place.

Learning Outcomes

- understands the Safety regulations related to printing industry.
- understands the importance of Safety guards in an offset machine.
- understands the safety measures for operating a cutting machine.
- chooses personal protective devices.
- classifies Fire & choose appropriate fire extinguishers.
- understands the importance of Green printing.

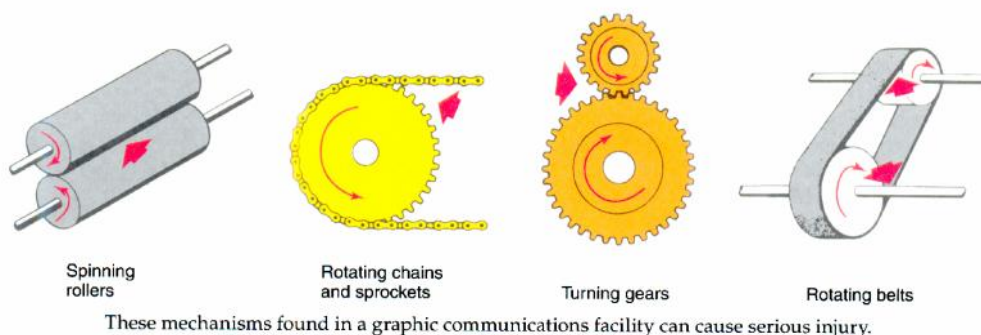
Safety and health are important considerations in the printing industry. This fact holds true for school graphic programs, training laboratories, small printing presses, and large printing firms. Many accidents are caused by carelessness and ignorance and can be prevented if all employees are well informed in preventive and protective safety measures.

Safety regulations

The five specified hazard areas in most printing presses are mechanical, chemical, noise, fire, and light. Careful adherence to regulations, good house keeping, and a healthy attitude towards safety can make the facility a safe and pleasant work space.

Mechanical hazards:- Many on-the-job physical injuries are the result of mechanical hazards that can be controlled if,

- machines are properly guarded
- energy isolating devices are locked out and tagged out during maintenance.
- workers properly use personal protective device.
- workers are trained to handle materials, tools and equipments safely.



Chemical hazards:- There are several types of chemicals or products that are toxic or hazardous. Chemicals can enter the body through the skin, by inhalation or by injection. Wear personal protective devices appropriate to the level of hazard. Organic solvents, platemaking chemicals, ink mist, gases and fumes are the different types of chemicals or agents that pose hazards to workers in the printing industry.

Noise hazards:- Unwanted and extensive loud noise is found in many industrial facilities. Excessive noise can lead to permanent hearing loss. Best way to protect against ear damage is to control the noise.

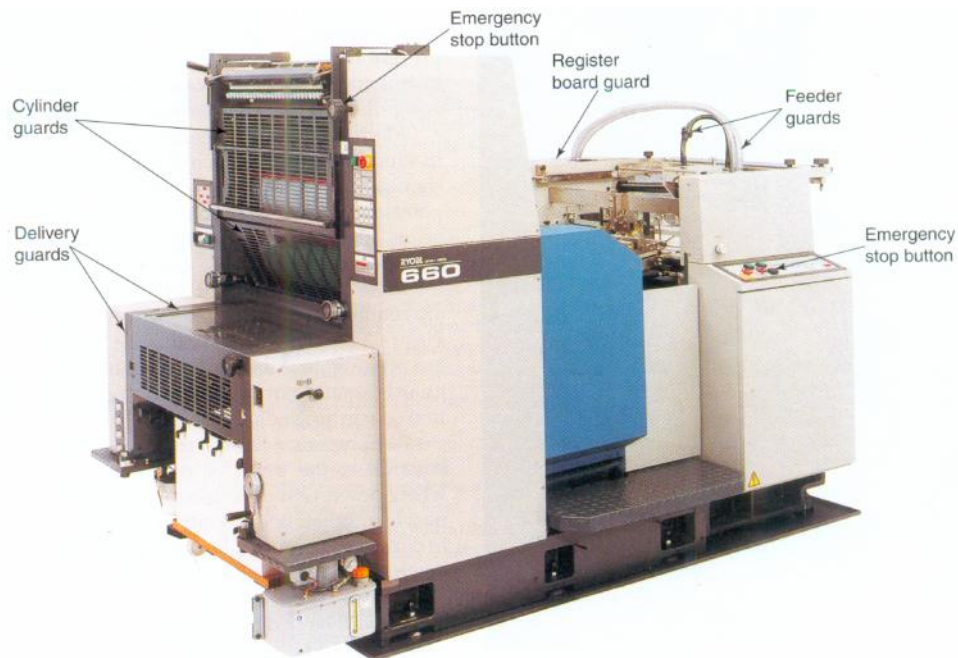
Fire hazards:- Printing involves flammable materials which create significant fire and explosion risks. Good housekeeping, preventive measures, and education are the key elements to fire protection plan. Provide Local Exhaust Ventilation (LEV) at printing units and adequate ventilation in work room to reduce the risk of fire. Also, provide fire detection and extinguishing systems.

Light hazards:- Light hazards include light sources that can cause damage to a person's skin or eye. Light sources commonly used in printing industry include UV radiation, infra-red light, laser beams, pulsed xenon lamps and mercury vapour lamps which are harmful to eyes and skin.

Safety guards in an offset machine

Machine guards:- Hazards are posed by reciprocating, rotating, and shearing actions of various type of machinery in the industry. Therefore, properly placed guards on mechanical equipment are very important for the operator's protection. Typical rotating mechanisms are spinning rollers, rotating chains and sprockets, turning gears, rotating belts, etc.

Most machines used in printing industry are equipped with some type of guarding. Emergency stop buttons, feeder guards, registration board guard, cylinder guards, delivery guards, machine guards, barrier guards are some among them.



Safety measures for operating a cutting machine

The bindery and finishing area has very powerful, high speed equipment. Some have sharp blades.

- Never place hands under a knife or clamp.
- Do not wear loose clothing while operating power machineries in binding area.
- Never bypass or rewire two-handed controls on paper cutting machine.
- Turn off the power when you are finished with paper cutting.
- Do not talk with others while operating the paper cutter.
- Make sure that only one person is near the paper cutter to prevent distraction.
- Do not test a blade for sharpness with your finger.

Personal protective devices

Personal protective devices include ear protection devices, eye protection devices, respiratory protection devices, skin protective devices

Ear plugs:- Ear plugs are utilised for protecting the workers from the adverse effects of loud noise produced by machines. Ear muffs give total protection and comfort to the wearer during work.



Eye protection devices include safety goggles, glasses, and face shields. Eye protectors should be worn when operating any type of machine that can cause material to fly and strike workers.

Respiratory protection devices include respirators and dust masks. Respiratory protection devices should be worn when air borne particles create respiratory hazards such as ink mist and chemical vapours



Skin protection devices include rubber, leather, or plastic gloves, aprons, and safety footwear and full safety suit. Skin protection devices should be worn when working with or cleaning up chemicals and solvents that can cause minor irritations or severe bodily damage.

Safety helmets are used in the industry for protection of head injuries during the operation and to prevent risk.

First aid kits

Everyone working in a printing industry should be trained in basic first aid. First aid should be visible and easily accessible and they should be checked and stocked at regular basis.

Fire classifications & Fire extinguishers

There are four general type of fires. Class A, Class B, Class C & Class D

Class A : Fire arising out of materials such as wood, paper, textiles, etc.

Soda acid and pressurized water are the type of fire extinguishers used for Class A fire. This type of extinguisher should not be used for Class B, Class C, and Class D.


















































Class B : Fire caused by flammable liquids such as grease, gasoline, oils, and paints.

Carbondioxide gas under pressure is the type of extinguisher used for Class B fire. It should not be used for Class A, Class C and Class D.

Class C : Fire caused by electrical equipment such as motors, switches, etc.

Dry chemicals and carbon dioxide gas are the most common fire extinguisher used for Class C fire. It should not be used for Class D.

Class D : Fire arising out of combustible metals such as magnesium and lithium. Granular type of dry chemical materials are used as fire extinguishers of Class D. It should not be used for Class A, Class B, and Class C.

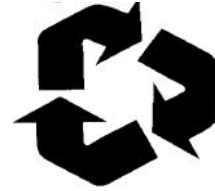
Fire Extinguishers and Fire Classifications									
Fires	Type	Use	Operation						
Class A Fires Ordinary Combustibles (Materials such as wood, paper, textiles.) <i>Requires...</i> cooling-quenching	Soda-acid Bicarbonate of soda solution and sulfuric acid 	Okay for use on  Not for use on   	Direct stream at base of flame.						
Class B Fires Flammable Liquids (Liquids such as grease, gasoline, oils, and paints.) <i>Requires...blanketing or smothering</i>	Pressurized Water Water under pressure 	Okay for use on  Not for use on   		Direct stream at base of flame.					
	Carbon Dioxide (CO₂) Carbon dioxide (CO ₂) gas under pressure 	Okay for use on   Not for use on  	Direct discharge as close to fire as possible, first at edge of flames and gradually forward and upward.						
Class C Fires Electrical Equipment (Motors, switches, and so forth.) <i>Requires...</i> a nonconducting agent	Foam Solution of aluminum sulfate and bicarbonate of soda 	Okay for use on   Not for use on  	Direct stream into the burning material or liquid. Allow foam to fall lightly on fire.						
Class D Fires Combustible Metals (Flammable metals such as magnesium and lithium.) <i>Requires...blanketing or smothering</i>	Dry Chemical 	<table><tr><td>Multi-purpose type</td><td>Ordinary BC type</td></tr><tr><td>Okay for   </td><td>Okay for  </td></tr><tr><td>Not okay for </td><td>Not okay for  </td></tr></table>		Multi-purpose type	Ordinary BC type	Okay for   	Okay for  	Not okay for 	Not okay for  
	Multi-purpose type	Ordinary BC type							
Okay for   	Okay for  								
Not okay for 	Not okay for  								
Dry Chemical Granular type material	Okay for use on  Not for use on   	Smother flames by scooping granular material from bucket onto burning metal.							

Green printing

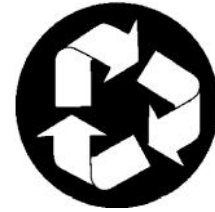
As a result of the growing concerns over environmental issues, the printing industry has become dedicated to becoming more green. Green printing instruct and help companies plan on how to reduce their environmental impact.

Recycled paper:- Current environmental concerns include a papers content of recycled fibre and the chemistry used in its bleaching. Recycled paper is produced from pulp made from recovered paper and paper products, manufacturing wastes, non paper materials, and wood residues.

Logos of recyclable and recycled paper:- Paper products carrying recycling logos are not necessarily made from recycled fibres. Dark chasing arrows indicate the paper is made from paper that has been recycled, and light chasing arrows indicates the paper is appropriate to be recycled.



Paper made with alternative chemicals:- The primary bleaching chemical for producing white paper is chlorine gas. It was discovered that the waste water from paper mills contained tiny amounts of dioxin which is harmful. Paper mills have sort out alternative methods of bleaching pulp because most dioxin is produced when the element chlorine is used as a bleaching agent.



Elemental chlorine-free (ECF) bleaching:- It is an alternative bleaching process that uses chlorine dioxide or sodium hypochlorite instead of chlorine gas as a bleaching agent.

Totally Chlorine Free (TCF) bleaching:- Any method of bleaching that uses no chlorine neither in its element state, nor as part of a compound such as chlorine dioxide or sodium hypo chlorite.

Oxygen delignification:- An approach to eliminating dioxin formation that allows chlorine bleaching. It uses oxygen to remove lignin from pulp in preparation for bleaching.

Acid free paper / Alkaline paper:- Paper that has pH above seven are classified as acid free papers. During production acid free paper is treated with an alkaline compound, usually calcium carbonate, to neutralize the acid and to bring the pH of paper to seven or slightly more.

Wood free paper:- is paper created exclusively from chemical pulp rather than mechanical pulp. Chemical pulp is normally made from pulp wood, but is not considered wood as most of the lignin is removed and seperated from the cellulose fibres during processing.

Vegetable inks (soy ink):- Vegetable oils have replaced mineral oils in ink manufacturing for environmental reasons. Petro chemical solvents and mineral oils emit environmental toxic Volatile Organic Compounds (VOC). Vegetable oil based inks have several technical benefits such as cleaner and sharper printing and brighter colour. Soy inks use oil extracts from soy bean as part of the vehicle. Soy oil is free of environmentally harmful substances. Therefore printing with soy ink result in less release of VOC within the press room.

Soft proofs:- Soft proofs are electronic files that represent what the final printed page will look like. Soft proofs are becoming more widely used than digital

proofs. Soft proofs reduce the use of paper in multiple rounds of checking proofs. They eliminate the use of ink and creation of any VOC's in the production of printing proofs. There is no transportation involved since soft proofs are sent over the internet.

Use of renewable energy resources in printing:- Regular printing uses vast amount of energy. In contrast eco-friendly printing mainly uses alternative energy sources such as sun, wind, and water power. This is in comparison to those energy sources which produce carbon dioxide emission that can easily damage the environment.

Practical Activities

1. Identify the different safety guards and safety button on the HMT offset printing machine in your lab.
2. Identify the possible circumstances of fire in your printing lab and take appropriate measures to prevent it.

Assessment Activities

1. Assignment: Prepare a presentation on different classes of fire that is likely to occur in an offset press.
2. Prepare a chart on different personal protective devices used in the printing industry.
3. Collect samples of recycled paper.
4. Prepare a chart showing various renewable energy resources in printing.

TE Questions

1. What are the five specified hazard areas in the printing industry?
2. What are the major protective devices used by printers?
3. What are the four general classes of fire and name the appropriate fire extinguishers for each class?
4. What are the major safety measures to be taken while operating a cutting machine?

Unit - 2

CONVENTIONAL BINDING

Introduction

The process of binding books remained a slow specialised craft until the 18th century. Modern book binding is mechanised for the most part. Decoration is simplified and the effect is retained on the overall appearance. Paper bags and threadless binding have suppressed the old fashion binding. New fabrics are available for case books.

Learning Outcomes

The learner:

- understands and define binding
- classifies different methods of binding
- understands the styles of binding
- lists the different steps involved in the binding process
- understands different covering and finishing operations

Definition of binding

Book binding is the hand or machine process of fastening together printed or plain sheets and enclosing them within a protective cover. It include gluing, stitching, sewing, stapling, or other mechanical means.

Classification of binding

Binding has been classified according to the use of the products and the types of binding.

They are mainly classified into letterpress binding and stationery binding.

