Swami Keshvanand Institute of Technology,
Management & Gramothan

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1.1.2 Midterm Paper and Solution (Sample)

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Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

I Mid Term Examination, April 2022

B.Tech./ Semester –VI **Branch: Mechanical**

Subject: Measurement & Metrology **Subject Code: 6ME3-01**

Time: 1½ Hours **Maximum Marks: 20**

Part A-Attempt *All* questions (Upto 25 words)

Q.1. Define interchangeability. [2]

Q.2. Define calibration. [2]

Q.3. What is zero, positive and negative error in micrometer. [2]

Part B- Attempt *any Two* questions (Upto 100 words)

Q.4 Define error in measurement. List the various types of errors. Explain any two errors. [1+1+1+1]

Q.5 Explain the principle and working of vernier caliper in linear measurement with neat sketch. [1+2+1]

Q.6 What is accuracy and precision? Differentiate between "Precision" and "Accuracy" with suitable example and neat diagram. [1+1+2]

Part C- Attempt *any One* question

Q.7 What is slip gauge? Why the slip gauges are termed as end gauges? Explain the method of making a required combination with help of slip gauges. Build the dimension of 34.587 mm using a set of M-112 slip gauges. [1+1+2+2]

Range (MM)	Steps (MM)	Number of Pieces
1.001 to 1.009	0.001	9
1.01 to 1.49	0.01	49
0.5 to 24.5	0.5	49
25, 50, 75, 100	25	4
1.0005	—	1
	Total	**112**

Q.8 Explain the working principle of sine bar with a neat diagram. Why is sine bar not suitable for measuring angles above 45°? Also mention sources of errors in sine bar. [2+2+1+1]

Swami Keshvanand Institute of Technology, Management &Gramothan,
Ramnagaria, Jagatpura, Jaipur-302017

Question Paper Solution

Branch :MechanicalSemester: VIth Subject: MM (6ME03-0) 1st mid term examination April 2022

Submitted By : Yogesh Kumar Sharma

Part A-Attempt *All* questions (Upto 25 words)

Q.1. Define interchangeability.

Ans. Interchangeability can be defined as it is a system of producing the mating parts. To reduce the cost and time, mass production of the system was developed. In the production systems, the components will be produced in one or more batches by different operations on different machines. [2]

Q.2. Define calibration. **[2]**

Ans. In measurement technology and metrology, **calibration** is the comparison of measurement values delivered by a device under test with those of a calibration standard of known accuracy. Such a standard could be another measurement device of known accuracy, a device generating the quantity to be measured such as a voltage, a sound tone, or a physical artifact, such as a meter ruler.

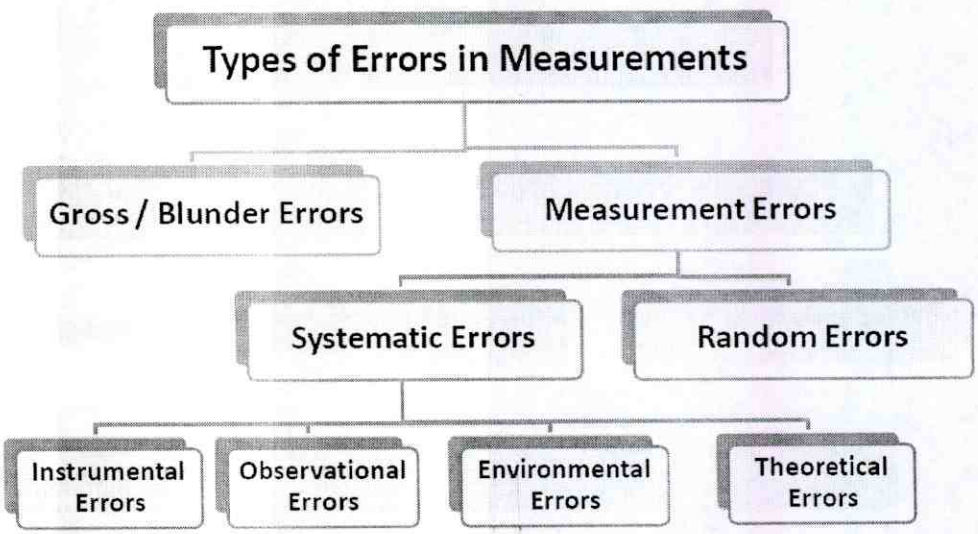
Q.3. What is zero, positive and negative error in micrometer. **[2]**

Ans. While working with a screw gauge, you need to make sure that the zero of the main scale coincides with the zero of the vernier scale.But in some cases this may not happen.

If the zero of the vernier scale lies to the bottom of the main scale, then its called positive zero error.If the zero of the vernier scale lies to the top of the main scale, then it is called negative zero error.

Part B- Attempt any *Two* questions (Upto 100 words)

Q.4 Define error in measurement. List the various types of error. Explain any two errors. [1+1+1+1]



1. Systematic errors: These are due to some known causes according to a definite law and are tend to be in one direction, either positive or negative. We can minimize the systematic errors by selecting better instruments, by improving the experimental techniques or procedures and by removing personal errors as far as possible. For a given experimental set-up, these systematic errors may be calculated to a certain extent and the necessary corrections may be applied to the observed readings.
2. Random error: It is the error caused by the individual who measures the quantity. The random error depends on the qualities of the measuring person and the care taken in the measuring process. It is also called as the chance error. In order to minimise random errors, the measurements are repeated several times and the average (arithmetic mean) value is taken as the correct value of the measured quantity. The mean value would be very close to the most accurate reading. When the number of observation is made 'n' times, the random error reduces to 1/n times. If a_1, a_2, a_3 ..... a_n are the n different readings of

Question Paper Solution

Branch :Mechanical Semester: VI[th] Subject: MM (6ME03-0) 1[st] mid term examination April 2022

Submitted By : Yogesh Kumar Sharma

a physical quantity when it is measured, the most accurate value is its arithmetic mean value which is given by

$$a_{mean} = \frac{a_1 + a_2 + ... + a_n}{n} = \frac{1}{n}\sum_{i=1}^{n} a_i$$

Q.5 Explain the principle and working of vernier caliper in linear measurement with neat sketch. [1+2+1]

Ans: A vernier caliper is an instrument which is most commonly used for a variety of exact measurements. There are three types of vernier caliper used in the physics laboratory to measure lengths of small objects accurately which could not have been possible with a metre scale.

