B V RAJU COLLEGE

BHIMAVARAM

To support that the institution ensures effective curriculum delivery through a well planned and documented process; we are here by providing the sample copies of teaching/lesson plans, some handouts, sample PPT's of some departments.

B.V.RAJU COLLEGE

VISHNUPUR – BHIMAVARM -534202

DEPARTMENT OF PHYSICS & ELECTRONICS

HAND OUTS

B.V.RAJU COLLEGE

VISHNUPUR – BHIMAVARM -534202

DEPARTMENT OF PHYSICS & ELECTRONICS

DEPARTMENT OF PHYSICS AND ELECTRONICS

1. Dr. CH. V. SRINIVAS, M.Sc., Ph.D.,
2. B. KIRAN, M.Sc., APSET, (Ph.D),
3. K. ESWARA PRASAD, M.Sc., ELECTRONICS,
4. K. SATYANARAYANA RAJU, M.Sc., ELECTRONICS
5. B.S.SESHAGIRI RAO, M.Sc., TECH ELECTRONICS
6. Y. KIRAN KUMAR, M.Sc., B.Ed.,
7. K.K.J. CHAKRAVARTHI, M.Sc ELECTRONICS, M.Sc PHYSICS
8. B.KAVYA, M.Tech, ECE
9. V.N.V.RADHA KRISHNA MURTY, M.Sc., M.Phil., (Ph.D),
10. CH.CH.V.V.B.VASANTH, M.Sc., PHYSICS,
11. S. NAGA MANI, M.Sc.,
12. B. NAGA SESHU, M.Sc., PHYSICS,

PHYSICS SYLLABUS 2020-21

I B.Sc I SEMESTER: MECHANICS, WAVES AND OSCILLATIONS

Learning outcomes:

 to understand basic theories related with properties of matter and its applications to determine values of various physical quantities associated with matter.

 be able to apply knowledge of the properties of matter to explain natural physical processes and related technological advances.

 to learn about fundamentals of verbal and mathematical concepts of waves and oscillations

 we should make the students to know their skills required to get the information from the syllabus and use them in a proper way

UNIT I:

Mechanics of Particles: Review of Newton's Laws of Motion, Motion of variable mass system, Motion of a rocket, Multistage rocket, Concept of impact parameter, scattering cross-section, Rutherford scattering-Derivation.

Mechanics of Rigid bodies: Rigid body, rotational kinematic relations, Equation of motion for a rotating body, Angular momentum and Moment of inertia tensor, Euler equations, Precession of a spinning top, Gyroscope, Precession of the equinoxes

UNIT II:

Motion in a Central Force Field: Central forces, definition and examples, characteristics of central forces, conservative nature of central forces, Equation of motion under a central force, Kepler's laws of planetary motion- Proofs, Motion of satellites, Basic idea of Global Positioning System (GPS), weightlessness, Physiological effects of astronauts

UNIT III:

Relativistic Mechanics: Introduction to relativity, Frames of reference, Galilean transformations, absolute frames, Michelson-Morley experiment, negative result, Postulates of Special theory of relativity, Lorentz transformation, time dilation, length contraction, variation of mass with velocity, Einstein's mass-energy relation.

UNIT IV:

Undamped, Damped and Forced oscillations: Simple harmonic oscillator and solution of the differential equation, Damped harmonic oscillator, Forced harmonic oscillator – Their differential equations and solutions, Resonance, Logarithmic decrement, Relaxation time and Quality factor.

Coupled oscillations: Coupled oscillators - introduction , Two coupled oscillators, Normal coordinates and Normal Modes.

UNIT V:

Vibrating Strings: Transverse wave propagation along a stretched string, General solution of wave equation and its significance, Modes of vibration of stretched string clamped at ends, Overtones and Harmonics.

Ultrasonic's: Ultrasonics, General Properties of ultrasonic waves, Production of ultrasonics by piezoelectric and magnetostriction methods, Detection of ultrasonics, Applications of ultrasonic waves, SONAR

REFERENCE BOOKS:

1. Sc. Physics, Vol.1, Telugu Academy, Hyderabad
2. Fundamentals of Physics Vol. I - Resnick, Halliday, Krane ,Wiley India 2007
3. College Physics-I. T. Bhimasankaram and G. Prasad. Himalaya Publishing House.
4. University Physics-FW Sears, MW Zemansky& HD Young,Narosa Publications, Delhi
5. Mechanics, S.G.Venkatachalapathy, Margham Publication, 2003.
6. Waves and Oscillations. N. Subramanyam and Brijlal, VikasPulications.
7. Unified Physics - Waves and Oscillations, Jai PrakashNath&Co.Ltd.
8. Waves & Oscillations. S.Badami, V. Balasubramanian and K.R. Reddy, Orient Longman.
9. The Physics of Waves and Oscillations, N.K.Bajaj, Tata McGraw Hill
10. Science and Technology of Ultrasonics- Baldevraj, Narosa, New Delhi,2004