Letterpress Binding

Letterpress binding is again classified as extra leather binding (also called extra letterpress binding), library binding, miscellaneous binding and publishers binding.

Extra leather binding

Extra leather binding is done as 'tight-back' without the help of machines. Usually leather or such type of materials are used for covering.

Library binding

Good quality materials are used for library binding. End papers are used and it is sewn by placing tapes. Half binding and Full binding is also done in library binding.

Miscellaneous binding

Usually periodicals come under this category. Calico, leather, etc is not used in this type of binding. Attractive covers are used.

Publishers Binding

It is done with the help of machines. Book and cover are separately made and the book is inserted in the cover. It is known as case binding.

Stationery binding

The process of binding the writing materials is called stationery binding. Account books, ledgers, day books, registers, diaries, bill books, cheque books, receipt books, blank proformas, and exercise notebooks are examples for stationery binding.

Stationery binding is again classified into four as account book binding, manifold binding, general and office stationery binding and exercise note book binding.

Account Book Binding

It is done manually without the help of machines. Sewing is done by placing tape. Half leather or full leather binding is done. It is also known as ledger binding.

Manifold Binding

This type of binding is carried out for receipt books, bill books, cheque books etc in cheap cost with the help of machines. It will have numbering and Perforation.

General and Office Stationery binding

It include binding of office stationery like file boards, file books, writing boards, letter pads etc.

Exercise Notebook binding

It is the binding of books in cheap rate for the use of students with or without the help of machines.

Styles of binding**Paper back cut flush binding**

Most of the exercise books are bound in this style. Thick paper is covered on the notebook or registers. All the three edges are trimmed along with the cover. This process of trimming is called flush-cut.

Board covered Cut Flush Binding

Trimming the folded and sewn sheets after putting the suitable paper board cover is cut flush binding. These types of books will not have the projection of covers at its ends.

Quarter bound cut flush

Account books and small size ledger books are covered with thick boards. Its case is prepared separately using leather or rexine on the back edge of the book. About quarter part of both sides of the book along with the spine, is covered with covering material. The edges of the board are made similar to the size of the book.

Quarter Cloth Turned in

In this type of binding after cutting the edges of the book the covering material is folded inwards to hide the edges of the board. It will not have the projected cover boards.

Full bound

When the covering material is fully covered on both sides of the board using a single material like leather or calico is called full bound book. The full covering of the book ensures long life to the book. It also makes it attractive.

Half Bound

When the covering materials like leather or calico is covered one fourth part on the back side including spine and corners of the book is called half bound book. Sheet of paper is pasted in the uncovered part of the board and 3mm overlapped on the corners and back of the covering material.

Quarter Bound

When the covering material like leather or calico is covered about one fourth part of the width of the book on the back side including spine is called quarter bound book. Fore edge, tail and head of the paper is turned inside the board about 3mm.

Materials for book binding

The important materials used in stationery book binding are paper, board, binding cloth, leather, tape, paste, gum, animal glues, synthetic adhesives, threads, and egg albumin.

Boards

Boards used for covering the books are available in 78 X 102 cm size, which can be cut into various sizes according to the size of the book. Straw board, mill board, pulp board, duplex board, and index board are various qualities of boards. Mostly straw boards and mill boards are used for binding of books.

Adhesives used in binding

Adhesives are sticky materials which join any two surfaces. Various types of adhesives used in book binding are vegetable adhesives, animal glues, synthetic adhesives or hot metal adhesives.

Vegetable adhesives are of two types - paste and gum.

Paste:- It is very cheap but best adhesive used in various operations of stationery binding. It is prepared by fine wheat flour (maida). Water, alum, and formaldehyde is mixed with the flour and the paste is prepared by boiling it. Copper sulphate is also mixed as a preventive for rats, insects and fungus.

Gum: It is also a vegetable material obtained from Accasia trees. Gum is mostly used in packaging book binding, envelopes, stickers, stamps, and labels.

Animal glue: It is prepared from the bones, skins and other parts of animals.

Synthetic glue: They are ready to use adhesives which are available in tubes and containers. They are made from poly vinyl acetate in liquid form. These adhesives are used in adhesive binding, foil, lamination, back lining and cartons.

Hot metal adhesives:- They are made from resins, waxes and polymers in solid state. They are used in highspeed machines.

Steps in Binding

Various steps in binding includes warehousing, forwarding, covering, and finishing.

Warehousing

Operations such as counting of sheets, examining and rejecting of bad sheets, folding, gathering, collating, sewing and stitching are done here.

Counting: Press sheets when received would be counted and compared with the work order features. Wrongly backed sheets, sheets with smears, setoff, smudges, tone sheets, sheets out of register, etc are to be rejected.

Jogging: This is piling the sheets into neatly laid edges, expelling air and avoiding bulking. Jogging is done before the sheets leave the machine room.

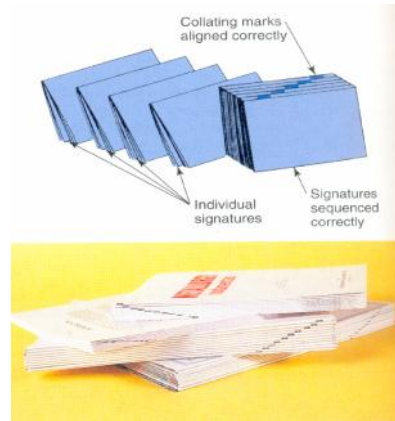
Pressing: Without pressing the sheets will not be solid and the book cannot be compact.

Folding: Folding can be done either by hand or on a machine. The person who is folding should understand the imposition and the number of folds as well as the direction of the fold. A bone or wooden stick used to strike down the sheets in hand folding is called a folder.

Signatures are small figure or letter printed on the first page of every form in case of a half sheet work and first and third page of every full sheet work to signify the number of the form.

Gathering: This is the next operation after folding. Gathering is the process of assembling signatures by placing one next to the other. It is commonly used to prepare books whose page thickness will be greater than one centimetre.

Collating: Examining the gathered sections and rectifying any omissions, wrong placing or duplication of sections is called collating. Collating marks are marks made at the back edge of the folded sections during the printing process of the forum. Books with large number of pages should have collating marks in the continuous steps. If the collating marks are in uneven step, it means the gathering of sections are not correct.



Sewing and Stitching : The process of joining of all the gathered sections of a book using a thin wire or thread is called sewing. The wire sewing is called stitching and sewing with thread is called thread sewing.

Wire stitching

Wire stitching is done by two processes a) Saddle stitching and b) side stitching.

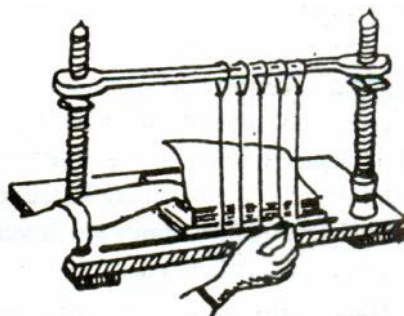
- (a) A method in which metal wire is forced through the folded edges of a signature and formed into staples to hold the pages together is called saddle stitching.
- (b) A form of stapling in which metal wire is forced through the sides of the sheet and formed into staples to hold sheets together is called side stitching.

Thread sewing

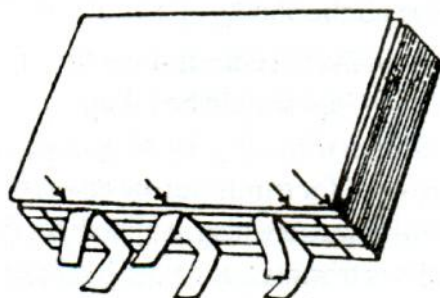
Thread sewing is the process used to bind thin and thick books with thread. All the sections of book are sewen with a thread using a long steel needle. Linen thread is used for book sewing. The needle along with the thread is inserted into all the sections one by one and the sections are joined together. Overcast sewing, cord sewing (sawn-in-sewing), tape sewing (library sewing), flexible sewing, and double flexible sewing are different types of thread sewing.

Overcast sewing : Generally old books are sewen by this process. Holes are made on two or three places at the back edge of the book leaving about half to one centimetre. Needle is inserted in all the holes along with the thread one by one. The thread is tightened and a knot is made in the last.

Cord sewing (Sawn-in-sewing) : It is done for thick and high quality books. Two or three thick cotton cords are placed on the spine of the book. Grooves are then cut in the spine of the book to accommodate the thickness of the cords. Threads are covered over the cords during the sewing process.



Tape sewing (library sewing) : In this sewing four strong tapes are placed in the spine of the book. The tapes are covered with threads during the sewing process of sections of the book. Tape sewing makes the book more durable.



The tapes should be kept flat. The needles with the thread proceeds outside the tape without encircling it. Tape sewing is similar to cord sewing, but it is more easier. It is not necessary to pull the threads tight for every tape.

Flexible sewing:- In flexible sewing no saw cuts are made at the back. The sections are sewn one by one on the stout cords that ultimately form the raised bands across the back. A leather band is pasted directly on the back. With the threaded needle in the right hand it is pushed through the inside of the section at the head of kettle stitch mark and with the left hand it is returned again to the outside at the far side of the first cord and passes again through the inside and sewn round encircling the cords similarly, until knot is made at the kettle stitch mark. This process is repeated at the rest of the sections. The knot made at the kettle stitch mark is known as kettle stitch, chain stitch or catch up stitch.

Double flexible sewing:- In double flexible sewing two cords are used and the threads encircles each of the cords.

Forwarding

Forwarding includes all operations after sewing upto covering. There are two broad kinds of forwarding, namely inboard forwarding, in which the board is attached and then the edges are cut and outboard forwarding, in which the edges are cut first and then boards are attached. Different steps in forwarding includes attaching end papers, fraying the slips, hammering, gluing the back, rounding, backing, attaching the board, cleaning the glue in the back.

End Papers

The papers which are pasted or sewn on both sides of a book are called end papers. These two inside sheets hold the cover to the body of the book. End papers may be made thicker than the papers of the book. The cover of the book becomes more durable due to end papers. Various types of end paper are single end paper, double end paper, made end paper, cloth joint end paper, zig zag end paper, self end paper, etc.

Single end paper: This end paper is very simple and used in paper back cover books. Two leaves are made for this end paper, one leaf is pasted with the cover and other becomes open with the book.

Double end paper: This is also called inserted end paper. Two sheets of paper are folded, inserted with each other and tipped at the back edge. The first is cut leaving about half inch and second sheet is pasted with the cover. The third and fourth sheets are fly leaves and are attached to the book. This end paper is used in thicker and more durable books.

Made end paper: The made end paper has two fly leaves and one made end leaf. It is more durable than double end paper. This end paper is mostly used for leather bound books. Three folded sheets or six open sheets are used to prepare one made end paper. The first is waste sheet, second and third are pasted with each other. Fourth sheet is tipping sheet. Fifth and sixth sheets are fly leaf and remains open towards the book.

Cloth joint end paper: This end paper is used with thick and large size books. A strip of linen or cloth is pasted with the back of this end paper. The cloth joint end paper has one waste sheet, two paste down sheets, one stiff leaf, and two fly leaf. This end paper is sewn with the book as first and last section.

Zig-zag end paper: This is very strong and durable end paper. The zig-zag design of this end paper prevents the extra drag of the cover with the book. It has also six sheets to make the end paper. The back of two sheets is made in zig-zag design. Another two folded sheets are set into the zig-zag part. The first sheet is waste sheet, two and three are stiff sheets, fourth is tipping sheet. Fifth and sixth are fly leaf. Marble sheets are also used in this end paper.

Self end paper: Generally self end papers are used in exercise books. The first and last sheet of the book is pasted with the cover. It does not have durability, with the book and its cover.

Glueing

Rubbing thin glue into the back of the sewn sections is known as glueing. The final shape of the book depends upon this operation. knock the head and back squarely maintaining proper level. Confine the glue to the back sections without

getting on the cords or tapes. It is convenient to place the book between two pieces of waste board and the slips being tucked away between them.

Rounding

By rounding the swelling in the back of the book is reduced. Rounding gives the familiar round shape to the back, convex at the back and concave at the foreedge. After some use the back of the book may sink in, but rounding prevents this.

Backing

Backing is carried out only for letterpress binding. For account books, spring back is adopted and only rounding is done. The objective of backing is to bind the sections together independent of sewing, to form a slight fold down the back for ease in opening the book flat; to form a groove or joint to attach the board to the book.

Trimming the edges

The last operation is to trim the head, tail, and foreedge of the book. Adhesive bound or perfect bound books are ready for use after the above operations are completed.

Edge decoration

It is the method of decorating the edges by different methods. Edges are decorated for improving the appearance of the book and for preventing the edges from getting dirt.

Colouring, sprinkling, gilding, painting, gaufering, and marbling are different edge decoration methods.

Colouring: This is the simplest method of edge decoration. The book is kept under a weight board, water colour is applied with a brush evenly through the edges.

Sprinkling: Different colours are sprinkled or sprayed to the edges with a brush or with a sprayer.

Gilding: Gilding is the method of producing solid gilt edges instead of solid cut edges.

Painting: Painting is done only at the foreedge since the leaves are frayed out or fanned out for painting the picture.

Gaufering: After gilding, solid gilt edges are cut into different patterns (like flowers, leaves, etc.) harmonizing with finishing the works on the cover. This is done with small hot tools.

Marbling: It is a colouring process used for decorating the edges of heavy account books. Thick and smooth paper should be used for marbling. It is usually done after cutting the edges or before rounding.

Covering and Finishing

Covering

The covering operation is done in the last of the book binding process. Cover of the book contains the name of the book, author, and publisher. It is made attractive by printing in multicolours. Cheap edition and general textbooks are covered with thick printed card sheets. High quality books are covered with boards. There are two types of covering process namely Paper back edition and Board cover edition also called hard bound book.

Paper back edition:- In paper back edition, the book is covered with a thick card or paper. The centre part of the book cover is creased according to the thickness of the book. Paste is applied on the spine of the book and in the centre part of the cover. The spine of the book is placed on the cover and fixed with the book. Then paste is applied to both sides of the end papers and pasted with the cover of the book. When it is dry, the edges are trimmed in the last.