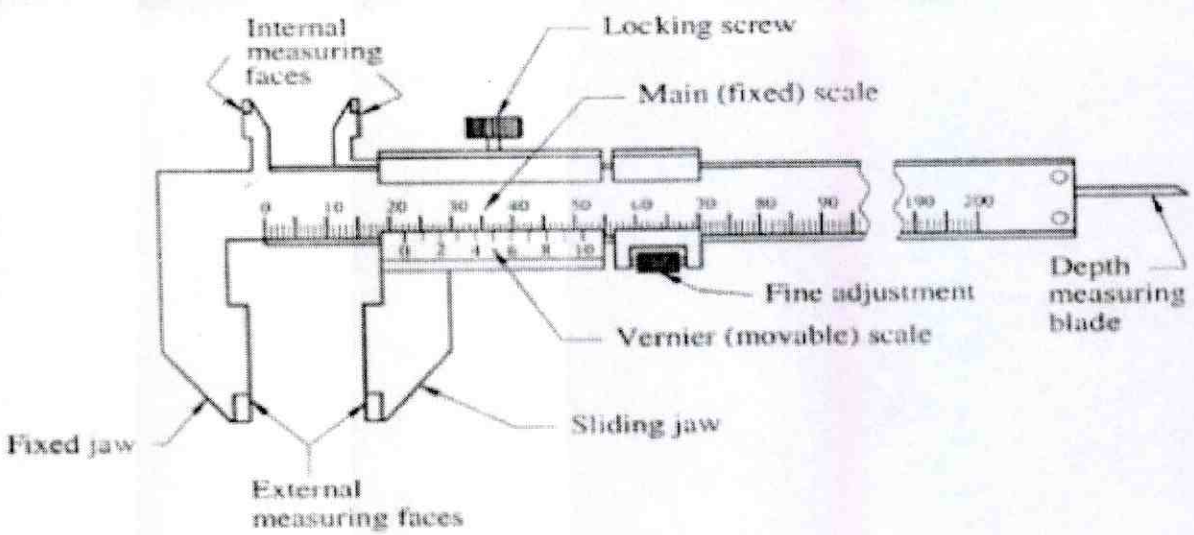
- Type A
- Type B
- Type C.

The main use of the vernier caliper is to measure the internal and external diameters of an object. The word caliper means any instrument with two jaws which is used to determine the diameters of objects.

The principle of the vernier caliper is that when two scales or divisions slightly different in size are used, then the difference between them is used to increase the accuracy measurement.
The main elements of the vernier caliper are the

- Main Scale
- Vernier scale
- Thumbscrew
- Lock screw
- Depth Rod
- Fixed jaw, and
- Sliding jaw

Construction :



THE PRINCIPLE OF VERNIER CALIPER

A scale cannot measure objects which are smaller than 1mm but a vernier caliper can measure objects up

to 1mm. As already know that vernier caliper has two scales the main scale and the vernier scale together this arrangement is used to measure very small lengths like 0.1mm.

Here the main scale has the least count of 1mm and vernier scale has the least count of 0.9mm. So therefore 10 unit of the main scale is 1cm whereas 10 unit of vernier scale is 0.9mm.

The unit of the vernier scale is 9mm. So this difference between the main scale and vernier scale which is 0.1mm is the working principle of vernier caliper.

VERNIER CALIPER LEAST COUNT

The difference between the value of one main scale division and the value of one Vernier scale division is known as the least count of the Vernier. Least count of vernier caliper is the smallest value that we can measure from this device. To calculate the least count of vernier caliper is the value of one main scale division divided by the total number of division on the vernier scale.

WORKING OF VERNIER CALIPER

The sliding jaw runs on the main scale with the guiding surface, which is accompanied by a vernier scale, in which it has a measuring tip on the left side.
When two measuring tip surfaces are in contact with each other, the scale shows zero reading.
The finer adjustment of the movable jaw can be done by adjusting screw. First, the whole movable jaw assembly is adjusted so that the two measuring tips just touch the part to be measured. Then lockout B is tightened.
Final adjustment depending upon the sense of correct feeling is made by adjusting screw, which makes the part containing locking nut A and sliding jaw to move, as the adjusting screw rotates on a screw which is in a way fixed to the movable jaw.
After all, the final adjustment has been done, the locking nut has also been tightened and the reading has been noted. Measuring tips are designed so that they can be used to measure external dimensions as well as internal dimensions.

Q.6 What is Accuracy and Precision? Differentiate between "Precision" and "Accuracy" with suitable example and neat diagram. [1+1+2]

Ans. The ability of an instrument to measure the accurate value is known as accuracy. In other words, it is the the closeness of the measured value to a standard or true value. Accuracy is obtained by taking small readings. The small reading reduces the error of the calculation. The accuracy of the system is classified into three types as follows:

Point Accuracy

The accuracy of the instrument only at a particular point on its scale is known as point accuracy. It is important to note that this accuracy does not give any information about the general accuracy of the instrument.

Accuracy as Percentage of Scale Range

The uniform scale range determines the accuracy of a measurement. This can be better understood with the help of the following example:
Consider a thermometer having the scale range up to 500°C. The thermometer has an accuracy of ±0.5, i.e. ±0.5 percent of increase or decrease in the value of the instrument is negligible. But if the reading is more or

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less than 0.5°C, it is considered a high-value error.

Accuracy as Percentage of True Value

Such type of accuracy of the instruments is determined by identifying the measured value regarding their true value. The accuracy of the instruments is neglected up to ±0.5 percent from the true value.

PRECISION

The closeness of two or more measurements to each other is known as the precision of a substance. If you weigh a given substance five times and get 3.2 kg each time, then your measurement is very precise but not necessarily accurate. Precision is independent of accuracy. The below example will tell you about how you can be precise but not accurate and vice versa. Precision is sometimes separated into:

Repeatability: The variation arising when the conditions are kept identical and repeated measurements are taken during a short time period.

Reproducibility: The variation arises using the same measurement process among different instruments and operators, and over longer time periods.

Accuracy	Precision
Accuracy refers to the level of agreement between the actual measurement and the absolute measurement.	Precision implies the level of variation that lies in the values of several measurements of the same factor.
Represents how closely the results agree with the standard value.	Represents how closely results agree with one another.
Single-factor or measurement.	Multiple measurements or factors are needed.
It is possible for a measurement to be accurate on occasion as a fluke. For a measurement to be consistently accurate, it should also be precise.	Results can be precise without being accurate. Alternatively, the results can be precise and accurate.

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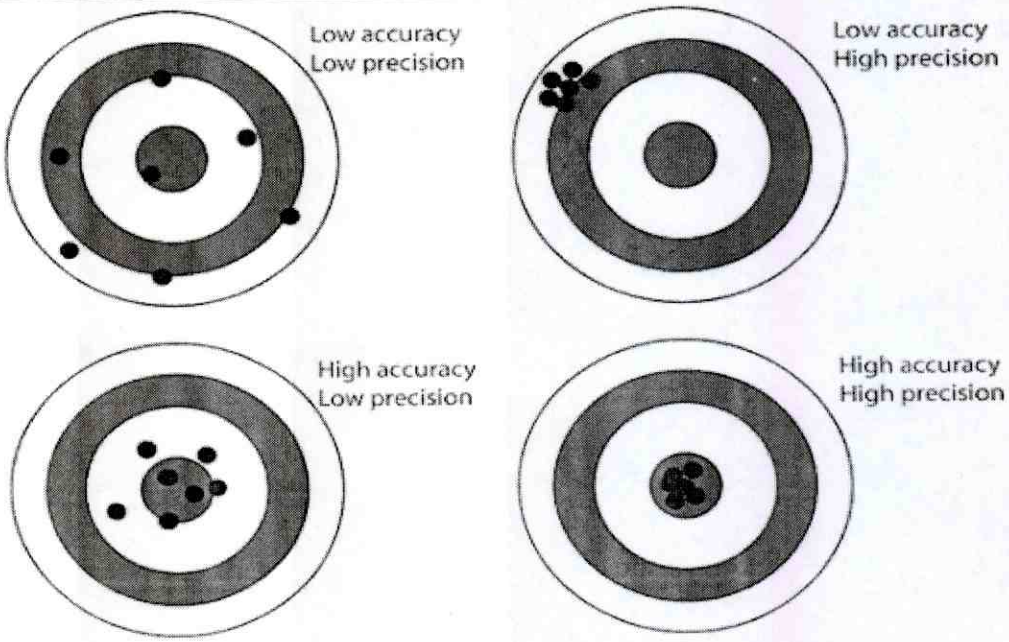

Part C- Attempt any *One* question

Q.7 What is slip gauge? Why the slip gauges are termed as end gauges? Explain the method of making a required combination with help of slip gauges. Build the dimension of 34.587 mm using a set of M-112 slip gauge. [1+1+2+2]

Range (mm)	Steps (mm)	No. of pieces
1.001 to 1.009	0.001	9
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0.5 to 24.5	0.5	49
25,50,75,100	25	4
1.0005	---	1
	Total	112

Ans. **Slip gauges** also known as Gauge blocks or **Johannson gauges** are cuboidal-shaped blocks of high-grade steel with a high finish. They are used mainly used as measuring standards in the engineering field.