Details of Lab/Practical/Experiments/Tutorials syllabus:

DEPARTMENT OF PHYSICS AND ELECTRONICS

PHYSICS LAB EXPERIMENTS

Minimum of 6 experiments to be done and recorded:

1. Young’s modulus of the material of a bar (scale) by uniform bending

2. Young’s modulus of the material a bar (scale) by non- uniform bending

3. Surface tension of a liquid by capillary rise method

4. Viscosity of liquid by the flow method (Poiseuille’s method)

5. Bifilar suspension –Moment of inertia of a regular rectangular body.

6. Fly-wheel -Determination of moment of inertia

7. Rigidity modulus of material of a wire-Dynamic method (Torsional pendulum)

8. Volume resonator experiment

9. Determination of ‘g’ by compound/bar pendulum

10. Simple pendulum- normal distribution of errors-estimation of time period and the error of the mean by statistical analysis

11. Determination of the force constant of a spring by static and dynamic method.

PHYSICS AND ELECTRONICS

PHYSICS LAB 1: ROOM NO: 211

PHYSICS LAB 2: ROOM NO: 212

PHYSICS LAB 3: DARK ROOM

ELECTONICS LAB 1: ROOM NO: 214

ELECTONICS LAB 2: ROOM NO: 213

Padmasri Dr. B.V. Raju Institute of Computer Education

Vishnupur, Bhimavaram

Lesson plan 2020- 2021

Name of the Faculty: B.S. SESHAGIRI RAO **Group:** MECS.B

Department: physics & Electronics **Title of Paper:** Digital Electronics **Paper:** 3. (III Sem)

S.No.	Period	Unit No.	Chapter Name	Topic Name	Text book Name & Page No.	Activity	Objective
1	1	-	-	Introduction to syllabus	-	-	-
2	2	I	No System & Codes	Introduction to no systems	unified electronics - III 293-330	practice the conversions	detailed study
3	3		"	Decimal, Binary systems & Conversions			
4	4		"	Hexadecimal, octal systems conversions	-do-	-do-	-do-
5	5		"	BCD system conversions			
6	6		"	1's & 2's Complements			

S.No.	Period	Unit no	Chapter Name	Topic Name	Text book Name & Page no	Activity	Objective
7	7		"	9's & 10's complements	Unified electronics IV 333-340	practice for complement & subtraction	detailed study
8	8		"	Addition & Subtraction			
9	9		"	Gray & Excess-3 codes - Conversion			
10	10	5	Boolean Algebra & theorems	Introduction to Boolean Algebra	Unified electronics IV 361-398		
11	11		"	Boolean theorems - proof			
12	12		"	De Morgan's laws - proof		verify laws in the lab	detailed study
13	13		"	Digital logic gates - logic OR gate			
14	14		"	AND, NOT logic gates			

S.No.	Period	Unit no	Chapter Name	Topic Name	Text book Name & Page no	Activity	Objective
15	15	II	Boolean Algebra & theorems	NAND, NOR logic gates	Unified electronics & 342-351	Verify the logic gates	detailed study
16	16		"	Universal (multi level) gates = NAND, NOR			
17	17		"	Solving some problems		in the lab	
18	18		"	Standard representation POS & SOP			
19	19		"	Karnaugh map with 4 variables	Unified electronics & 353-358	practice reduction	detailed study
20	20		"	Karnaugh map with 5 variables			
21	21		"	Map method with don't care condition		method	
22	22		"	Solving some problems			

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S.No.	Period	Unit no	Chapter Name	Topic Name	Text book Name & Page no	Activity	Objective
23	23	III	Combinational digital circuit	introduction - Half adder	Unified electronics 355 - 368	verify the adders in lab	detailed study
24	24		"	Full adder - Truth Table			
25	25		"	Half Subtractor - T.T			
26	26		"	Full Subtractor - T.T			
27	27		"	Parallel binary adder			
28	28		"	magnitude Comparator - ckt	Digital logic and B.Ram 250-259	verify the	detailed study
29	28		"	Multiplexers (2:1, 4:1)		study in the	
30	30		"	De multiplexers (1:2, 1:4)		lab	

S.No.	Period	Unit no	Chapter Name	Topic Name	Text book Name & Page no	Activity	Objective
31	31	III	Combinational Digital circuits	Encoder - 8 to 3 line-ckt	Digital logic ckts M.M. Mano	verify the ckts in lab	detailed study
32	32		"	Decoder - 3 to 8 line-ckt			
33	33		"	IC logic families - TTL logic			
34	34		"	DTL & RTL logic ckts	Unified electronics III	observe the ckt in lab	detailed study
35	35		"	CMOS logic families			
36	36		"	NAND gate - Truth Table			
37	37		"	NOR gate - Truth Table			
38	38		"	Bi-CMOS inverter.			