Board cover edition (Hard bound books):- Books that need long life are covered with boards. Board covering process is divided into the following processes:

- 1) Preparation of the cover: The cover of the book is prepared separately. Two pieces of boards for each book are cut 5 mm larger in the length and same size in the width of the book. The covering material of the boards is also cut 15 mm larger in the length, and width plus spine of the book. A thin layer of paste is applied on the rough side of the covering material. Both pieces of the board are placed on it and pasted with turning in, the excess part of the covering material. A thick strip of paper is pasted on the covering material left for the spine of the book.
- 2) Preparation of the book: First the book is trimmed at the head, tail, and fore edge of the book. Thin liquid glue is applied on the spine. Rounding and backing operations are done for the spine of the book. A strip of cloth is pasted on the spine with overlapping about one inch on both sides of the book. Headbands are fixed on both sides of the spine.
- 3) Setting cover of the book: The spine of the book is placed in the centre of the prepared cover. Paste is applied on both sides of the end paper and pasted on the board of the cover. Paste is also applied in the spine for tight back book. For hollow back book, a strip of paper is pasted on the spine of the book and the spine remains unpasted with the cover.

Finishing

All the work that is done in binding after forwarding is called finishing. Preparing the leather for tooling, designing, decoration of the cover, tooling

the design and title on the cover, polishing the leather sides and back of the book are included in this process.

Tools made of brass used for impressing on surfaces of leather or cloth are called finishing tools.

Practical Activities

1. Letterpress binding
2. Stationery binding.
3. Different types of sewing
 - a) Cord sewing (Sawn-in-sewing)
 - b) Tape sewing
 - c) Overcast sewing
 - d) Flexible and double flexible sewing
4. Case binding
5. Gum preparation for binding
6. End paper making
7. Backing, rounding and edge decoration of books.

Assessment activities

1. Prepare a Notebook using flexible sewing method.
2. Prepare an Account book using cord sewing method in half cloth style binding.
3. Prepare a file board and a writing board.
4. Prepare a Notepad in A5 size with paper back cover.
5. Prepare a chart showing different types of end papers.

TE Questions

1. Define book binding.
2. What are the main classifications of binding?
3. What is an end paper? Write notes of different types of end papers.
4. What are the various materials used in book binding?
5. Explain briefly about different types of adhesives used in book binding.
6. Describe the various covering processes in book binding.
7. Explain briefly about the different types of sewing processes you have studied.
8. What are collating marks?

Unit - 3

MODERN FINISHING OPERATIONS

Introduction

After printing the product needs further operations to be finished. The two most common types of classifications are finishing and binding. In the previous unit we have learnt about the binding operations. In this unit, we study about all other operations that enhance the appearance of the printed product.

Learning Outcomes

The learner:

- understands and demonstrate the operation of a paper cutting machine.
- categorises folding operations.
- understands other finishing operations.
- lists out various methods of binding.

Finishing

Finishing is the term used to describe all operations performed on a printed material which include cutting, folding, slitting, perforation, scoring, die cutting, embossing, foil stamping, numbering, laminating, drilling, varnishing etc. One or more finishing operations are done on many jobs. The equipment used to perform these operations may either be automatic or semi-automatic.

Cutting

Making a large sheet of paper into several smaller sheets is termed cutting. Paper cutting can be of either inline or offline. Inline cutting are commonly performed in web-offset presses. As the web moves out of the printing unit it will be cut into sheets of desired length.

Offline cutting is performed in sheet fed presses. Sheets are cut to size so that it can be fed into presses or the printed sheets can be cut to produce finished products such as business cards.

Trimming is the process of cutting uneven edges of the paper. It is performed in booklets, magazines or other publications.

Cutting and trimming are done by equipment such as guillotine cutters (single knife cutters) and three knife cutters

Guillotine cutter

It is a device equipped with a single blade to trim or cut a pile of paper to finished size.

The most basic guillotine cutters consist of the following parts:

Bed:- It is the flat, smooth and level surface on which the paper pile sits on a cutting machine. Modern automatic cutters are equipped with air table with a number of small holes through which air passes to help the operator to slide the paper easily.

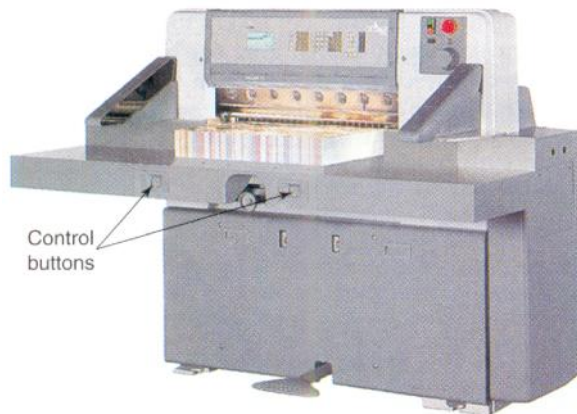
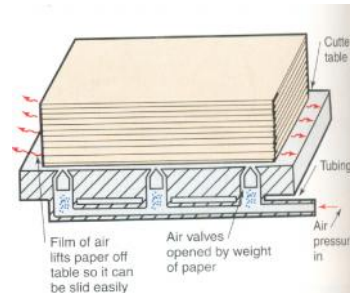
Side Guide:- It is a wall on the left side of the bed against which the left side of the paper pile is aligned.

Movable Back guide:- It is a guide on the cutting device used to hold a stack of paper and to position it in the desired position on the bed.

Clamp:- It is a metal device that moves downwards against the paper pile to hold the paper pile with force while it is being cut.

Knife:- It is a razor-sharp metal cutting blade made of steel or steel-carbide and is mounted to a bar located near the front of the machine just in front of the clamp.

Cutting Stick:- It is a plastic or wooden piece located directly below the cutting blade beneath the table to protect the blade when it touches the table after cutting the paper pile.



Three-Knife cutters

It is a paper cutting device with three blades; two parallel knives and a right angled knife to trim the three sides of printed publications such as magazines. All the three knives do not cut together. First the two parallel knives cut together and then the right angled knife cuts individually. Three knife trimmers can be stand-alone unit or part of collating, folding and binding system.

Folding operations

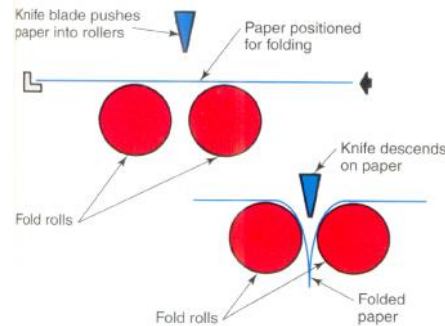
It is another method of finishing operation. Most printed materials require some type of folding which is done on a folding machine. There are two basic type of folds- Parallel fold and right angle fold. Parallel fold is made parallel to the previous fold whereas a right angle fold is made at right angle to the

preceding fold by changing the direction of the sheet 90° before the second fold is made.

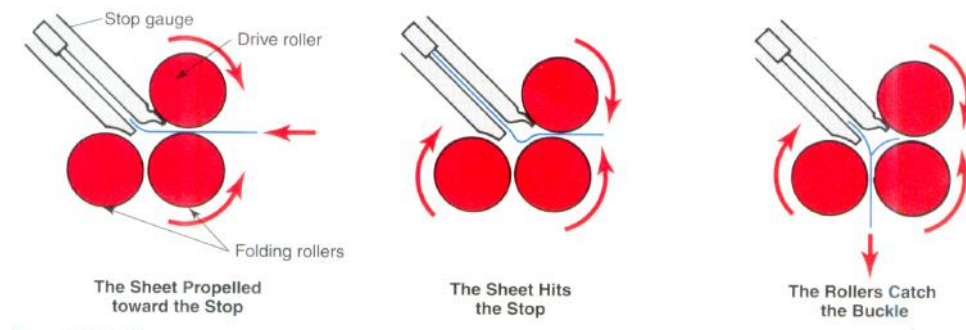
Other type of folds include letter fold, accordion fold, French fold, barrel fold, gate fold and short fold.

Types of folders: There are two type of folding equipments - Knife folder and buckle folder. Some equipments use a combination of these two configurations.

Knife folder: It is a folding device that use a metal blade to force a sheet through a set of folding rollers to create a fold. Fold rollers are metal rolls that transport a sheet through a folder. The paper is fed into the folding unit with moving tapes or belt. Side guide keeps the paper aligned and fold guides stop the paper in position above the nip of a fold roller. Then the knife is lowered and it pushes the paper into the rotating fold rollers that crease the sheet. If additional folds are required, one or more folding units are added and folded sheets are added to them automatically. Knife folders are more accurate in producing right-angle fold. Heavier-weight papers perform well on knife folders.



Buckle Folders: It is folding device that use a fold plate to force a sheet to buckles so the sheet can be pulled through a set of folding rollers. The buckle folder uses tapes or belts to carry a sheet of paper. The sheet is carried towards a fold plate consisting of two metal plates positioned at a slight incline above the drive and the fold rollers. The drive feeds the sheet into the fold plate and continues to move the sheet after it hits the stop gauge at the top of the fold plate assembly. The sheet buckles downwards, and the fold rollers catch them in a predetermined spot. The rollers grab the sheet at the buckle, pull the sheet



down and create a fold. The location of the fold can be adjusted by moving the fold guide slightly. Light weight papers fold better on buckle folders.

Other finishing operations

Punching

Punching is an operation in which rectangular or specially shaped holes are cut in paper by forcing a metal rod through the paper to remove the stock. Punching is used for such applications as producing holes needed to do spiral binding. Automatic punching machines are used for this.

Drilling, Slotting and Cornering

Drilling is a piercing operation that uses a revolving hollow drill bit with very sharp edges to produce round holes in the paper. Drills are available in various diameters. This operation is performed by a machine called paper drill.

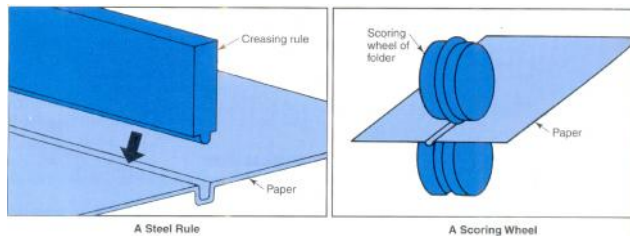
Slotting is a method of making holes on paper for binding that are not round.

Round cornering is a rounding operation performed on the corners of paper.

Slotting and rounding operations are also done by a paper drilling machine.

Scoring

Compressing a line across a heavy sheet of paper to improve the sheets ability to fold on that line is called scoring or creasing. Scoring is performed by pressing a steel rule against a paper or by sending the sheets under scoring wheel.



Following points should be observed when scoring a paper

- For thicker paper, thicker scoring should be given.
- Scoring wheels are not effective as steel rules.
- Scoring wheels should be used with extreme care on coated paper.

Slitting

Slitting is the process of cutting printed sheets or web into two or more sections by means of a cutting wheel on a printing or folding machine. It is used to separate two or more products from a large sheet.

Die cutting

It is a finishing operation that uses a sharp steel rule or knife to cut a specific pattern into a substrate or to cut a substrate into a specific pattern. Irregular shapes or designs that cannot be cut with a straight cut is done by this process.

In die cutting process pressure is used to force a sharp metal die through the stock.

A die has a metal cutting edge that matches the outline shape of the design used. A die used in the process consist of a base, called die board, with steel rules shaped and inserted in a saw kerf. The saw kerf is the open area left after sawing the base material. Pieces of sponge rubber are glued to the die board on either side of the rules to release substrate material after cutting.

Die cutting presses are similar to letterpress printing presses. Sometimes letterpresses are used for die cutting. Example for die-cut products include boxes, cartons, tags, labels, cards, children's pop-up books, etc.

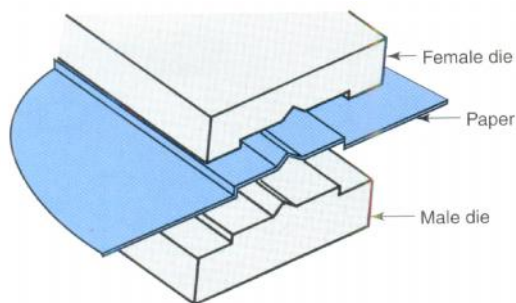
Foil Stamping

It is a letterpress process that transfers a thin layer of metallic tone or colour to a substrate using heat and pressure.

In foil stamping process a heated die containing the relief image presses down on a roll of foil passing between the product to be stamped and the heated die. The relief image presses against the foil and the combination of heat and pressure transfers the metallic coating on the foil film to the substrate. The film or foil used for foil stamping is very thin and made entirely of metal or a tissue like material coated with metal. In most case the metals used to create silver and gold appearance are aluminium and brass. Hand operated to web rotary presses are used for foil stamping.

Embossing

The processes that create a three dimensional raised image on a substrate by pressing it between two dies is called embossing. Embossing is done by a male die and a female die. One die is relief (male die), while the other is recessed (female die). When they are brought together with the stock between them, the clamping force creates a raised image on the stock. Normally the image is printed and the stock is then embossed. Sometimes ink is not used and the stock itself creates the raised image after embossing. This technique is called *blind embossing*. If an image is sunken into the substrate using embossing processing, it is called *debossing*. The dies are three dimensional moulds that press their image into the paper under great pressure to make the raised design.

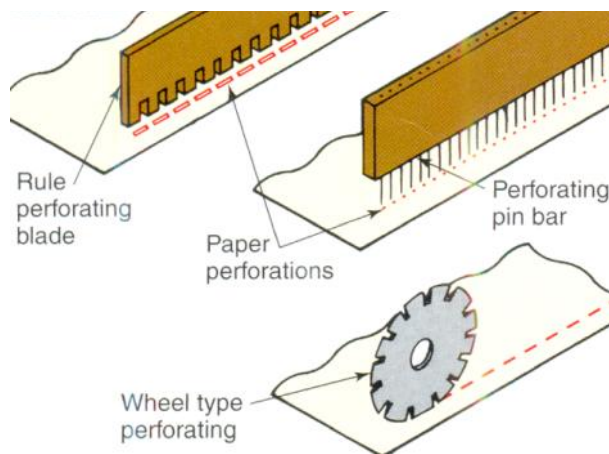


Numbering

The process of imprinting tickets, cheques, certificates, or other items with consecutive figures numbers and letters is called numbering. Using a device called numbering machine, the figures are transferred from an inked relief image onto the stock. Often numbering is set to start from the maximum amount and run in the reverse order, so the last figure printed will be 1. This prevents an over run and places the tickets, forms or other numbered material in correct order.

Perforation

Perforation is an operation that places a series of small cuts or slits in the substrates using various types of blades or wheels on the press or folder. Whenever it is necessary to remove a portion of printed material, the sheet is perforated. This makes it possible to readily tear off and remove a reply card on an advertising circular or a page from a book.



Varnishing

Varnishing is a process that places a coating, or surface finish, on printed sheets to impart resistance to chemicals, heat, water and other elements that would otherwise damage the paper. Varnish can be applied over an entire press sheet or on selective areas as a clear ink. An image printed in a dull varnish over a gloss sheet is visible, due to the difference in reflection. A water based clear and fast drying material called aqueous coating is replacing other types of varnishes. Aqueous coating is available in both matte and gloss finishes.