These are first hardened to resist wear and carefully stabilized so that they are independent of any subsequent variation in size or shape.

The longer gauges in the set and length bars are hardened only locally at their measuring ends.

1.1 PROCEDURE OF WRINGING SLIP GAUGES

The two slip gauges in precision measurement are joined by the process called **"wringing"**

Step 1:

This is accomplished by pressing the faces into contact keeping them perpendicular such that it appears as a cross from the top.

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Submitted By : Yogesh Kumar Sharma

Step 2:

And then imparting a small twisting motion whilst maintaining the contact pressure. The contact pressure is just sufficient in order to hold the two slip gauges in contact and no additional intentional pressure.

Step 3:

It is found that the phenomenon of wringing occurs due to molecular adhesion between a liquid film (whose thickness may be between 6 to 7 x 10-6 mm) and the mating surfaces.

When two gauges are wrung together and the overall dimension of a pile made of two or more blocks so joined is exactly the sum of the constituent gauges.

The accuracy of micrometers, vernier calipers, dial indicators can be checked by a slip gauge
These may be used as reference standards for transferring the dimensions of the unit of length from the primary standard to gauge blocks of lower accuracy, and for the verification and graduation of measuring apparatus, as well as length measures for the regulation and adjustment of
indicating measuring apparatus and for direct measurement of linear dimensions of the industrial component.

APPLICATIONS OF SLIP GAUGES

(a) Reference standards for transferring the dimension of the unit of length from the primary standard to gauge blocks of lower accuracy and for the verification and graduation of measuring apparatus.

(b) Length measures for the regulation and adjustment of indicating measuring apparatus and for the direct measurement of linear dimensions of industrial components.

Given dimension is 34.587

Choose 1st slip gauge of 1.007

$$\begin{array}{r} 34.587 \\ 1.007 \\ \hline 33.58 \end{array} \quad \text{—— (1)}$$

Choose 1.08

$$\begin{array}{r} 33.58 \\ 1.08 \\ \hline 32.5 \end{array} \quad \text{—— (2)}$$

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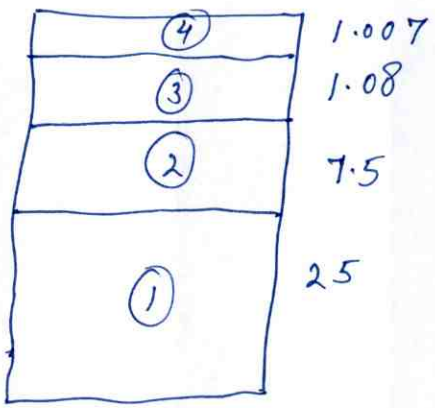
3rd slip gauge 7.5

32.5
7.5 — (3)
25 — (4)



Q.8 Explain the working principal of sine bar with a neat diagram. Why is sine bar not suitable for measuring angles above 45° ? Also mentions sources of errors in sine bar.
[2+2+1+1]

Ans. Sine Bar is a precise angle measuring instrument. It is used to measure angles very accurately or to align the workpiece at a given angle. Sine Bar is the most accurate instrument for measuring angles.

Sine bar is made up of high carbon high chromium corrosion resistance steel. Sine bar is made with this material so that it can avoid wear and tear of sine bar when handling. As the tear and wear are avoided, the errors are eliminated and the accuracy of the sine bar is maintained.

WORKING PRINCIPLE OF SINE BAR:

The principle of operation of the sine bar is based on the law of trigonometry.
If one roller of sine bar is placed on the surface plate and the other roller is placed on the height of slip gauges, then the structure formed by the sine bar, surface plate, and slip gauges forms a triangle. The hypotenuse of this triangle is the sine bar, perpendicular is formed by combination of slip gauges and the surface plate is the base.
Suppose the height of slip gauges is **H** and the length of the sine bar is **L**, then sine ratio the angle theta will be **H** divided by **L**.
Now the angle **θ** can be calculated as sine inverse of **H** divided by **L**.

Question Paper Solution

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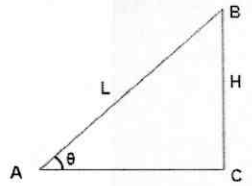


Sine Bar Working Principle

$$sin\theta = \frac{H}{L} \text{ or } \sin\theta = \frac{BC}{AB}$$

$$\theta = \sin^{-1}\left(\frac{H}{L}\right)$$

CONSTRUCTION OF SINE BAR:

A sine bar consists of a ground body made with hardened material like steel. Two rollers are attached at the end of the steel bar. The rollers are of equal diameters and axes of these rollers are parallel to each other.
The top of the steel bar is parallel to the line through the centres of two rollers.
The length of the sine bar is equal to distance between centre of two rollers.
This length of the sine bar is either 100mm, 200mm or 300 mm.This length is very precise and accurate.
Relief holes are provided just to minimize the weight of sine bar.

Only a sine bar alone can't be used for measurement of angles of a component. The sine bar is always used in association with slip gauges and height gauge for measurement of the angles.

Surface Plate:
A surface plate is used as the base for the arrangement of sine bar and other components like slip gauges and height gauge.
It can be assumed that the surface plate provides an exact horizontal surface to the sidebar. If we have a sine bar on the surface plate then the upper surface of the sine bar should be parallel to the horizontal surface of surface plate.

Dial Gauge:
A dial gauge is used to check the parallelism of a surface. If a dial gauge shows zero deflection while traveling on the surface, then we can say that the surface is parallel to its base. In the sine bar arrangement, the dial gauge is used to check whether the upper surface of the workpiece is parallel to the surface plate or not to measure the angle of tapered side of the workpiece.

Block Gauges or Slip Gauges:
Block Gauges or Slip Gauges are the standards for measuring the height or length of an object in a very precise manner.

Vernier height gauge:
A vernier height gauge is used to measure the height of the roller of the sine bar when the angle of a large component is to be measured.