Faculty HOD PRINCIPAL

S.No.	Period	Unit no	Chapter Name	Topic Name	Text book Name & Page no	Activity	Objective
39	39	IV	Sequential digital Circuits	Introduction - SR FF	Unified Electronics FF	verify the [illegible]	detailed Study
40	40		"	JK FF - truth table		FFs in lab	
41	41		"	T & D type FF - truth tables			
42	42		"	Master slave FFs - Excitation Tables			
43	43		"	Introduction to registers	Unified electronics IV	observe [illegible]	detailed Study
44	44		"	Shift left registers - ckt		CKT in lab	
45	45		"	Shift right registers - ckt			
46	46		"	basic working of Counters by FFs			

S.No.	Period	Unit no	Chapter Name	Topic Name	Text book Name & Page no	Activity	Objective
47	47	IV	Sequential Digital ckts	Asynchronous Counter - Mod 16 ckt	Unified electronics III	observe the	detailed study
48	48		"	Mod 10, Mod-8 Counter - timing diagram		ckt in lab	
49	49		"	Down Counter - ckt			
50	50		"	4 bit Synchronous Counter.			
51	51		"	Ring Counter - ckt.			
52	52	V	Memory Devices	General Memory operations	Digital logic ckts M M Mano	observe the	detailed study
53	53		"	ROM - ckt (Static & Dynamic)		ckt in lab	
54	54		"	RAM - ckt (Static & Dynamic)			

Faculty HOD PRINCIPAL

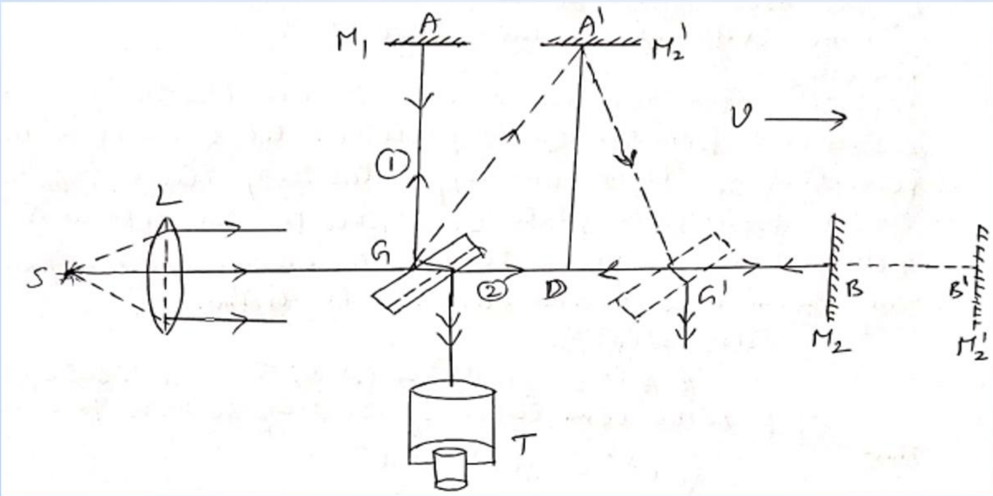
S.No.	Period	Unit no	Chapter Name	Topic Name	Text book Name & Page no	Activity	Objective
55	55	V	Memory devices	PROM, EPROM - ckts -	Digital Design M.M. Mano	observe in ckt in lab	Detailed study
56	56		"	EEPROM - ckt - working			
57	57		"	EAPROM - ckt - working			
58	58		"	Timing characteristics of memory devices	- do -	- do -	- do -
59	59		"	PLA - ckt - working			
60	60		"	PAL - ckt - working			

Faculty HOD PRINCIPAL

MICHELSON-MORLEY EXPERIMENT

In order to search for an absolute frame of reference and to determine the absolute velocity of the earth with respect to ether frame, Michelson-Morley carried out an experiment using Michelson Interferometer.

The experimental arrangement is shown in figure.