Lamination

It is a process in which a thin film of plastic with an adhesive coating is bonded to a printed substrate to provide protection against abrasion and moisture. A common application of lamination is on restaurant menu cards which must be protected from moisture and constant handling.

Liquid lamination is a coating method similar to varnishing. The plastic material is applied in liquid form and then cured into a tough protective layer by exposure to uv-light. For this reason it is sometimes called *UV-cured coating*.

Thermography

Thermography is a process of producing raised printing through the application of powder and heat.

Several steps are required to produce thermographic effect. First a fine resin powder is sprinkled on a freshly printed sheet. Second, the excess powder is removed from the non inked area. Third the powder remaining on the wet image area is heated. The heat melts the powder and creates a raised effect when the powder cools. Clear powders allow the colour of the base ink to show through, whereas opaque powder colours have complete hiding power. Thermography can be used on illustrations, halftones and type. Type smaller than six point in size and letters with delicate serifs should be avoided because they both tend to fill in.

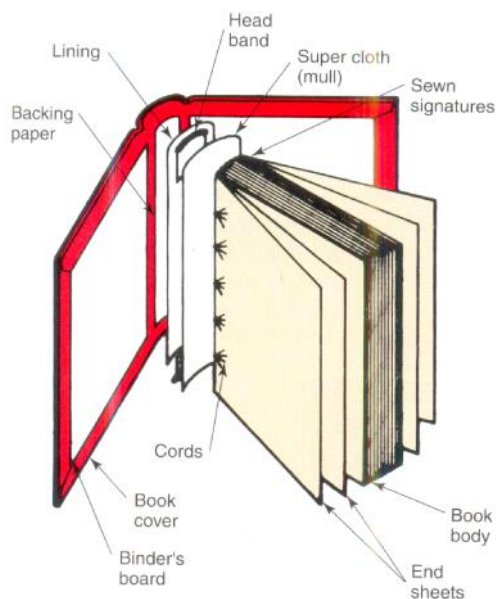
Binding

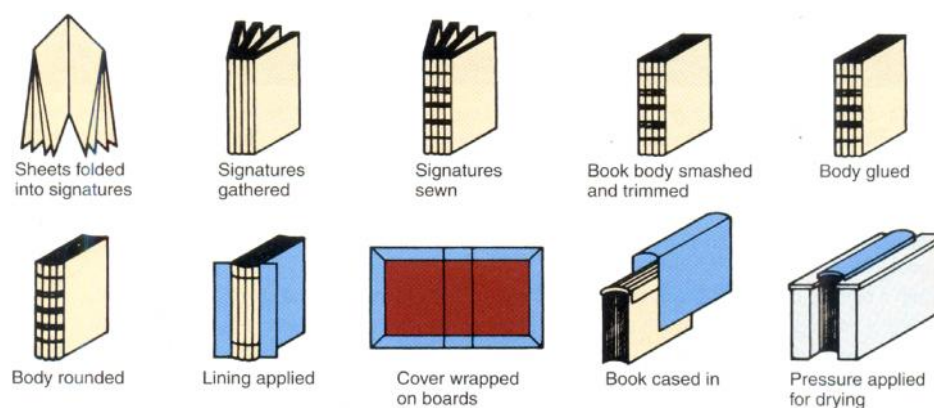
Pamphlet binding : Most of today's magazines, catalogues, and booklets fall into the pamphlet binding category. One of the simplest techniques is saddle wire stitching. Sheets are folded, gathered, and stitched through the centre, or saddle, of the folded sheets.

Many booklets and magazines are fastened by this method. The folded sheets are placed one over the other and then placed on the saddle of the stitcher. The maximum number of pages is regulated by the limit of the stitcher and/or pamphlet thickness allowing the booklet or magazine to lie flat.

When larger publications are bound, the machine is capable of gathering the signatures and cover. They are then stitched and trimmed.

Edition binding : Also called case binding, is considered the most durable and permanent method of binding books that will be used extensively over a period of time, such as text books and reference books. The parts of an edition-bound book are backing paper, lining, head band, supercloth (mull), sewn signatures, book body, end sheets, cords, book cover, and binders board. The binding process involves gathering and sewing the signatures together, then compressing the signatures, and trimming the edges.





The book body is then glued, the spine rounded, and lining applied. The book cover is manufactured separately by wrapping and gluing a printed cover on binder's board. It is then attached to the body with an adhesive in a process called casing in. The bound book is then clamped in a fixture until the adhesive dries.

Perfect binding : The perfect binding process, used for producing books that are usually described as softcover or paperback, is a fast and relatively low-cost method. Since it eliminates the need for sewing and constructing a hard cover, it is more economical than edition binding. Perfect binding is not as long-lasting or rugged as edition binding. For this reason, it is often selected for products that will have a limited lifespan, such as telephone directories, magazines, and some books for children. Its low cost has made it popular for mass-market novels and other books where price is a competitive factor.

In this process, either signatures or single sheets can be gathered or collated to form the book body. The binding equipment then grinds or saws the binding edge of the book body to roughen the surface, and a flexible glue is applied. The cover is then placed on the body and clamped until the glue sets. The book is then trimmed.

Mechanical binding : It consists of a number of methods that employ a mechanical device (metal spring, plastic fastener, etc.) to hold sheets together in loose-leaf form. Two of the methods usually used are plastic comb binding and spiral binding.

Plastic comb binding:- It is commonly used for booklets that might have to be altered by adding or removing pages. Books bound with this method permit the pages to lay perfectly flat when open.

This method involves using a special machine, to punch rectangular holes along one edge of the printed material. After the sheets are punched, they are positioned over the spread or expanded plastic teeth of the fastener. When released, the plastic teeth are extended to the punched holes to bind the publications. The same machine can be used to open the comb teeth so pages can be removed or added.

Spiral binding:- It is similar to the plastic comb method, but does not allow opening the binding for the addition or removal of pages. In this method, smaller round holes are punched, then the wire is spiral fed through the booklet using an automatic equipment. The method is used for many types of products from small pocket notebooks to calendars, to books an inch or more in thickness. Several variations of the spiral method are used, but all follow the same principle.

Like most mechanical bindings, the spiral wire method allows a book to be opened flat and remain that way. The spiral binding allows for the tearing out of a page but not the insertion of sheets.

Practical Activities

1. Perforation
2. Numbering
3. Spiral binding
4. Plastic comb binding
5. Case binding
6. Wire stitching

Assessment activities

1. Collect samples of printed products processed with
 - a) embossing
 - b) die cutting
 - c) foil stamping
 - d) lamination
 - e) numbering
 - f) slitting
- 2) Identify male and female dies used for embossing
- 3) Distinguish between creasing rule and cutting rule.

TE Questions

1. What are the two types of folders you have studied? Explain.
2. What is the difference between a guillotine cutter and a three knife cutter.
3. What is an air table in a cutting machine?
4. Draw a neatly labelled diagram showing the parts of a cutting machine.
5. Explain the process of lamination.
6. Explain the perfect binding process.
7. What is embossing? How is embossing done?
8. Explain the process of case binding.
9. Identify the different parts of an edition bound book.
10. What is the difference between film lamination and liquid lamination.

Unit - 4

PACKAGING

Introduction

Packaging is a branch of printing industry which includes the production of hand made card boxes, machine made cartons manufacturing or flexible bags and craft paper bags, polythene and plastic bags, collapsible tubes for tooth pastes and balms, tin containers for powders and similar materials. The main purpose of packaging is protection of the contents. Packaging plays an important role in advertising. Packaging basically involves wrapping, strapping, or boxing of different products for delivery to the customer. This is highly specialised branch of printing profession which requires special equipments and highly skilled technicians. In this unit, you'll learn about the functions of packaging, different materials used in the packaging industry, different types of cartons, packaging dies and the scope of packaging industry.

Learning Outcomes

The learner:

- understands and defines the importance of packaging
- understands the fundamentals of packaging design
- lists out the different materials used in the packaging industry
- classifies cartons based on its style and construct a packaging die

Functions of packaging

Packaging is the technology of enclosing or protecting products for distribution, storage, sale, and use. Packaging also refers to the process of designing, evaluating, and producing packages. It is a coordinated system of preparing goods for transport, warehousing, logistics, sale, and end use. Most products have some form of packaging.

Package may be defined as 'all products made of any materials of any nature to be used for the containment, protection, handling, delivery and preservation of goods from the producer to the user or consumer'.

Major functions of packaging are:

- 1) *To protect a product from contamination by micro organisms, air, moisture and toxins:-* The product must be protected against the climate including high temperatures, humidity, light and gases in the air. It must also be protected against micro organisms, chemicals, soil, and insects.
- 2) *To keep the products together, to contain it so that it does not spill :-* Some shapes can not be easily packaged, for example certain vegetables. They may fit into cans. Some products such as fruit juice and sausages

need to be contained in packages that hold them together and are sealed to prevent spillage and loss.

- 3) *To identify the product:-* Packaging is the main way products are advertised and identified. The customers usually recognize the product using package. Package, through its colour scheme and logo helps the customer to identify the product.
- 4) *Protection during transport and ease of transport:-* Package should be designed to make it easy to transport, move and shift. The product must be protected against being dropped, crushed and vibration it suffers during transport. Unusually shaped packages can lead to space being wasted and this can be costly. A regular shaped package such as cuboid which can be stacked without wasting too much space between each package. This means more packages can be transported in a container or lorry.
- 5) *Stacking and storage:-* In supermarkets and shops it must be possible to stack packages so that space is not wasted on the shelves. The packaging must be designed in such a way that all important information can be seen by a potential buyer, especially the product name. The shape and the form of the package determines how efficiently they can be stacked or stored.
- 6) *Printed information:-* Information that is useful to customers and companies such as supermarkets is printed on packages. This includes the ingredients, 'sell by date', price, special offers, manufacturer's address, product title, bar code and more.

Packaging design

Packaging design reveals much about the cultural values of the market. Since packaging design exists primarily in market places, where people with varied cultural backgrounds and values come together, they must grab the consumer's attention immediately. This is achieved by employing the visuals and design elements that attract the target consumer.

Packaging design objectives are framed around the relevant marketing background and strategic objectives for a brand. The marketer or manufacturer provides specific, detailed information and points exactly to measurable roles for packaging design.

Materials for packaging

Metals - Aluminium and tin are the most commonly used metals in packaging

Aluminium:- Aluminium is appropriate for packaging foods (canned foods). For drinks such as soft drinks and beers, aluminium is often used.

It is also used for packaging of tablets. Aluminium is attractive, light and strong. It can be recycled.

Tin:- Tin plate is a solid, heavy, steel covered with tin to protect it against rust. It is used to package canned foods. It can be recycled.

Glass:- Glass can be moulded into a variety of shapes. It can also be manufactured in a variety of colours. One of the reasons for using glass is that the product (normally a liquid) can be seen inside it. Glass is used for preserving foods like honey and jams. Some drinks have gases added and so glass bottles must be able to withstand internal pressure. It is even used for consumable goods like, medicines, cosmetics (perfumes), beer, wine, juice bottles. It can be recycled.

Plastics:- Plastic is the most common packaging material and, at the same time, one of the most difficult to dispose of. The factors common to all plastics are that they are light, strong and cheap to manufacture.

Poly Ethylene Terephthalate (PET):- a shatter proof plastic becoming very popular for drinks containers. It is light weight and 90% recyclable.

Poly Vinyl Chloride (PVC):- used for soft drinks containers that are not pressurised.

High Density Polythene (HDPE):- a strong plastic used for buckets, bowls, pipes etc.

Low Density Polythene (LDPE):- a softer plastic used for plastic bags, squeeze bottles for substances such as detergents. Also used for pouches containing products such as drinks and semi-solid foods. Very popular as containers of sports/energy drinks. These containers are flexible, shatter proof, and cheap to produce.

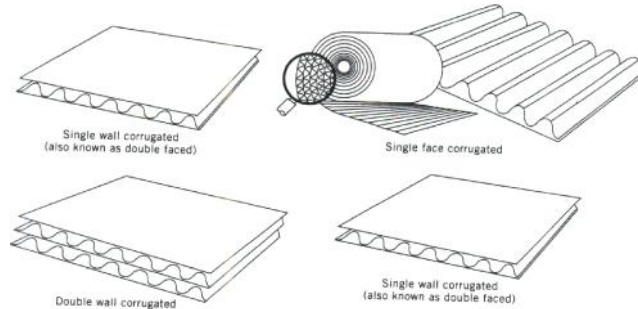
Paper and cellulose film:- This type of packaging material is easy to print on and can be coated, treated or laminated. Often it is manufactured from renewable materials (recycled paper and pulp). It is easy to handle and light weight. In addition, it can be folded into a variety of shapes by machines or by hand. In general, it is used for labels, cartons, boxes and wrappings.

Brick carton:- It is a light, strong air-tight packaging material made up of several layers of plastic, paper, aluminium. Its complex composition makes it difficult to recycle. It is becoming the main packaging material for basic food stuffs. It is used mainly to keep drinks such as milk, juice, etc.

Cardboard:- Cardboard is appropriate for packaging materials wrapping. It is used in the form of boxes or sheets. It is highly recyclable.

Corrugated board:- Corrugated cardboard is a stiff, strong, and light weight material made from a combination of two sheets called liners glued to the corrugated inner medium called fluting.

These three layers of paper are assembled in a way which gives the overall structure, a better strength than that of each distinct



layer. One sided corrugated boards having a flute with one layer of sheet are called single faced corrugated boards. A flute with sheets on both sides is called single wall corrugated or double faced corrugated boards. Single walled, double walled or triple walled corrugated paper boards are commonly used for outer packagings such as shipping cartons and containers.

Special packages

Blister packs:- It is a rigid plastic packing method. This plastic is thermoformed around the front face of product allowing it to view through the transparent plastic. The blister is adhered on to a printed paper board backing on which the product information are displayed. Hinged or double blisters (clam shell) are formed around both sides of the product allowing for complete product visibility. Graphics can also be printed directly on the plastic structure. Battery packs, toys etc. are examples. Capsules and tablets are also blister packed but backed with aluminium foil instead of paper board.



Bubble wrap:- It is a special type of package used for packing fragile products, electronics items, etc. It is a pliable transparent plastic material in which regularly spaced, protruding air-filled bubbles provide cushioning for fragile items.

Shrink wrap:- Also called shrink film is a material made up of polymer plastic film. When heat is applied, it shrinks tightly over whatever it is covering.