Question Paper Solution

Branch :MechanicalSemester: VIth Subject: MM (6ME03-0) 1st mid term examination April 2022

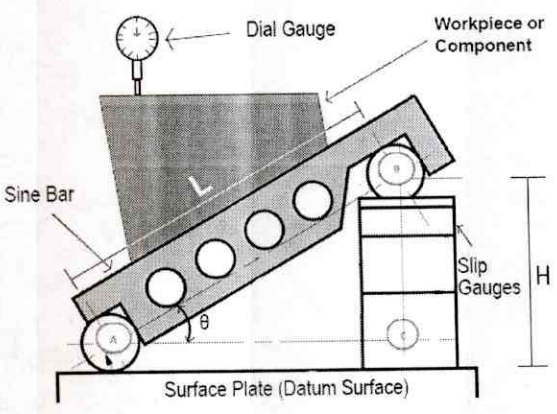
Submitted By : Yogesh Kumar Sharma

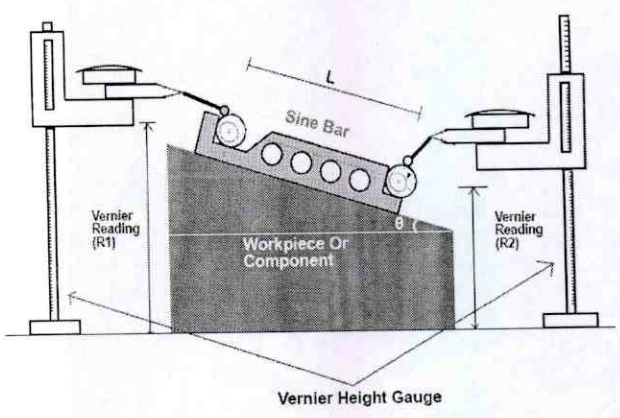
Working:

Working when angle of small component is to be measured:

To measure the angle of a small component, the sine bar is set up at an approximate angle on the surface plate by placing one roller of sine bar over the suitable number of slip gauges combination.
The component whose angle is to be measured is placed over the sine bar.
A dial gauge is used to check whether the upper surface of the component is parallel to the surface plate. This dial gauge is moved over the component throughout its length. The variation in parallelism of the upper surface of the component and the surface plate can be detected by the deflection of pointer of dial gauge.
After that the height of the slip gauges are adjusted by adding or removing block of slip gauges. It is adjusted until the reading of the dial gauge becomes zero throughout the length of the component.
When this condition is reached, the angle of component becomes equal to the angle of sine bar over the surface plate.

Now the angle of sine bar over surface plate can be easily measured by taking sine inverse of **H** divided by **L**, where **H** is the height of slip gauges and **L** is the length of sine bar.





Working when angle of large component is to be measured:

In case of large component, the sine bar is placed over the component as the component cannot be placed over the sine bar.
When the sine bar is placed over large component, the lower surface of the large component is parallel to the datum surface.
The sine bar is placed on the upper surface of the component. The upper surface of the component is inclined and its angle is to be measured.
The sine bar over the upper surface is also in an inclined position and there is difference in heights of two rollers of the sine bar.
The height of the two rollers is measured using vernier height gauge and the height of two rollers is written as **H1** and **H2**. Here the height **H1** is more than **H2**.
The difference in heights **H1** and **H2** is the rise of the sine-bar.
The measuring pressure is also measured using a dial gauge. The height gauges are until the dial gauge reading becomes zero each time.

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Question Paper Solution

Branch :Mechanical Semester: VIth Subject: MM (6ME03-0) 1st mid term examination April 2022

Submitted By : Yogesh Kumar Sharma

TYPES OF ERRORS IN SINE BAR:

1) Progressive Angle Error:

This error occurs duw to error in the distance of centres of two rollers.

2) Contant Angle Error:

This error occurs when the surface of the component and the roller axes are not parallel to each other.

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

I[st] Mid Term Examination, 2022

B.Tech./ Semester – III/VI | **Branch: ECE**

Subject: FOC | **Subject Code: 6EC4-03**

Time: 1½ Hours | **Maximum Marks: 24**

PART-A

Attempt All questions: **4*2**

Q.1 Write the Maxwell equation for dielectric medium. 2

Q.2 Differentiate Step Index and Graded Index Fiber 2

Q.3 State Snell's law condition for TIR Phenomenon. 2

Q.4 A silica optical fiber with a core diameter large enough to be considered by ray theory analysis has a core refractive index of 1.50 and a cladding refractive index of 1.47. Determine: (a) the critical angle at the core–cladding interface; (b) the acceptance angle in air for the fiber [1+1= 2]

PART-B

Attempt any Two questions: **2*4**

Q.5 A graded index fiber with a core axis refractive index of 1.5 has a characteristic index profile (α) of 1.90, a relative refractive index difference of 1.3% and a core diameter of 40μm. Estimate the number of guided modes propagating in the fiber when the transmitted light has a wavelength of 1.55μm, and determine the cutoff value of the normalized frequency for single-mode transmission in the fiber [2+2=4]

Q.6 Drive the electric field equations for homogeneous and inhomogeneous medium. [2+2=4]

Q.7 A 15 km optical fiber link uses fiber with a loss of 1.5 dB km^{-1}. The fiber is jointed every at every two kilometers with connectors which give an attenuation of 0.7 dB each. If the coupler is used to at both end of the fiber with attenuation of 0.2 dB each. Calculate the minimum mean optical power (in dBm) which must be launched into the fiber in order to maintain a mean optical power level of 0.6μw. 4

PART-C

Attempt any One question: **1*8**

Q.8 Explain the different types of attenuation mechanism in a optical fiber [3+2+3=8]

Q.9 Derive the relation for model analysis of wave Propagation in step index fiber (Cylindrical coordinate). [8]

Question Paper Solution

Branch : ECE Semester: VI Semester Subject: Fiber Optics Communication Mid Term: 1st

Submitted By : Dr. Monika Mathur, Ankit Agarwal

PART-A

Ans. 1. Maxwell equation give the relationships between the electric and magnetic fields. For a linear, isotropic dielectric medium these equation take the form

$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} \quad \text{——— (1)}$$

$$\nabla \times \vec{H} = \frac{\partial \vec{D}}{\partial t} \quad \text{——— (2)}$$

$$\nabla \cdot \vec{D} = 0 \quad \text{——— (3)}$$

$$\nabla \cdot \vec{B} = 0 \quad \text{——— (4)}$$

where $D = \epsilon E$ and $B = \mu H$. ϵ = Permittivity & μ = Permeability.

Ans 2. In step Index fiber having the refractive index of the core uniform throughout and undergoes on absupt changes at the core cladding boundary. The step index fiber are further two types single mode and multimode step index fibers.

In Graded index fiber the refractive index of the core is made to vary gradually such that it is maximum at the centre of core. The graded index fiber are only of multimode graded index fiber type.

Ans. 3. According to the snell's law for light propagating from denser medium n_1 to lower dielectric medium n_2 $(n_2 < n_1)$

$$n_1 \sin\phi_1 = n_2 \sin\phi_2$$

The critical angle can be found from snell's law, putting in an angle of 90° for the angle of the refracted ray θ_2

$$\therefore \sin\phi_c = \frac{n_2}{n_1} \quad (n_1 > n_2)$$

Ans. For any angle larger than the critical angle, Snell's law will not able to be solved for the angle of refraction In this case all the light is totally reflected off the interface, obeying the law of reflection.

Ans 4. Here given $n_1 = 1.50$ and $n_2 = 1.47$

The critical angle $\theta_c = \sin^{-1}\left(\frac{n_2}{n_1}\right)$

$= \sin^{-1}\left(\frac{1.47}{1.50}\right) = 78.52^\circ$ Ans

The acceptance angle $\alpha_m = \sin^{-1}\left(\sqrt{n_1^2 - n_2^2}\right)$

$\alpha_m = \sin^{-1}\left(\sqrt{n_1^2 - n_2^2}\right) = 17.36^\circ$ Ans

PART B.

Ans. 5 Given that $n_1 = 1.5$ $\alpha = 1.9$ $\Delta = 1.3\%$ $\alpha = 1.90$ $a = 40\ \mu m$ $\lambda = 1.55\ \mu m$. For n_2 we know $\frac{n_1 - n_2}{n_1} \approx \Delta \Rightarrow \frac{1.5 - n_2}{1.5} \approx \frac{1.3}{100} = 1.4805$

(i) $V = \frac{2\pi a}{\lambda} n_1 (2\Delta)^{1/2}$

putting the values $V = \frac{2 \times \pi \times 40}{1.55} \times 1.5 \times \left(2 \times \frac{1.3}{100}\right)^{1/2}$

$V = 39.21$

No. of modes $m_g = \frac{\alpha}{\alpha + 2} \frac{V^2}{2} \Rightarrow \frac{1.9}{3.9} \times \frac{(39.21)^2}{2} = 374.5$

(ii) Off value of normalized freq is (for single mode transmission)

$V_c = 2.405 \left(1 + \frac{2}{\alpha}\right)^{1/2}$

$= 2.405 \left(1 + \frac{2}{1.9}\right)^{1/2} = 2.405 \left(1 + 1.0526\right)^{1/2}$

$V_c = 2.405 \left(2.0526\right)^{1/2} \Rightarrow 3.445 \approx 3.45$

Question Paper Solution

Branch : ECE Semester: VI Semester Subject: Fiber Optics Communication Mid Term: I Midterm

Submitted By : Dr. Monika Mathur, Ankit Agarwal.

Ans 6 Maxwell's Equation

$$\nabla \times E = -\frac{\partial B}{\partial t}$$

$$\nabla \times H = J + \frac{\partial D}{\partial t}$$

$$\nabla \cdot D = \rho$$

$$\nabla \cdot B = 0.$$

$E \rightarrow$ Electric field vector (V/m)

$D \rightarrow$ Electric Displacement C/m^2

$H \rightarrow$ magnetic field vector (A/m)

$B \rightarrow$ magnetic induction vector (H/m)

$B = \mu H$; $\mu \rightarrow$ magnetic Permeability

$D = \varepsilon E$; $\varepsilon \rightarrow$ dielectric

Inside the ideal dielectric material, free charge density $\rho = 0$ and $\sigma = 0$; Therefore maxwell's equations for a dielectric medium modify to

$$\nabla \times E = -\frac{\partial B}{\partial t} \quad \text{—(1)}$$

$$\nabla \times H = \frac{\partial D}{\partial t} \quad \text{—(2)}$$

$$\nabla \cdot D = 0 \quad \text{—(3)}$$

$$\nabla \cdot B = 0. \quad \text{—(4)}$$

from Eq^n (1)

$$\nabla \times \nabla \times E = -\nabla \times \frac{\partial B}{\partial t} = -\frac{\partial}{\partial t}(\nabla \times B)$$

$$= -\mu \frac{\partial}{\partial t}(\nabla \times H) = -\mu \frac{\partial}{\partial t}\left(\frac{\partial D}{\partial t}\right)$$

$$= -\mu\varepsilon \frac{\partial^2 E}{\partial t^2}$$

$$\nabla \times (\nabla \times E) = \nabla(\nabla \cdot E) - \nabla^2 E \quad \text{— [4(b)]}$$

$\nabla \cdot E = \nabla \cdot (D/\varepsilon) = 0$ from Equation (3)

$$-\nabla^2 E = -\mu\varepsilon \frac{\partial^2 E}{\partial t^2} \quad \text{—(5)}$$

Similarly $$-\nabla^2 H = -\mu\varepsilon \frac{\partial^2 H}{\partial t^2} \quad \text{—(6)}$$

Question Paper Solution

Branch : ECE Semester: VI Semester Subject: Fiber Optics Communication Mid Term: I Midterm

Submitted By : Dr. Monika Mathur, Ankit Agarwal.

we write ψ to represent cartesian component of $E(E_x, E_y, E_z)$ or $H(H_x, H_y, H_z)$. than eq^n ⑤ & ⑥ become a set of scaler wave eq^n.

$$\nabla^2\psi - \mu\epsilon\frac{\partial^2\psi}{\partial t^2} = 0$$

$$\left[\begin{array}{l}\mu = \mu_0\mu_r \\ \epsilon = \epsilon_0\epsilon_r.\end{array}\right]$$

$$\nabla^2\psi - \mu_0\epsilon_0\mu_r\epsilon_r\frac{\partial^2\psi}{\partial t^2} = 0.$$

$$\nabla^2\psi - \frac{1}{v_p^2}\frac{\partial^2\psi}{\partial t^2} = 0 \quad \text{or} \quad \nabla^2\psi - \frac{n^2}{c^2}\frac{\partial^2\psi}{\partial t^2} = 0. \qquad \left[v_p = \frac{c}{n}\right]$$

$$\psi = \psi_0 \exp\{i(\omega t - \beta z)\}$$

$$E = E_0 \exp\{i(\omega t - \beta z)\} \Rightarrow \text{Electric field Equation for Homogeneous medium.}$$

for inhomogeneous medium.

$$\nabla\cdot D = \nabla\cdot(\epsilon E) = \nabla\cdot(\epsilon_0\epsilon_r E) = 0.$$

$$\epsilon_0\left[\nabla\cdot(\epsilon_r E)\right] = 0.$$

$$\epsilon_0\left[\nabla(\epsilon_r)\cdot E + \epsilon_r\nabla\cdot E\right] = 0.$$

$$\nabla\cdot E = -\frac{1}{\epsilon_r}\nabla(\epsilon_r)\cdot E \qquad -⑦$$

Put the value of eq^n ⑦ in eq^n 4(b).

$$\nabla\times\nabla\times E = -\mu\frac{\partial^2 D}{\partial t^2} = -\mu_0\epsilon_0\epsilon_r\frac{\partial^2 E}{\partial t^2} \qquad (\mu_r = 1)$$

$$\nabla^2 E - \nabla(\nabla\cdot E) - \mu_0\epsilon_0\epsilon_r\frac{\partial^2 E}{\partial t^2} = 0.$$

$$\boxed{\nabla^2 E + \nabla\left\{\frac{1}{\epsilon_r}\nabla(\epsilon_r)\cdot E\right\} - \mu_0\epsilon_0\epsilon_r\frac{\partial^2 E}{\partial t^2} = 0}$$

Electric field Equation for an inhomogeneous medium.

Question Paper Solution

Branch : ECE Semester: VI Semester Subject: Fiber Optics Communication Mid Term: I Midterm

Submitted By Anmonika mathur, Ankit Agarwal

Q.7 Given that $L = 15$ km

$\alpha_{dB} = 1.5$ dB/km.

Connector loss = 0.7 dB each

Coupler loss = 0.2 dB

No. of connector = 7

No. of coupler = 2.

radiated power $P_r = 0.6$ μW (received power)

Total loss $\Rightarrow \alpha_{dB} \cdot L + \alpha_{Conn} \times N + \alpha_{coup} \times N$

Total loss $= 1.5 \times 15 + 7 \times 0.7 + 0.2 \times 2$

$= 22.5 + 4.9 + 0.4$

Total loss $= 27.8$ dB $\Rightarrow 27.8 + 30$ dBm $= 57.8$ dBm.