Cartons

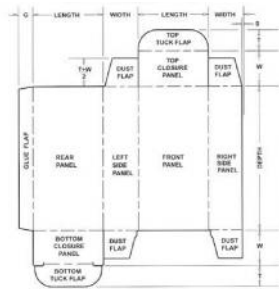
A carton is a box or container usually made of paperboard and sometimes of corrugated fiberboard. Many types of cartons are used in packaging. Sometimes a carton is also called a box.

Classification of Cartons based on its style

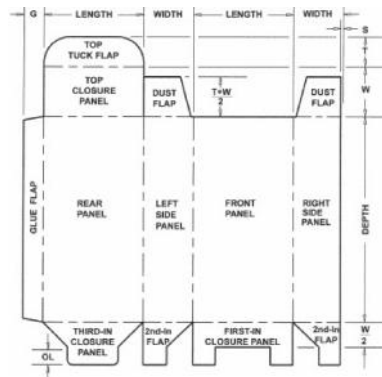
General types of box styles are: four panel styles box, tray style boxes & other box styles.

Four panel style boxes:- These often include end enclosure panels and flaps which are fastened in a variety of ways to create tuck end, seal end, or lock end closure devices.

Straight Tuck End (STE):- In the STE box, the top and bottom closure panels tuck from the rear to the front or from the front to the rear. It is particularly well suited for products requiring a paper box with a window in the front display panel. The STE is used in most categories, including beverage boxes, cosmetic boxes, food boxes, medical boxes, pharmaceutical packaging boxes, retail boxes, toy boxes etc.



Reverse Tuck End (RTE):- In the RTE box, the top closure hinges off the front panel and tucks to the rear, while the bottom closure hinges off the rear and tucks to the front. This style is preferred for cosmetic boxes since it presents a more finished appearance and better graphic design opportunities.



It is also used for food boxes, medical boxes, pharmaceutical packaging boxes, retail boxes etc.

Snap lock bottom:- It is also called 1-2-3 closure. The bottom structure is simple, aesthetic and economic with strength and

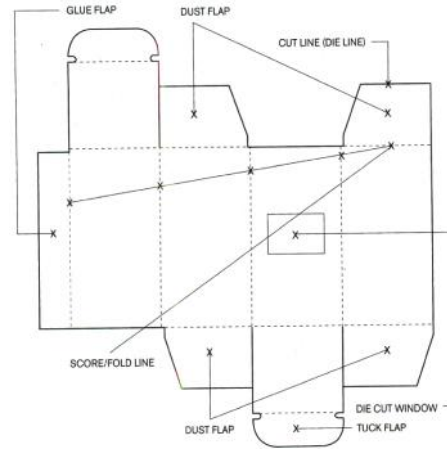


Figure 1

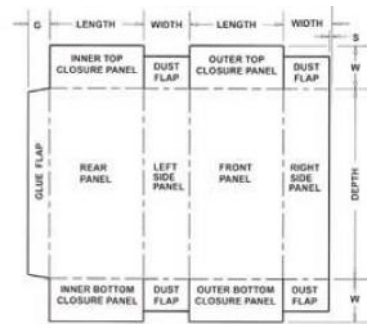
tightness. It is the most commonly used lock bottom structure and widely used in cosmetics, alcohol and food packaging.

Automatic lock bottom:- In automatic lock bottom type cartons, the body and the bottom of the box can be folded into a flat plate shape, and the bottom of the box can be automatically restored to the sealing status when the box is stretched. This structure is complex and the cost is higher compared to other boxes.

Tray style boxes:- Many tray style custom boxes also include covers or lid components hinge-connected to one or more of the upper edges of the side or end panels.

Seal End:- The seal end box is typically erected, filled and closed by packaging equipment. It is often used for food boxes, medical boxes and retail boxes.

Set-up boxes:- Set-up boxes are rigid pre-assembled structures with a top and bottom. They are made from heavy weight paper board laminated with decorative papers, materials, and other finishes that cover all of the outer side and edges. Cosmetics, candy, jewellery, and other high end products that need luxury impression uses this type of packaging.



Packaging Die

Once a packaging structure and material are determined, a designer usually receives a digital file of the packaging die from the client. The die is the blue print of the structure or design layout and provides the exact dimensions and product specifications. Bleed requirements and gluing specifications are included in a two dimensional drawing to which a designer can apply brand informations and graphics using computer software.

A die prepared for a packaging job has two parts. First is the preparation of cutting and creasing rules which are prepared according to the size and design of the job. Cutting and creasing rules are made of flexible steel. One edge of the cutting rule is sharp and the other edge is blunt or thick. Both sides of the creasing rules are blunt or thick. These rules are cut and bent into circles or triangles or semi circles according to the size and design of the job.

The second part is specially made ply board or die board. The board used for this purpose is strong and about 1.5 cm thick. The board pieces are cut about 2 cm larger than the actual size of the job. The line design of the packaging job is drawn on the ply board by a pencil. A hole is made on any line of the design by a drilling machine. The ply board is placed on the plate of a board cutting machine. A zero number saw blade is inserted into the holes of the ply boards. The saw blade is made up and down by pressing the pedal of the machine. The ply board is rotated or moved by hands so that the saw blade should move and cut only on the lines of the packaging design. By this cutting process, all the line design of the ply board is cut very carefully. All the cutting and creasing rules are then set within the cut pieces of the ply. Normally the thickness of the saw blade is similar to the thickness of the rules. Therefore all the cutting and creasing rules are easily fitted with the cut pieces of the ply board.

Scope of packaging

Printing and packaging are the two sides of a coin. All the packagings are printed first and then converted into package. Job opportunities for printing has been increased due to the developments in the packaging industry. Packaging has become necessary for creating attraction in selling the products to the customers. Attractive packages printed in multi-colour catches the attention of the customers at the point of purchase. Due to the expansion and development of various industrial products, the packaging industry has also been developed so much. Many edible materials, soaps, detergents, electrical and electronic goods have global market. They are to be transported and sold worldwide. Hence the usage of packaging has become extensive.

Practical Activities

1. Prepare a carton with the given measurements.
Length - 9 cm width- 5 cm depth - 5 cm.
2. Prepare the drawing for the carton die of the above project.
3. Draw the picture of a STE/ RTE/ FSE carton and label the various parts of it in your practical record book.

Assessment Activities

1. Collect samples for different styles of cartons.
2. Prepare a carton for the given product.
3. Collect samples for special packages like a blister pack, a shrink wrapper, a bubble wrap etc.
4. Prepare a set up box for a Necklace.
5. Collect ten types of packages made of different materials.

TE Questions

1. Illustrate the various functions of packaging.
2. Write briefly about the different types of packaging materials you have studied.
3. What is a packaging die? How is it prepared?
4. Describe the purpose of design for packaging.
5. Describe the scope of packaging industry.
6. What are the different styles of cartons?

Unit - 5

BASIC ENGINEERING

Introduction

An understanding of simple electric, electronic, mechanical and pneumatic components provides the background necessary to explore more complex system of components used in various equipment and machineries used in the printing industry.

Learning Outcomes

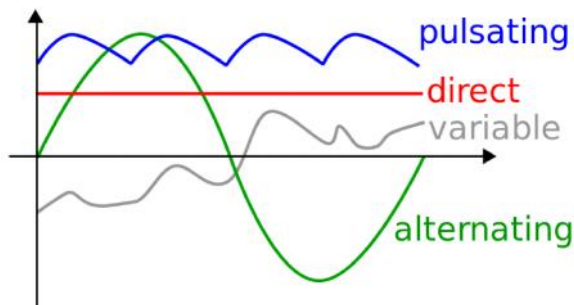
The learner:

- distinguishes between Alternating current and Direct current.
- understands the functions of Motors and Transformers.
- identifies Basic Electronic Circuit components.
- recognises Mechanical components.
- recognises Hydraulics and Pneumatics.
- recognises Mechanical, Electrical, Electronic and Pneumatic parts of a printing machine.

Alternating current and Direct current

Alternating current and Direct current: Alternating current (AC) is an electric current in which the flow of electric charge periodically reverses direction, whereas in direct current (DC) the flow of electric charge is only in one direction. AC is the form in which electric power is delivered to businesses and residences. The usual wave form of AC in most electric power circuit is a sine wave. In certain applications, different wave forms are used, such as triangular or square waves. The rate at which the electric current changes its direction per second is called frequency and it is denoted in Hertz. The electric supply that we get at our home is usually 230 volts and its frequency is 50 Hz.

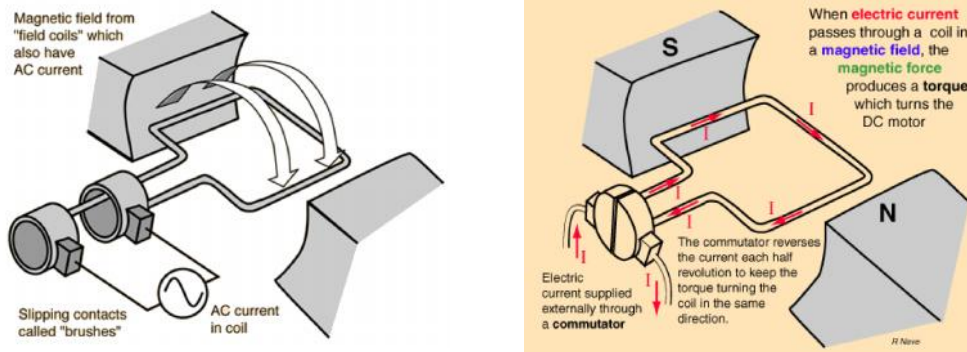
Direct current (DC) is the unidirectional flow of electric charge. DC is produced by sources such as batteries, power supplies, thermocouples, solar cells, or dynamos. DC may flow in a conductor such as a wire, but can also flow through semi conductors, insulators, or even through a vacuum as in electron or ion beams. The electric current flows in a constant direction, distinguishing it from AC.



DC may be obtained from an AC supply by use of a rectifier, which contains electronic elements that allow current to flow only in one direction. DC may be converted into AC with an inverter or a motor-generator set. DC is used to charge batteries and as power supply for electronic systems.

Motors and Transformers

Electric motors are machines which convert electrical energy into mechanical energy. There are two types of electric motors - AC motors & DC motors.



Both AC and DC motors serve the same function but they are powered, constructed and controlled differently. The most basic difference is the power source. AC motors are powered from alternating current while DC motors are powered from direct current, such as batteries, DC power supplies, or an AC-to-DC power converter. DC wound field motors are constructed with brushes and a commutator, which add to the maintenance, limit the speed and usually reduce the life expectancy of brushed DC motors.

AC induction motors do not use brushes. They have long life expectancies. The final basic difference is speed control. The speed of a DC motor is controlled by varying the armature winding's current while the speed of an AC motor is controlled by varying the frequency, which is commonly done with an adjustable frequency drive control.

Transformers are basically very simple static (or stationary) electro-magnetic passive electrical devices that work on the principle of Faraday's law of induction by converting electrical energy from one value to another.

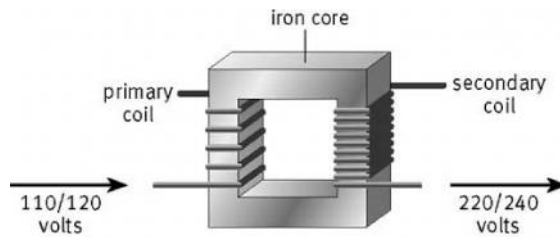
The transformer does this by linking together two or more electrical circuit using a common oscillating magnetic circuit which is produced by the transformer itself. A transformer operates on the principles of 'electromagnetic induction', in the form of mutual induction.

Mutual induction is the process by which a coil of wire magnetically induces a voltage into another coil located in close proximity to it. Then we can say that

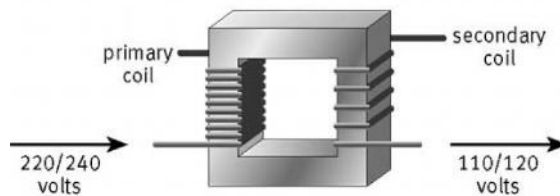
transformers work in the 'magnetic domain', and transformers get their name from the fact that they 'transform' one voltage or current level into another.

Transformers are capable of either increasing or decreasing the voltage and current levels of their supply, without modifying its frequency, or the amount of electrical power being transferred from one winding to another via the magnetic circuit. There are basically two types of transformers:

1. *Step-up transformer*:- a step-up transformer is one whose secondary voltage is greater than its primary voltage. The number of turns on the secondary winding of a step-up transformer is greater than the number of turns on its primary winding.



2. *Step-down transformer*:- it is the opposite of the above, i.e., one whose primary voltage is greater than its secondary voltage. Step-down transformers are used to step down high voltages i.e., from 11000 V to 220 V and from 220 V to 10, 12, 20 or 24 Volts etc. The number of turns on the primary winding of a step-up transformer is greater than the number of turns on its secondary winding.



A single phase voltage transformer basically consists of two electrical coils of wire, one called the 'primary winding' which takes power and another called the 'secondary winding' which delivers power.

These two coils are not in electrical contact with each other but are instead wrapped together around a common closed magnetic iron circuit called the 'core'. This soft iron core is not solid but made up of individual laminations connected together to help reduce the core's losses.

The two coil windings are electrically isolated from each other but are magnetically linked through the common core allowing electrical power to be transferred from one coil to the other. When an electric current passed through the primary winding, a magnetic field is developed which induces a voltage into the secondary winding as shown.

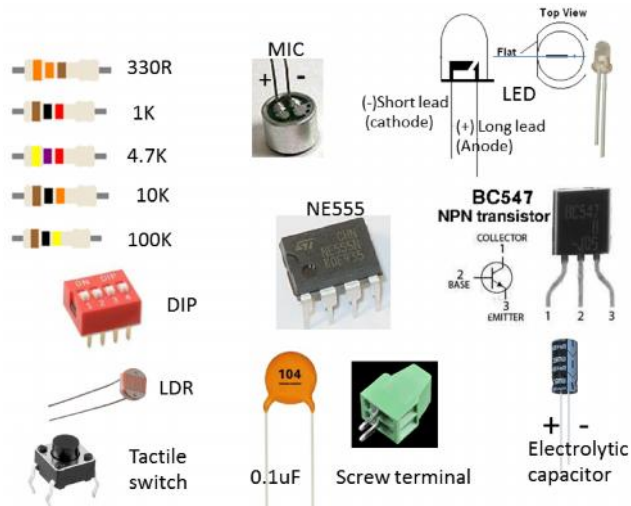
In brief, a transformer changes the voltage level (or current level) on its input winding to another value on its output winding using a magnetic field. A transformer consists of two electrically isolated coils and operates on Faraday's

principle of 'mutual induction', in which an EMF is induced in the transformer's secondary coil by the magnetic flux generated by the voltages and currents flowing in the primary coil winding.