Received Power $(P_r) = 0.6$ μW $\Rightarrow 0.6 \times 10^{-3}$ mW

$\Rightarrow -32.21$ dBm

$P_r = P_T -$ Total loss

$\Rightarrow P_T = P_r +$ loss

$= -32.21$ dBm $+ 57.8$ dBm

P_T (Tx Power) $\Rightarrow 25.58$ dBm. — Ans

Part-C

Q.8 Attenuation is the ratio of input optical power into the fiber to output optical power from the fiber.

Question Paper Solution

Branch : ECE Semester: VI Semester Subject: Fiber Optics Communication Mid Term: I Midterm

Submitted By : .....

Attenuation

- Absorption loss
  - Imperfection
  - Intrinsic loss
  - Extrinsic loss
- Scattering loss
  - Rayleigh scattering
  - mie scattering
- Bending loss.
  - macro bending
  - microbending.

Attenuation $\alpha_{dB} \cdot L = 10 \log_{10}\left(\frac{P_{in}}{P_{out}}\right)$

$P_o = P_i - \alpha_{dB} \cdot L \ (dB)$

$P_o = P_i \ 10^{-\alpha L/10} \ (W)$

Imperfection loss :- This loss is due to imperfect structure of optical fiber. The responsible reason of this loss is

i) Imperfection in core diameter.
ii) Imperfection in Refractive Index profile.

Intrinsic loss :- This loss appear due to photon absorption interaction with the main component of Glass. This loss occurs in the UV region and peak also in the IR region from 7 to 12 μm region.

Extrinsic loss :- This loss occur due to photon absorption interaction with the impurity added at the time of Glass fiber fabrication by conventional melting technique Impurity like copper and chromium can excess the attenuation by 1 dB/km. Other major impurities are hydroxyl or OH^- ions.

Hydroxyl ions causes large absorption at 1.37, 1.23, 0.95 μm.

Question Paper Solution

Branch : ECE | Semester: VI Semester | Subject: Fiber Optics Communication | Mid Term: I Midterm

Submitted By : Dr. Monika Mathur, Ankit Agarwal.

Scattering :- Scattering is due to random refractive index of the core. The Glass was formed using heat, which cause a random movement of the molecules and when solidified the molecules were frozen in their random location.

Rayleigh Scattering :- It occurs when the size of the density fluctuation is less than one-tenth of the operating wavelength. It is the main loss mechanism b/w UV and IR region and main source of loss.

Mie Scattering :- It occurs when size of defect is greater than one-tenth of the operating wavelength. This is caused by large defects in the core.

Rayleigh scattering Parameter $\gamma_R = \frac{8\pi^3}{3\lambda^4} n^8 p^2 \beta_c K T_F$

$$\zeta_{km} = \exp\{-\gamma_R L\}$$

$$\text{Attenuation} = 10 \log_{10}(1/\zeta_{km})$$

Bending loss :- Reason of radiation loss at bend or curves of fiber

Macrobending :- In this bend, the radius are large compared to the fiber diameter. These are large enough to be seen by the Human eye. $\alpha_b = C \exp(-C_2 R_b)$ and $R_c = \frac{3n_1^2 \lambda}{4\pi (n_1^2 - n_2^2)^{3/2}}$

Microbending :- microbending refers to small scale bending in the fiber. It is often from pressure exerted on the fiber.

Q.9 consider an ideal step-index fiber containing a uniform cylindrical dielectric rod of radius a and R.I n_1 surrounded by an infinitely thick uniform dielectric rod of cladding of R.I n_2. we attempt a solution of the wave equation for electric and magnetic fields for the modes propagation by such a fiber.

we know that the equations for an electric field in an isotropic, linear, non-conducting and non-magnetic but

Question Paper Solution

Branch : ECE Semester: VI Semester Subject: Fiber Optics Communication Mid Term: 1st

Submitted By : Monika Mathur, Ankit Agarwal

Ans. inhomogeneous medium is given by

$$\nabla^2 E + \nabla\left\{\frac{1}{\epsilon_r}\nabla(\epsilon_r)\cdot E\right\} - \mu_0\epsilon_0\epsilon_r\frac{\partial^2 E}{\partial t^2} = 0 \quad \text{—— (1)}$$

similarly the eqn for a magnetic field is given by

$$\nabla^2 H + \frac{1}{\epsilon_r}\left(\nabla(\epsilon_r)\times(\nabla\times H)\right\} - \mu_0\epsilon_0\epsilon_r\frac{\partial^2 H}{\partial t^2} = 0 \quad \text{—— (2)}$$

In the present case, the RI $n = \sqrt{\epsilon_r}$ is constant ($= n_1$) up to $r \le a$ and equal to n_2 for points $r > a$. but there is a discontinuity at $r = a$ Let us assume that this discontinuity is small (i.e. $n_1 \approx n_2$). This is called a weakly guiding approximation. with this approx the second term of L.H.S of eqn (1) may be neglected & each cartesian comp. of E & H satisfies the scalar wave eqn putting $\epsilon_r = n^2$

$$\nabla^2\psi = \epsilon_0\mu_0 n^2\frac{\partial^2\psi}{\partial t^2} \quad \text{—— (3)}$$

where ψ represents the scalar E & H field.

In cylindrical coordinates (r, ϕ, z) may be written as

$$\nabla^2\psi - \epsilon_0\mu_0 n^2\frac{\partial^2\psi}{\partial t^2} = \frac{\partial^2\psi}{\partial r^2} + \frac{1}{r}\frac{\partial\psi}{\partial r} + \frac{1}{r^2}\frac{\partial^2\psi}{\partial\phi^2} + \frac{\partial^2\psi}{\partial z^2} - \epsilon_0\mu_0 n^2\frac{\partial^2\psi}{\partial t^2} = 0 \quad \text{—— (4)}$$

since n may depend on transverse coordinate (r, ϕ) we may write

$$\psi(r, \phi, z, t) = \psi(r, \phi)\, e^{i(\omega t - \beta z)} \quad \text{—— (5)}$$

Substituting the value of ψ from (5) to (4)

Question Paper Solution

Branch : ECE Semester: VI Semester Subject: Fiber Optics Communication Mid Term: 1st

Submitted By : Monika mathur, Ankit Agarwal.

Ans $e^{i(\omega t-\beta z)}\frac{\partial^2\psi}{\partial r^2}+\frac{1}{r}e^{i(\omega t-\beta z)}\frac{\partial\psi}{\partial r}+\frac{1}{r^2}e^{i(\omega t-\beta z)}\frac{\partial^2\psi}{\partial\phi^2}$

$+\psi(-\beta^2)\,e^{i(\omega t-\beta z)}-\epsilon_0\mu_0 n^2(-\omega^2)\psi e^{i(\omega t-\beta z)}=0$ — (6)

or $\frac{\partial^2\psi}{\partial r^2}+\frac{1}{r}\frac{\partial^2\psi}{\partial r}+\frac{1}{r^2}\frac{\partial^2\psi}{\partial\phi^2}+\left[\epsilon_0\mu_0\omega^2n^2-\beta^2\right]\psi=0$ — (7)

putting $\epsilon_0\mu_0=\frac{1}{c^2}$ and $\frac{\omega}{c}=k$

$$\frac{\partial^2\psi}{\partial r^2}+\frac{1}{r}\frac{\partial\psi}{\partial r}+\frac{1}{r^2}\frac{\partial^2\psi}{\partial\phi^2}+\left[n^2k^2-\beta^2\right]\psi=0 \quad \text{— (8)}$$

since fiber under consideration has cylindrical symmetry

$$\psi(r,\phi)=R(r)\phi(\phi) \quad \text{— (9)}$$

where R is a function of only r and ϕ is a functio

$$\phi\frac{\partial^2R}{\partial r^2}+\frac{1}{r}\phi\frac{\partial R}{\partial r}+\frac{R}{r^2}\frac{\partial^2\phi}{\partial\phi^2}+\left[n^2k^2-\beta^2\right]R\phi=0 \quad \text{— (10)}$$

since the derivative involved are dependent either on r or ϕ only partial derivative may be replaced by full derivatives

$$\therefore \frac{1}{R}\frac{d^2R}{dr^2}+\frac{1}{Rr}\frac{dR}{dr}+\frac{1}{r^2}\frac{1}{\phi}\frac{d^2\phi}{d\phi^2}+\left[n^2k^2-\beta^2\right]=0$$

$$\frac{r^2}{R}\left(\frac{d^2R}{dr^2}+\frac{1}{r}\frac{dR}{dr}\right)+r^2\left(n^2k^2-\beta^2\right)=-\frac{1}{\phi}\frac{d^2\phi}{d\phi}=\ell^2(\text{say}) \quad \text{— (11)}$$

Question Paper Solution

Branch : ECE Semester: VI Semester Subject: Fiber Optics Communication Mid Term: I

Submitted By : Monika mathur, Ankit Agarwal.

Ans. ~~The eqn~~ where l is constant known as azimuthal eigenvalue

The complete transverse field will be given by

$$\psi(r, \phi, z, t) = R(r)\, e^{il\phi}\, e^{i(\omega t - \beta z)} \quad \text{——(11)}$$

The radial part of eq^n (10) may be write as

$$\frac{l^2}{R}\left(\frac{d^2R}{dr^2} + \frac{1}{r}\frac{dR}{dr}\right) + r^2(n^2k^2 - \beta^2) = l^2$$

which can be rearranged to give

$$\boxed{r^2\frac{d^2R}{dr^2} + r\frac{dR}{dr} + [r^2(n^2k^2 - \beta^2) - l^2]R = 0} \quad \text{——(12)}$$

4.04.2022
I

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

I Mid Term Examination, April 2022

B.Tech./ Semester –VIII **Branch: Mechanical**

Subject: Supply and Operations Management **Subject Code:8ME5-12**

Time: 1½ Hours **Maximum Marks: 24**

Section A (Attempt **ALL** questions. Each question carries **2 marks)**

Q.1 Define the term 'operations management'. [2]

Q.2 What is meant by the term 'mass customization' [2]

Q.3 Define Productivity. Enlist various types of Productivity. [2]

Q.4 What is meant by Competitiveness? [2]

Section B (Attempt **ANY TWO** questions. Each question carries **4 marks)**

Q.5 What are the differences between product and service? [4]

Q.6 Briefly describe historical evolution of operations management. [4]

Q.7 Briefly explain the product process matrix with the help of neat sketch. [4]

Section C (Attempt **ANY ONE** question. Each question carries **8 marks)**

Q.8 Star AC dealer has been experiencing overproduction and underproduction because of forecasting errors.

The following data are its demand in number of air conditioners for the past three weeks.

	3 Weeks Ago	2 Weeks Ago	Last Week
Demand	22000	19000	24000

Make a forecast of air conditioners for this week based on the following:

(i) Using a simple three-week moving average. [3]

(ii) Using exponential smoothing method (α =0.2). [3]

(iii) If the actual number of AC demand in this week is 21500 what is the forecast error for this week ? [2]

Q.9 The owner of a small hardware store has noted a sales pattern for window locks that seems to parallel the number of break-ins reported each week in the newspaper.

Break-ins	1	2	3	4	5	6	7
Sales	9	8	10	12	11	13	14

Develop the regression equation and determine the sales when break-ins are 10. [4+4]

Question Paper Solution & Marking Scheme.

Branch: ME Semester: VIII Subject: Supply and Operations Management Mid Term: I/II/~~Extra/Imp~~.

Submitted By : Mr. Dharmendra Hariyani and Dr. Achin Srivastav

Section A

Q.1 Define the term 'operations management'. [2]

Ans 1

Operations management is the management of systems or processes that create goods and/or provide services.

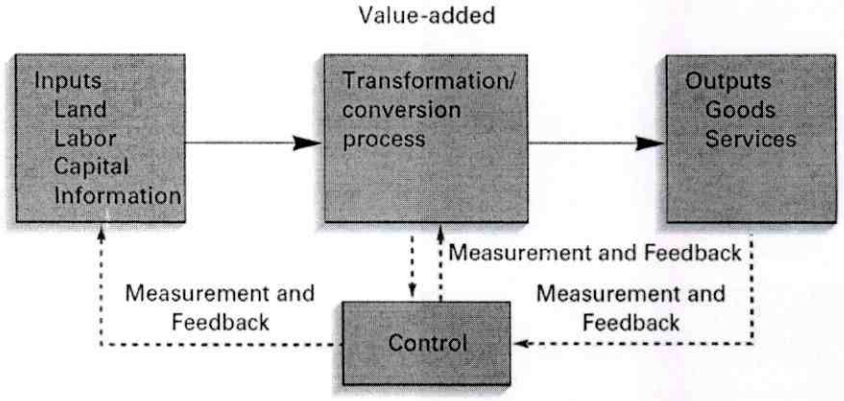

Fig. 1: Operations management as a transformation process

[1 and half Marks to be awarded for defining operations management correctly and 1/2 Mark for giving sketch of OM as a transformation process]

Q.2 What is meant by the term 'mass customization'. [2]

Ans 2

Mass customization, a strategy of producing standardized goods or services, but incorporating some degree of customization in the final product or service. [2]

[2 Marks to be awarded for defining mass customization]

Q.3 Define Productivity. Enlist various types of Productivity. [2]

Ans 3

Productivity is a measure of the effective use of resources, usually expressed as the ratio of output to input. Productivity is an index that measures output (goods and services) relative to the input (labor, materials, energy, and other resources) used to produce it. In business organizations, productivity ratios are used for planning workforce requirements, scheduling equipment, financial analysis, and other important tasks.

Types of Productivity: (i) Partial Productivity (ii) Multifactor Productivity and (iii) Total Productivity

[1 Mark to be awarded for defining productivity correctly and 1 Mark for enlisting types of productivity]

Q.4 What is meant by Competitiveness? [2]

Question Paper Solution

Branch: ME Semester: VIII Subject: Supply and Operations Management Mid Term: I/II/~~Extra/Imp~~.
Submitted By : Mr. Dharmendra Hariyani and Dr. Achin Srivastav

Ans 4

Competitiveness is how effectively an organization meets the wants and needs of customers relative to others that offer similar goods or services. Competitiveness is an important factor in determining whether a company prospers, barely gets by, or fails. Business organizations compete through some combination of price, delivery time, and product or service differentiation.