Basic Electronic Circuit Components

An electronic circuit is composed of individual electronic components, such as resistors, capacitors, transistors, inductors, and diodes, Light Emitting Diodes(LED), Integrated Circuit (IC) chips connected by conductive wires or traces through which electric current can flow. The combination of components and wires allows various simple and complex operations to be performed. Interconnections between the components are done by photolithographic techniques on a laminated substrate (a Printed Circuit Board or PCB) and solder the components to these interconnections to create a finished circuit. Screen printing technique is mainly employed in the production of PCBs.

Resistor: A resistor is an electrical component that limits or regulates the flow of electrical current in an electronic circuit. Resistor values are often indicated with colour codes. Practically, all resistors with a power rating upto 1 watt are marked with colour bands. Standard unit of resistance is Ohm (Ω).



Capacitor: A capacitor is a passive electronic component used to make a time-delay in a circuit. We can charge and discharge it just like a battery. It consists of two conducting plates separated by an insulating material called the dielectric. The standard unit of capacitance is the Farad (F).

Diode: Diode is an electronic device that restricts current flow chiefly to one direction. A diode consists of two electrodes called the anode and the cathode. Most diodes are made with semi-conductor materials such as silicon, germanium, or selenium.

Diodes are sometimes used as rectifiers. A rectifier changes AC to DC. A light emitting diode or LED is a component that gives light. It is used in an electronic circuit to give a visual feedback.

Transistor: A transistor is a device that regulates current or voltage flow and acts as a switch or gate for electronic signals. A transistor amplifies, oscillates, or switches the flow of current between two terminals. Transistors consist of three layers of a semiconductor material, each capable of carrying a current. The transistor's three-layer structure contains an N-type semiconductor layer sandwiched between P-type layers (a PNP configuration) or a P-type layer between N-type layers (an NPN configuration).

Integrated circuit (IC): A device made of interconnected electronic components such as transistors, resistors, and capacitors, that are etched or imprinted onto a tiny slice of a semiconducting material such as silicon or germanium. An IC can function as an amplifier, oscillator, timer, counter, computer memory, micro processor etc.

Mechanical components

Gears:- A gear is a rotating machine part having cut teeth which mesh with teeth in another part to transmit or receive force and motion. Main types of gears seen on a printing machine are the following:

- 1) *Spur gear:* Spur gears are the most common type of gears and have straight teeth and are parallel to the axis of the wheel. The advantages of spur gears are their simplicity in design, economy of manufacture and maintenance. Spur gears are known as slow speed gears. These gears are comparatively noisy.
- 2) *Helical gear:* Helical gears have their teeth cut at an angle to the face of the gear. Their teeth are inclined to the axis of the shafts in the form of a helix, hence the name helical gears. These gears are usually used as high speed gears. It can take higher loads than similarly sized spur gears. the motion of helical gears is smoother and quieter than the motion of spur gears.
- 3) *Bevel gear:* Bevel gears are gears where the axes of the two shafts intersect and the tooth-bearing faces of the gears themselves are conically shaped. Bevel gears are most often mounted on shafts that are 90° apart, but can be designed to work at other angles as well. The teeth on bevel gears can be straight or spiral.
- 4) *Worm gear:* Worm gears are used when large gear reductions are needed. It is a gear arrangement in which a worm (which is a gear in the form of a

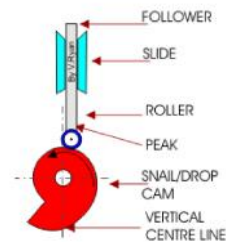
screw) meshes with a worm gear (which is similar in appearance to a spur gear). The two elements are also called the worm screw and worm wheel.

Shaft:- A shaft is a rotating machine element, usually circular in cross section, which is used to transmit power from one part to another, or from a machine which produces power to a machine which absorbs power. The various parts such as pulleys and gears are mounted on it.



Levers:- A lever is a rigid body capable of rotating on a point on itself. A lever amplifies an input force to provide a greater output force, which is said to provide leverage.

Cams:- A cam is a rotating or sliding piece in a mechanical linkage used especially in transforming rotary motion into linear motion or vice versa. A cam follower is a machine part that moves up and down in contact with a cam on a rotating shaft.



Chain and sprocket:- Chain drive is a way of transmitting mechanical power from one place to another. A sprocket is a wheel with teeth that mesh with a chain.

Nut and bolt:- A nut is a type of fastener with a threaded hole. Nuts are almost always used opposite a mating bolt to fasten a stack of parts together. A bolt is a form of threaded fastener with an external male thread.

Pulleys:- This is used to transmit drive from one to another. There are different types according to the shape of belts on it such as flat, grooved, teathed, etc. The diameter, width and number of grooves in a pulley depend on the load it has to transmit.

Bearings :- Bearings are supporting elements for shaft, cylinders, etc. They need intermittent oil lubrication at desired quantity. There are different types of bearings such as brush bearing, ball bearing, roller bearing, and needle bearing.

Hydraulics and Pneumatics

Hydraulics deals with the mechanical properties of liquids or fluids. Hydraulics is used for the generation, control and transmission of power by the use of pressurised liquids. A hydraulic drive system consists of three parts, the generator (hydraulic pump), driven by an electric motor, a combustion engine; valves, filters, piping etc. (to guide and control the system); and the actuator (hydraulic motor or hydraulic cylinder) to drive the machinery.

Pneumatics is a branch of engineering that makes use of gas or pressurised air. Pneumatic systems are commonly powered by compressed air or compressed inert gases. Their principle of operation is similar to that of the hydraulic power systems. With pneumatics, air is usually pumped into a receiver using a compressor. Energy produced by pneumatic systems are more flexible, less costly, more reliable, and less dangerous than some electric motors.

Mechanical, Electrical, Electronic and Pneumatic parts of a printing machine

Mechanical parts of an offset machine are :

Gears, cams and followers, chain and sprockets, side frames, plate, blanket and impression cylinders, pulleys, shafts, lever, bearings, nuts and bolts, washers, etc.

Electrical parts of an offset machine are :

Motors (AC & DC), transformers (step up & step down), electro magnets, relays, switches, etc.

Electronic parts of an offset machine are :

Printed circuit boards (PCBs), IC chips, transistors, resistors, capacitors, diodes, LEDs, no sheet detector, sensors, counter etc.

Pneumatic parts of an offset machine are :

Compressors for paper feeding, transferring and delivery

Hydraulic parts of an offset machine are:

Oil and grease pumping system.

Additional Information: Pascal's law is the basis of hydraulic drive systems. As the pressure in the system is the same, the force that the fluid gives to the surroundings is therefore equal to pressure \times area. In such a way, a small piston feels a small force and a large piston feels a large force.

Practical Activities

1. List out the different mechanical parts in an offset machine.

Assessment Activities

1. Collect various electronic components like resistors, capacitors, diodes, transistors, IC chips.
2. Prepare a chart of various kinds of mechanical, electrical, electronic and pneumatic parts of an offset machine.
3. Collect any four types of gears from your old toys.
4. Identify various types of DC and AC motors used in your home or printing lab.

TE Questions

1. How does the working of a DC motor differ from that of an AC motor?
2. What are the different types of gears used in the construction of an offset machine.
3. Draw the diagram of any two types of gears that you see on a cutting machine.
4. How does a step up transformer differ from a step down transformer? Identify the type of transformer that you see on an 11KV line near your home.

Unit - 6

ENGINEERING GRAPHICS

Introduction

It is a graphical language that communicates ideas and information from one mind to another. One of the best ways to communicate one's ideas is through some form of picture or drawing. This is especially true for an engineer. The purpose of this unit is to give you the basics of engineering sketching and drawing. We will treat "sketching" and "drawing" as one. "Sketching" generally means freehand drawing. "Drawing" usually means using drawing instruments, from compasses to computers to bring precision to the drawings.

Learning Outcomes

The learner:

- recognises lettering, numbering, dimensioning.
- applies principles of geometrical constructions.
- constructs basic shapes such as square, rectangle, circle, ellipse, etc.
- understands about projections of points, lines and planes.
- draws basic section views, auxiliary views and isometric views.

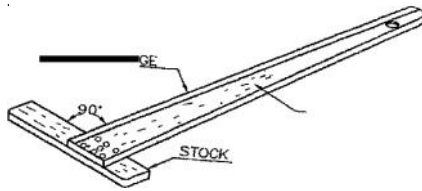
DRAWING INSTRUMENTS

Drawing Instruments are used to prepare drawings accurately and easily. The accuracy and quality of drawing depends on the accuracy and quality of drawing instruments. The following are the commonly used materials and tools in engineering drawing.

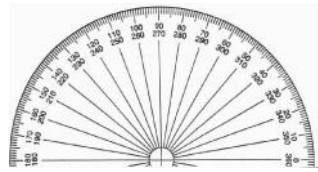
Basic Tools and materials

- Drawing board, Drawing paper, pencil, eraser, Drawing pins/ tape, Clips, Duster.
- T-Square and Set Square, Mini drafter, Scales, Dividers and Protractor.
- Compass, French curves and Templates

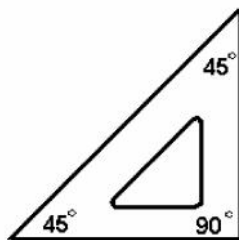
T-SQUARE



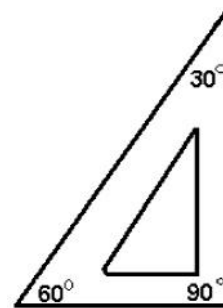
PROTRACTOR



SET SQUARE

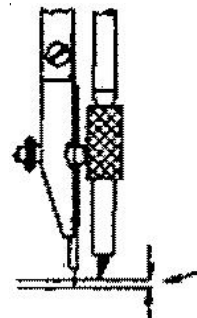
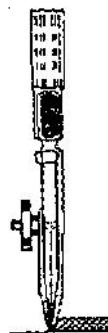
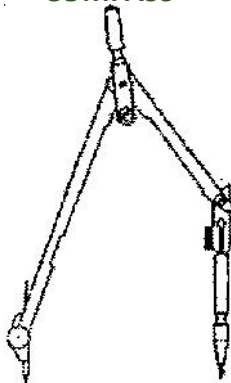


45° Set square

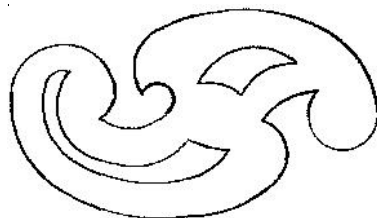


60° Set square

COMPASS



FRENCH CURVE



Drafting machine



A drafting machine is a device which is mounted to the drawing board. It has rulers whose angles can be precisely adjusted with a controlling mechanism. There are two main types of apparatus: an arm-type parallelogram apparatus based on a hinged arm; and a track-type apparatus which moves on a rail mounted to the top of the drawing board. Small drafting machines (mini drafters) are commonly used.

Rulers

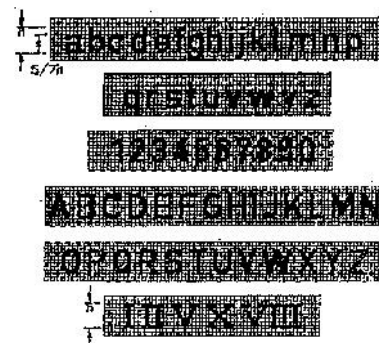
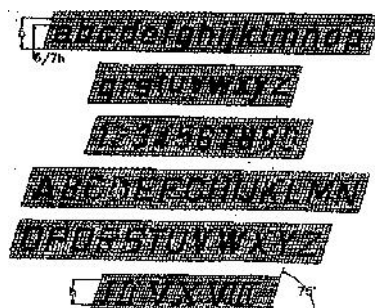
Rulers also called Architect's scale used in technical drawing are usually made of polystyrene. It is available in two types according to the design of their edge as (1) Straight edge and grooved edge.



*An architect's scale
(Rulers)*

LETTERING AND DIMENSIONING

Writing of titles, dimensions, notes and other important particulars on a drawing is called lettering. Lettering can be done in different ways such as hand lettering, mechanical lettering etc. Mechanical lettering can be done using typewriter or computer.



Dimension is a numerical value expressed in appropriate units of measurement and marked on a drawing with lines, symbols and notes. The dimension without any unit is considered in 'mm'. The elements of dimensioning are projection line or extension line, dimension line, leader line and arrowheads. Projection line is a thin, dark, solid line that extends from a point on the drawing to which a dimension refers. A dimension line is a thin line that shows where a measurement begins and where it ends. The dimension line should have a break in it for the dimension numbers. Dimension line should be at least 10mm from the lines of the drawing. Leader lines are thin lines drawn from a note or a dimension to the place where it applies. Arrowheads are used at the ends of

the dimension lines. They show where a dimension begins and ends.

POINTS TO BE CONSIDERED IN DIMENSIONING

- Each drawing shall use the same unit for all dimensions.
- Long extension line should be avoided.
- Do not cross a dimension line with another line.
- Each feature of the object shall be dimensioned only once on a drawing.
- All dimensions which are necessary to define an object or component must be clearly marked on the drawing.
- Dimension lines are placed outside the drawings except in special cases where marking inside the drawing is readable.
- In general, dimensions should be placed outside the view outline.
- Do not use a centre line or a line of the drawing as the centre line.

FREEHAND SKETCHING

Freehand sketch is a drawing made without the help of drawing instruments.

The important uses of freehand sketching are:

- It is used to convey the thoughts and ideas to the workers.
- It is used to present the ideas of the designer to the management.
- It is used for showing different layouts of the drawing.
- It is used in the production of temporary fixtures.
- It is also used to convey information regarding repair or modification needed in an existing structure or machine.

COMPARISON BETWEEN FREE HAND SKETCHING AND INSTRUMENTAL DRAWING

Free hand sketching	Instrumental drawing
Drawing made without the use of drawing instrument	Drawing made with the use of drawing instrument
It is not drawn to actual scale	It is drawn to actual scale
It is not a perfect drawing	It is a perfect drawing with uniform line thickness
It is used for temporary figures/fixtures	It gives exact details of object to be manufactured

LINES

In engineering drawing, different types of lines are used to describe different objects. The following are some of the commonly used lines.

1. Outline

They are drawn in the outer edge of an object.

This is a thick line drawn continuously without any break. They are also called object lines.