[2 Marks to be awarded for defining competitiveness correctly]

Q.5 What are the differences between product and service? [4]

Ans 5

Differences between Product and Service:

Characteristic	Product	Service
Output	Tangible	Intangible
Customer contact	Low	High
Behavioral skill content	Low	High
Demand Variability	Low	High
Variety of input	Low	High
Measurement of productivity	Easy	Difficult
Opportunity to correct problems	High	Low
Inventory	Much	Little
Evaluation	Easier	Difficult
Patentable	Usually	Not usual

[1/2 Mark to be awarded for mentioning single difference between Product and Service and up to a maximum 4 Marks for mentioning eight or more differences correctly]

Q6. Briefly describe historical evolution of operations management. [4]

Ans 6

Historical summary of operations management can be listed as below:

1776 Division of labor – Adam Smith
1790 Interchangeable parts - Eli Whitney
1911 Principles of scientific management - Frederick W. Taylor
1911 Motion study, use of industrial psychology - Frank and Lillian Gilbreth
1912 Chart for scheduling activities - Henry Gantt

1913 Moving assembly line – Henry Ford
1915 Mathematical model for inventory ordering – F. W. Harris
1930 Hawthorne studies on worker motivation – Elton Mayo
1935 Statistical procedures for sampling & quality control– H.F.Dodge, H.G. Romig, W. Shewhart, Tippett
1940 Operations research applications in warfare – Operations research groups
1947 Linear programming – George Dantzig
1951 Commercial digital computers – Sperry Univac, IBM
1950s Automation – Numerous
1960s Extensive development of quantitative tools – Numerous
1960s Industrial dynamics – Jay Forrester
1975 Emphasis an manufacturing strategy - W. Skinner
1980s Emphasis on flexibility, time-based competition, lean production – T. Ohno, S. Shingo, Toyota
1980s Emphasis on quality - W. Edwards Deming, J. Juran, K. Ishikawa
1990s Internet, supply chain management – Numerous
2000s Applications service providers, outsourcing, Social media, YouTube, and others - Numerous

[1/2 Mark to be awarded for listing singe historical evolution event and up to a maximum 4 Marks for listing eight or more events correctly]

Q7 Briefly explain the importance of the product process matrix with the help of neat sketch.[4]

Ans 7

The product-process matrix (Table 1) can facilitate the understanding of the strategic options available to a company, particularly with regard to its manufacturing function. A firm may be characterized as occupying a particular region in the matrix, determined by the stages of the product life cycle and its choice of production process(es) for each individual product.

		Volume per Product (Run)			
		Low volume	Moderate volume	High volume	Very high volume
Product Variety	High variety	Process focus			
	Moderately high variety		Batch	Mass customization	
	Moderate variety			Repetitive	
	Low variety				Product focus

Table 1: Product Process Matrix

Those in the upper-left quadrant of the matrix (job shop and batch) share a number of characteristics, as do those in the lower-right quadrant (assembly line and continuous). Upper-left firms employ highly skilled craftsmen (machinists, printers, tool and die makers, musical instrument craftsmen) and professionals (lawyers, doctors etc).

Most job shops tend to emphasize flexibility over efficiency. Since efficiency is not a strong point of upper-left firms, neither is low-cost production. Also, the low volume of production does not allow upper-left firms to spread their fixed costs over a wide enough base to provide for reduced costs. Finally, upper-left firms are also more likely to serve local markets.

Lower-right firms require production facilities that are highly specialized, capital intensive, and interrelated (therefore, inflexible). Labor requirements are generally unskilled or semi-skilled at most. Much of the labor requirement deals with merely monitoring and maintaining equipment. Lower-right firms are also more likely to serve national markets and can be vertically integrated.

[2 Marks to be awarded explaining Product Process Matrix and 2 Marks for drawing the Product Process Matrix correctly]

Section C

Q8 Star AC dealer has been experiencing overproduction and underproduction because of forecasting errors.

The following data are its demand in number of air conditioners for the past three weeks.

	3 Weeks Ago	2 Weeks Ago	Last Week
Demand	22000	19000	24000

Make a forecast of air conditioners for this week based on the following:

(i) Using a simple three-week moving average. [3]

(ii) Using exponential smoothing method (α =0.2). [3]

(iii) If the actual number of AC demand in this week is 21500 what is the forecast error for this week. [2]

Ans 8

(i)

$$F_t = \text{MA}_n = \frac{\sum_{i=1}^{n} A_{t-i}}{n} = \frac{A_{t-n} + \cdots + A_{t-2} + A_{t-1}}{n}$$

where

F_t = Forecast for time period t

MA_n = n period moving average

A_{t-i} = Actual value in period $t - i$

n = Number of periods (data points) in the moving average

Period	Demand	Three Month Simple Moving Averages
Three Weeks Ago	22000	
Two Weeks Ago	19000	
Last Week	24000	
This Week		**(22000+19000+24000)/3 = 21666.67**

[1 ½ Marks to be awarded for writing correct formula and up to a maximum 3 Marks to be awarded on computing correct answer]

(ii) Exponential Smoothing formula:

$$\text{Next forecast} = \text{Previous forecast} + \alpha(\text{Actual} - \text{Previous forecast})$$

where (Actual − Previous forecast) represents the forecast error and α is a percentage of the error.

$$F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1})$$

where

F_t = Forecast for period t
F_{t-1} = Forecast for the previous period (i.e., period $t - 1$)
α = Smoothing constant (percentage)
A_{t-1} = Actual demand or sales for the previous period

	Demand A_{t-1}	α	F_{t-1}	Error = $(A_{t-1} - F_{t-1})$	$F_t = F_{t-1} + \alpha (A_{t-1} - F_{t-1})$
3 Weeks Ago	**22000**	0.2	22000	0	22000
2 Weeks Ago	**19000**	0.2	22000	-3000	21400
Last Week	**24000**	0.2	21400	2600	21920
This Week			**21920**		

[1 ½ Marks to be awarded for writing correct formula and up to a maximum 3 Marks to be awarded on computing correct answer]

(iii) Error = Actual Demand- Forecast (Moving Average)
=21500-21667
= - 167

Error = Actual Demand- Forecast (Exponential Smoothing)
=21500-21920
= - 420

[1 mark to be awarded for determining error using moving average or exponential smoothing method and up to a maximum 2 marks to be awarded on computing error correctly with both methods]

Ans 9

X	Y	X^2	Y^2	X^Y
1	9	1	81	9
2	8	4	64	16
3	10	9	100	30
4	12	16	144	48
5	11	25	121	55
6	13	36	169	78
7	14	49	196	98

$\sum X = 28 \sum Y = 77 \sum X^2 = 140 \sum Y^2 = 875 \sum XY = 334$

$$\overline{X} = \frac{\Sigma X}{N} = \frac{28}{7} = 4 ,$$

$$\overline{Y} = \frac{\Sigma Y}{N} = \frac{77}{7} = 11$$

Regression coefficient

$$b_{yx} = \frac{N\Sigma XY - (\Sigma X)(\Sigma Y)}{N\,\Sigma X^2 - (\Sigma X)^2}$$

$$= \frac{7(334) - (28)(77)}{7(140) - (28)^2}$$

$$= \frac{2338 - 2156}{980 - 784}$$

$$= \frac{182}{196}$$

$$\therefore \quad b_{yx} = 0.929$$

Regression equation of Y on X

$$Y - \overline{Y} = b_{yx}(X - \overline{X})$$

$$Y - 11 = 0.929\,(X - 4)$$

$$Y = 0.929X + 7.284$$

[1 Mark to be awarded for writing correct formula, 2 Mark to be awarded for computing regression coefficients correctly and up to a maximum 4 Marks to be awarded on developing regression equation correctly]

To compute Sales for window locks when break-ins are 10

$$Y = 0.929 \times 10 + 7.284 = 16.57 \approx 17$$

Sales for 17 window locks when break-ins are 10

[4 Marks to be awarded on computing sales for window locks correctly]