2. Dotted lines

This line is drawn to indicate certain inner or hidden edge surface of an object. It is drawn with a break at regular intervals. ~~The dotted line is drawn with 2 mm length at 1 mm intervals.~~

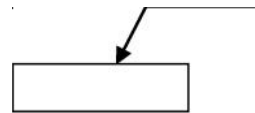
3. Centre line

This line indicates the centre point of circles and symmetric features. It is drawn using long and short lines respectively. The long line is six or eight times longer than the smaller lines which are present in between the long ones.



4. Extension & Dimension line

Dimension line indicates the size of an object. The arrow heads are drawn on either ends of this line. Gap at the centre can be used to indicate the dimensional value.



5. Section line or hatching line

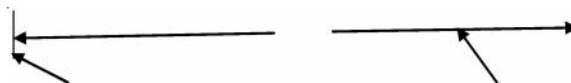
This line is drawn to indicate the cut section of an object. These lines are drawn at an angle of



40°. The spacing between the lines is approximately one to 15mm. These lines are drawn lighter than the object lines.

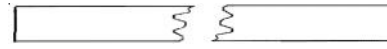
6. Pointer line

A light bend line with an arrow head pointing an object is known as a pointer line.



7. Short break line

This line is drawn to indicate unequal borders and a small break in a structure.

**8. Long break line**

This line is drawn to indicate a large break in a structure. It is drawn with zig zag line

**GEOMETRICAL DRAWING****INTRODUCTION**

The drawing of object views involves plane geometric constructions. It is necessary to have a good knowledge of plane geometry. Preparation of engineering drawings involve number of geometrical constructions. Hence it is necessary to study geometrical drawing. Geometrical constructions relating to straight lines, circles, arcs of circles, Triangle, rectangle, square, regular polygons and conic sections are illustrated in this chapter.

POINT

A point represents a location in space or on a drawing and generally represented by a very small circle or a small dot.

LINE

A line is the shortest distance between two points.

Types of lines :

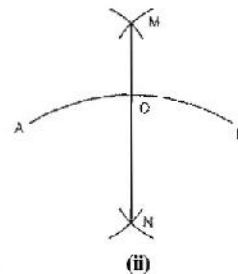
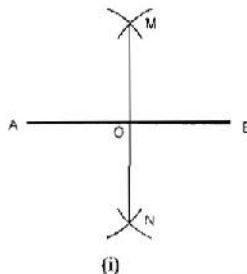
STRAIGHT LINE _____

PARALLEL LINES _____

CURVED LINES

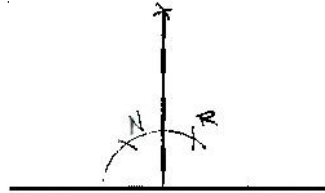


To bisect a given straight line or arc



- Let the given straight line or arc be AB.
- With A and B as centers and radius greater than half of AB, draw arcs intersecting each other at M and N respectively.
- Join M and N which bisect the given line or arc.

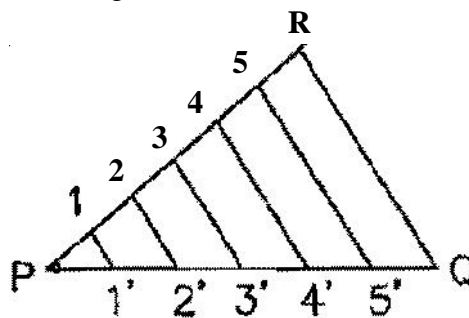
To draw a perpendicular line to a given line from a given point with in it



- Let P be the given point on a given line AB.
- With P as centre, draw an arc cutting AB at M by taking any suitable radius.
- With same radius, mark two equal divisions on the arc MN and NR respectively.
- With centers N and R and of any suitable radius draw arcs to intersect at a point O. Draw a line OP through O and P, the line OP is the required perpendicular line.

Dividing a line into equal parts

Dividing a line into number of equal parts by using dividers is not very accurate. A satisfactory method is given below.

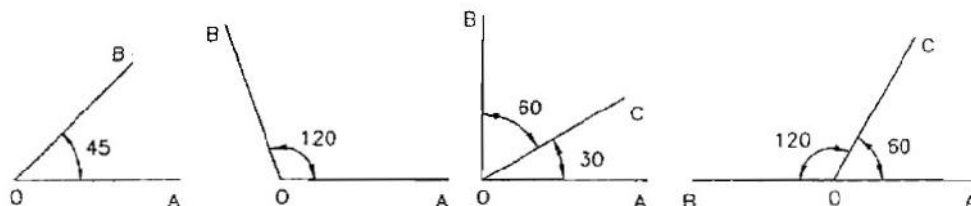


- If the line PQ is to be divided into six equal parts.
- Draw a line PR inclined at any convenient acute angle to PQ.
- Make six equal divisions along PR at any convenient length starting from P.

- Join Q and 6. Draw lines parallel to Q6 through the division points 1, 2, 3, 4 and 5 cutting
- PQ at 1', 2', 3', 4', and 5'.
- Points 1', 2', 3', 4' and 5' are the division points dividing PQ into equal parts.

ANGLES

An angle is the inclination between two intersecting lines.



Types of Angles

Right angle: Angle equal to 90° is called right angle.

Acute angle: Angle less than 90° is called acute angle.

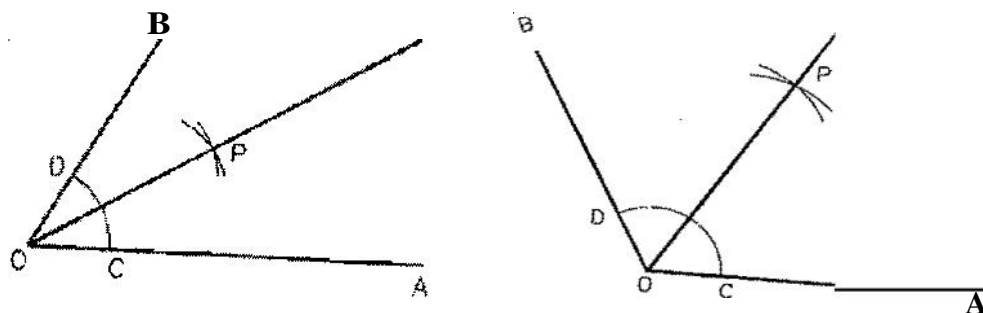
Obtuse angle: Angle greater than 90° is called obtuse angle.

Complementary angle:

Complementary angle are those angles which together form 90° , the angles AOC and BOC are complementary angles. The angle AOC is also said to be the complement angle of BOC and vice-versa.

Supplementary angles: supplementary angles are those when two angles together make 180° .

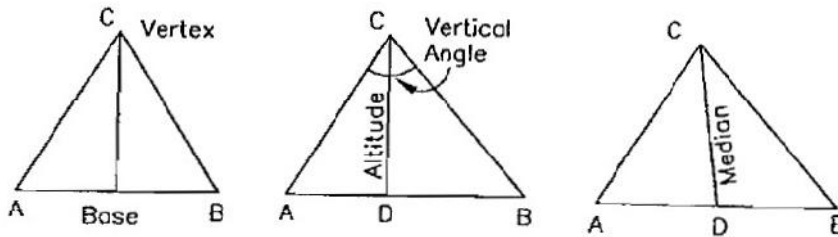
Bisecting a given angle between two given lines



- Let the given angle be AOB between two given lines OA and OB
- With O as centre and with any convenient radius, draw an arc cutting OA at C and OB at D.
- Now with C and D as centre and at any convenient radius draw arcs to intersect each other at P. Draw a line through O and P, which bisects the given angle AOB.

TRIANGLES

A Triangle is a plane figure bounded by three straight lines containing three angles. The sum of the three interior angles is 180°



- The sum of all the angles of a triangle is always 180° .
- The side on which it is supposed to stand is called its base and the angles at the base are known as base angles.
- The point where the other two sides meet is called a vertex and the angle at the vertex is called a vertical angle.
- The line drawn from the vertex and perpendicular to the base is called an altitude.
- The line joining the angular point of a triangle to the middle point of the opposite of an angular point is called the Median.

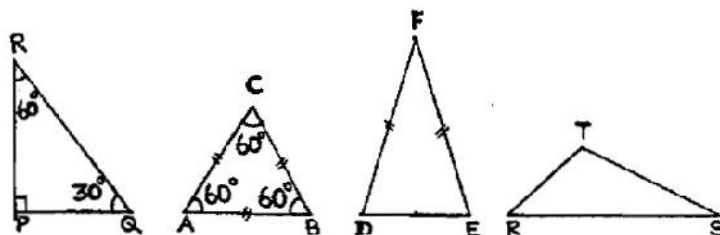
TYPES OF TRIANGLES

- Equilateral Triangle: It is that in which all the three sides are equal and the three angles are equal.
- Isosceles Triangle: It is that in which two sides as well as the angle opposite to them are equal.
- Scalene Triangle: It has no sides or angle equal. The altitude may either be within or outside the triangle.
- Right angled Triangle: It is that in which one angle is equal to 90° and the side opposite to the right angle is called hypotenuse.

- v) Acute angled triangle: It is that in which all the angles are acute ie. Less than 90° .
- vi) Obtuse angled Triangle: It is that in which one of its angles is obtuse and the other two angles are acute.

Drawing an equilateral triangle (given the length of one side)

Let AB be the given length of one side of an equilateral triangle.



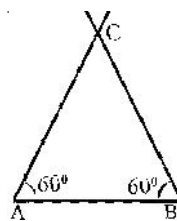
Draw a triangle with T-square and set-square only

Draw a line AB of given length by means of drafter.

Set the drafter at 30° - 60° and draw a line AN through A making an angle of 60° with AB.

Similarly through B, draw a line BN making the same angle with BA there by intersecting the first line at C.

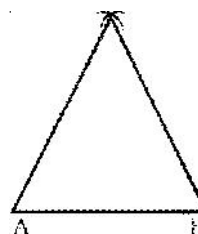
Join AC and BC. Then ABC is the required equilateral triangle.



With the help of compass

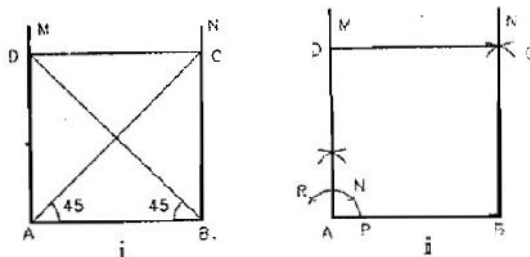
Draw a given line AE. With A and B as centers and radius equal to AB, draw arcs intersecting each other etc.

Join AC and BC. Then ABC is the required equilateral triangle.



SQUARE

Square is the quadrilateral in which all the sides are equal and the angles are at right angles. Draw a square- given the length of one side:



Let AB be the length of one side of square.

- (a) **With set square only:** Draw a line AB by means of a T-Square through A and B draw vertical line AM and BN Draw two lines AC and BD inclined at 45° to AB and BA, there by cutting BN at C and AM at D. Join C with D. Then ABCD is the required square.
- (b) **With the help of compass:-** Draw a given line AB. At A draw a line AM perpendicular to AB with A as centre and radius AB, draw an arc cutting AM at D. With B and D as centers and having same radius ie. AB, draw arcs intersecting each other at C. Join BC and CD. Then ABCD is the required square.

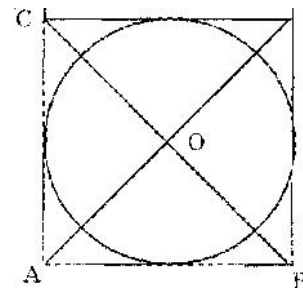
Draw a circle inscribed in a square:

Draw a straight line AB.

Draw vertical lines AM and BN from A and B.

With A and B as the centers draw arcs radius of AB, these arcs cut AM at C and BN at D. Join CD.

Draw two diagonals AD and BC. These two diagonals intersecting at O. Draw a vertical line from O to the midpoint of line AB. Draw a circle with O as centre and radius of OP.



RECTANGLE

Rectangle is the quadrilateral in which the opposite sides are equal and all the angles are at right angles.

Activity:- Draw a rectangle of length 60mm and breath 30mm.as per the procedure.

Procedure:

- Draw a straight line AB equal to 60mm
- From A draw vertical line AM.
- With A as centre and radius of 30mm draw an arc cutting AM at D.
- With D as centre and radius of 60mm draw an arc.
- With B as centre and radius of 30mm draw another arc.
- These 2 arcs intersects each other at C. Join BC and CD.
- Then rectangle ABCD is obtained

POLYGON

A polygon may be defined as a plane figure bounded by straight lines. It is a plane figure bounded by more than four straight lines and containing more than four angles.

Types of polygon

If all the sides and angles of a polygon are equal it is called a **Regular polygon**, but if all the sides and angles are unequal, then it is called an **Irregular polygon**.

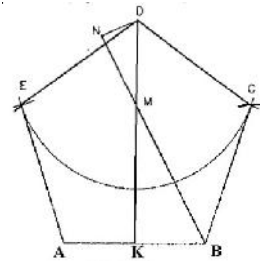
- Regular polygon can be inscribed in or circumscribed around a circle
- The polygons are named according to the number of their sides and angles.

PENTAGON

Pentagon is that which has five equal sides and angles

Activity: Draw a pentagon of a given side (say a 35mm side)

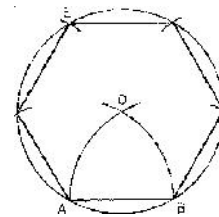
- Draw a line AB equal to 35mm. Bisect it at K and
- Draw KD perpendicular to it.
- Cut off KM=AB. Join BM and produce it to N so that MN=half of AB.
- With D as centre and radius equal to AB. draw an arc EC.
- With A and B as centers and having same radius cut the previous arc at E and C.
- Join BC, CD, DE and EA. Then ABCDE is the required Pentagon.



HEXAGON

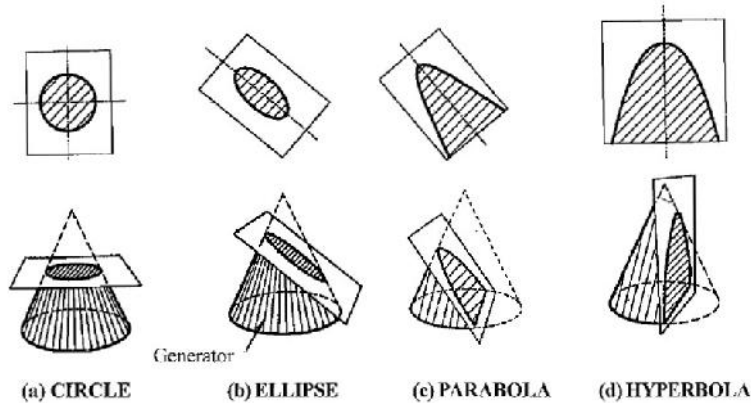
Hexagon is that which has six equal sides and angles. Draw a hexagon of given side (say 35mm side)

- Draw a Line AB equal to 35mm.
- With A and B as centers and radius of 35mm, draw arcs intersecting at O.
- With O as the centre and having 35mm radius, draw the segment of a circle.
- With AB as radius, cut the segment at C, D, E and F.
- Join BC, CD, DE, EF and FA. Then ABCDEF is the required regular hexagon.

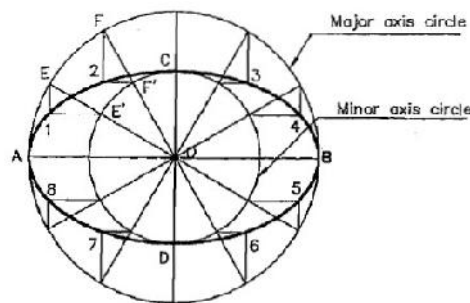


CONIC SECTIONS

Conic section are the curves obtained by the intersection of a right circular cone by a plane at different angles. Ellipse, parabola, and hyperbola are the curves thus obtained and hence are called the conic sections or conics.



Draw an ellipse of major axis 80 mm and minor axis 50mm in concentric circles method



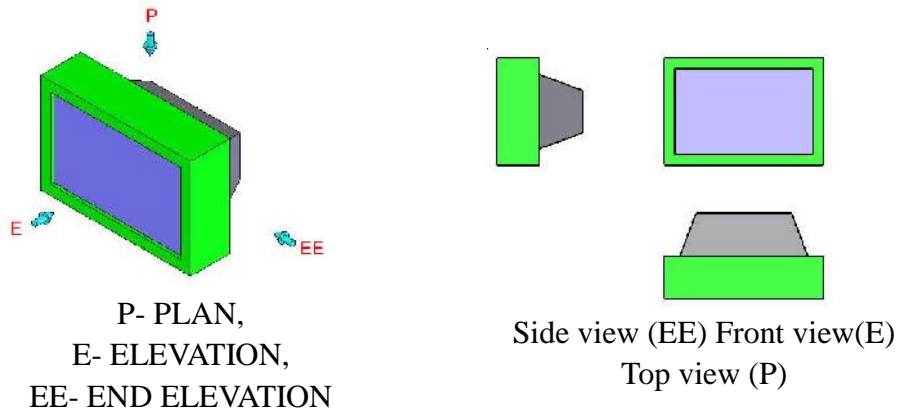
- 1) Draw AB (80mm) and CD (50mm) the major and minor axes perpendicular to each other cutting at O.
- 2) With O as centre, draw two concentric circles of diameter 80 mm and 50mm as shown
- 3) Draw radial lines OE', E, OF', F etc. at convenient angular intervals of say 30° .
- 4) From points E, F etc. on the major axis circle, draw lines perpendicular to the major axis AB. From points E' F' etc. on the minor axis circle, draw lines parallel to the major axis. The intersect is of perpendicular and parallel lines from points on the same radial line will fix a point on the required ellipse.
- (5) Draw a graceful curve through these points to define the ellipse.

Draw an ellipse of major axis 70mm and minor axis 45mm in concentric circle method.

ORTHOGRAPHIC PROJECTION

Orthographic projection is one method of projection used in engineering drawing in which the objects are projected on imaginary planes. This means we make the object become 2D. The difference between Orthographic Projection and any other drawing method is that we use several 2D views of the object instead of a single view.

In orthographic projection the object is placed at infinite distance from the observer. The image formed on the picture plane is orthographic projection. The word orthographic means to draw at right angles.



Basics of Orthographic Projection

Orthographic Projection involves us seeing an object in 2D. To do this we need to look at 90 degrees to the face of an object. The planes of projection are extended beyond the line of intersection to form four quadrants. The position of objects in any one these four quadrants are as follows

1. First horizontal plane(HP) in front of vertical plane(VP)
2. Second quadrant-Above HP and behind VP
3. Third quadrant-Below HP and behind VP
4. Fourth quadrant; Below HP and in front of VP

ORTHOGRAPHIC VIEWS

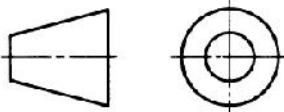
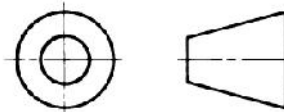
Orthographic views are obtained from orthographic projection. The front, top and side views are called as orthographic views. In orthographic projection, the picture planes are called as planes of projection and the perpendicular line are called as project lines or projectors. When we draw an Orthographic view of the front of an object it is called ELEVATION. When we draw an Orthographic view of the top of an object it is called PLAN. When we draw an Orthographic view of one side of an object it is called an END ELEVATION.

TYPES OF ORTHOGRAPHIC PROJECTION

Usually there are 4 types of orthographic projections

- 1) First angle projection
- 2) Second angle projection
- 3) Third angle projection
- 4) Fourth angle projection

In engineering drawing we prefer only the first angle projection.

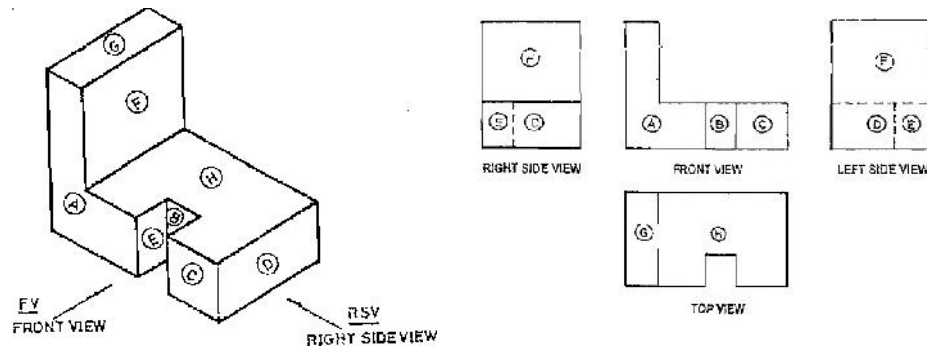
Projection	Symbol
First angle	
Third angle	

DIFFERENCE BETWEEN FIRST ANGLE AND THIRD ANGLE PROJECTION

First angle projection	Third angle projection
The object is placed in the first quadrant	The object is placed in the third quadrant
The object lies between the observer and the plane of projection.	The plane of projection lies between the observer and the object
In this method, when the views are drawn in their relative position, the plan comes below the elevation. The left side view is drawn in the right side of elevation.	In this method, when the views are drawn in their relative position, the plan comes above the elevation. The left side view is drawn in the left side of elevation.
The plane of projection is assumed to be non transparent	The plane of projection is assumed to be transparent
Normally this projection is used in India and British countries	Normally this projection is used in USA

Example 1

Draw the Elevation looking from the direction of arrow FV, plan and Right side view, left side view for the pictorial view show in figure.

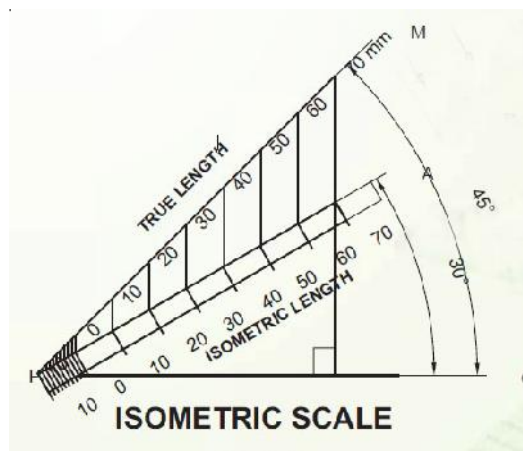


ISOMETRIC PROJECTION

The isometric projection of an object is a one plane view drawn with the object so placed with respect to the plane of projection that all the three principal axes appear to be inclined to each other at an equal angle of 120°

Isometric scale is used to measure the foreshortened length of dimensions of any object to draw the isometric projection. The steps of construction of isometric scale are given below

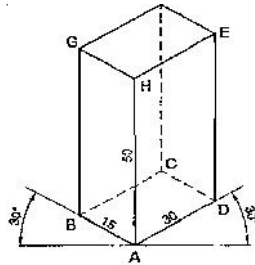
- (i) Draw a horizontal line PQ. (ii) Draw the true lengths on a line PM inclined at 45° to the horizontal line (say up to 70 mm) (iii) Draw another line PA at 30° to the horizontal line.
- (iv) Draw the vertical projection of all the points of true length from PM to PA.
- (v) Complete the scale with the details as shown in the figure. The lengths shown at the line PA are the isometric lengths to be used to draw the isometric projection.



ISOMETRIC DRAWING

Exercise: Draw the isometric drawing of a rectangular prism of base 30 mm x 15 mm and the height 50 mm

- Draw the isometric projection of a cube of side 50mm



- Draw the three isometric axes through point 'A'.
- Mark AB = 15 mm, AD = 30 mm and AH = 50 mm representing the three sides of prism.
- Draw two vertical lines parallel to the line AH through points B and D.
- Similarly draw two more lines parallel to AB and AD through point H.
- Mark G and E the intersecting points.
- Draw lines parallel to GH and HE through points G and E intersecting point is F.
- Draw lines parallel to AB & AD through points D and B respectively intersecting at C.
- Join CB & CD with dash lines.
- Join F and C also with dash lines.
- Rub off the construction lines and complete the prism.

AUXILIARY VIEW

If a surface of an object is inclined to any of the planes of projection, the view of the surface of that plane will not show its true shape and size. To overcome this difficulty a view of the inclined surface is projected on an imaginary plane parallel to this inclined surface. This imaginary plane is called Auxiliary plane and the view obtained on it is called Auxiliary view.

SECTIONAL VIEWS

Interior details of an object cannot be shown on principal exterior views. In such cases an imaginary cutting (sectioning) plane may be used to cut through

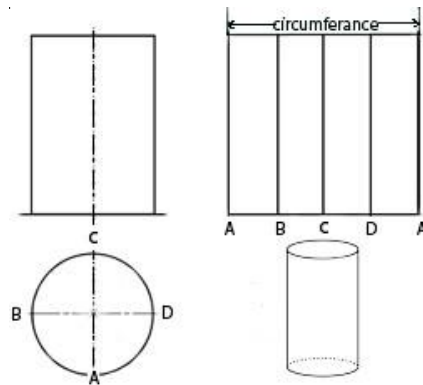
the object so that the portion in front of the plane can be imagined to be removed so as to expose inner details.

The sectional view shows and elaborates the internal construction of a machine, so that the drawing shows the components and parts that a machine consists of. The view can be the section of either Top view, Front view or Side view. Actually the sectional view is an “anatomy” study of a machine. Designers use these view to analyse the constructional details and to modify the design of a machine. They are the projected views (either Auxiliary or Orthographic) which show a cross section of the source object along the specified cut plane. There are different types of sectional views such as (1) Full Sectional view, (2) Half Sectional view, (3) Partial/ Broken Sectional view, (4) Revolved Sectional view, (5) Offset sectional view and (6) Removed sectional view.

DEVELOPMENT OF SURFACES

The knowledge of development of surfaces is used in the engineering applications such as sheet metal works, automobile body building, packing industry etc. The surface of an object which are opened out and laid on a flat plane is called the development of surfaces of that object.

DEVELOPMENT OF CYLINDER



Cylinder is wrapped around a paper. When the paper is opened, it is rectangle in size.

Length = circumference of cylinder

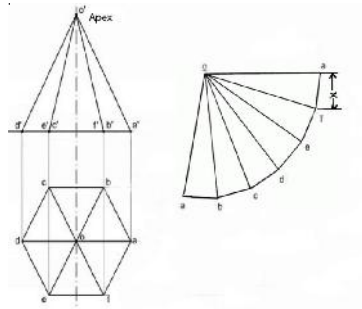
Breadth = Height of cylinder

Generally, parallel line method is used for development of cubes, prisms, cylinder etc.

DEVELOPMENT OF HEXAGONAL PYRAMID

Pyramid is developed as follows:

Draw an arc of radius $OA = o'a'$. Divide the arc into 6 equal sectors so that each sector is equal to distance x



TE QUESTIONS

1. Draw a bisecting line for given straight line AB of length 120 mm.
2. Draw a bisection line for given straight line PQ of length 60 mm
3. Draw a perpendicular line to a given straight line AB of length 110 mm from a given point O $AO=40\text{mm}$.
4. Divide the given straight line AB length of 120 mm into seven equal parts.
5. Divide the given straight line PQ of length 70 mm into five equal parts.
6. Draw an arc of 40 mm radius touching the two given straight lines $[AB = 80\text{mm}, AC = 70 \text{ mm}]$ at right angles to each other.
7. Draw an equilateral triangle ABC for given side. Side AB 40 mm.
8. Draw an Isosceles Triangle ABC for given data. $AB = 70\text{mm}, AC = BC=55\text{mm}$.
9. Draw a square for given length of one side $[Side AB = 60 \text{ mm}]$.

BIBLIOGRAPHY

1. Prust Z. A. : Graphic Communications, Edition 5 : The Printed Image, The Goodheart-Willcox Company, Inc.
2. J. Michael Adams, Printing Technology, Edition 5 : Delmer Publishers Inc.
3. Adams, Faux, Rieber : Printing Technology. Edition 3: Delmer Publishers Inc.
4. Helmut Kipphan : Handbook of Print Media : Springer-Verlag Berlin Heidelberg.
5. C. S Misra. : Technology of Offset Printing : Anupam Prakasan.
6. Viswanath Chakravarthy : A Hand Book for Printing & Packaging Technology. : Galgotia Publications Pvt. Ltd.
7. C. S Misra. : Printing Technology for Students : Anupam Prakasan.
8. Kenneth F. Hird, Charles E Finley : Offset Lithography Technology. Edition 4 : The Goodheart-Willcox Company, Inc.
9. Dr. Prakash Shetty : Printing Material Science : M J Publishers Chennai.
10. Richard D. Waner : Introduction to Security Printing : GATF USA.
11. Marianne Rosner, Klin Chuk : Packaging Design : Willy Inc. USA.
12. P I Varghese : Engineering Graphics with Autocad.: VIP Publishers Thrissur.
13. C. S Misra. : Printing Inks & Paper : Anupam Prakasan.
14. www.osha.gov
15. www.epa.gov
16. www.printwiki.org
17. www.fineprintsschool.com
18. www.pffc-online.com/mag/paper_roll_tack_printing