- If the apparatus is initially at rest in ether, the two reflected rays would take equal time to return the glass plate G. But actually the whole apparatus is moving along with the earth.
- Let us suppose that direction of motion of the is earth in the direction of the initial beam.
- Due to the motion of the earth, the optical paths of the two rays are are not the same.
- The reflections at the mirrors M_1 *and* M_2 do not take place at A and B but at A′ and B′ respectively.
- Thus the times taken by the two rays to travel to the two mirrors and back to G will be different in this case.

Theory:

- Let the two mirrors M_1 *and* M_2 be at an equal distance l from the glass plate G.
- Let c and v be the velocities of light and apparatus respectively.
- The reflected ray (1) from glass plate G strikes the mirror M_1 at A′ and not at A due to the motion of the earth. The total path of the ray from G to A′ and A′ to G′ will be G A′ G′.
- From the ΔGA′D,

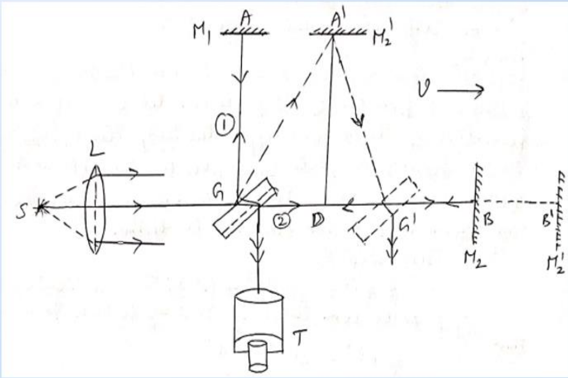
$$(GA')^2 = (AA')^2 + (A'D)^2$$

If t be the time taken by the light ray to move from G to A′, then

$$(ct)^2 = (vt)^2 + (l)^2$$

$$t^2(c^2 - v^2) = l^2$$

$$\text{Or } t = \frac{l}{\sqrt{(c^2-v^2)}}$$



- If t_1 be the time taken by the ray to travel the whole path G A′ G′, then,

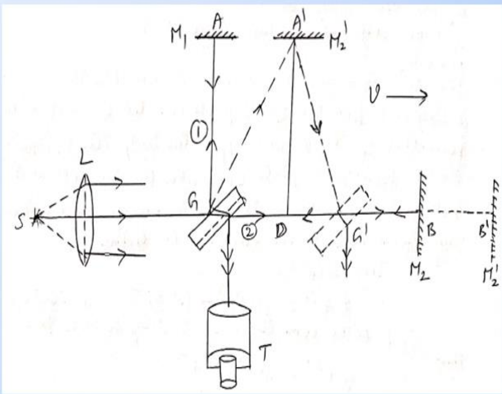
$$t_1 = 2t = \frac{2l}{\sqrt{(c^2-v^2)}}$$

On solving, we get $t_1 = \frac{2l}{c}\left(1 + \frac{v^2}{2c^2}\right)$ ------------(1)

- Now, the transmitted ray 2 which is moving longitudinally
- towards mirror M_2 has a velocity (c-v) relative to the
- apparatus when it is moving from G to B and during its
- return journey, its velocity relative to apparatus is (c+v).
- If t_2 be the time taken by the longitudinal ray 2 to
- travel the whole path G to B and G′ to B′, then,

$$t_2 = \frac{l}{c-v} + \frac{l}{c+v}$$

On solving, we get $t_2 = \frac{2l}{c}\left(1 + \frac{v^2}{c^2}\right)$ ------------(2)



- Thus the difference in times of travel is

$$\Delta t = t_2 - t_1$$

$$= \frac{2l}{c}\left(1 + \frac{v^2}{c^2}\right) - \frac{2l}{c}\left(1 + \frac{v^2}{2c^2}\right)$$

On solving, we get

$$\Delta t = \frac{lv^2}{c^3} \quad \text{--------------(3)}$$

- Therefore, optical path difference between two rays is given by

$$\Delta = \text{velocity X } \Delta t = c\,\Delta t$$

If λ is the wavelength of light used, then the path difference in terms of wavelength is

$$\Delta = \frac{lv^2}{c^2\lambda} \quad \text{--------------(4)}$$

- Michelson and Morley performed the experiment in two steps i.e., firstly by the setting shown in figure and secondly by turning the apparatus through 90^0. When the apparatus was turning through 90^0, the positions of two mirrors are changed.
- Now, the path difference is in opposite directions i.e., the path the path difference is $\Delta = -\frac{lv^2}{c^2\lambda}$
- The resultant path difference now becomes,

$$\Delta = \frac{lv^2}{c^2\lambda} - \left(-\frac{lv^2}{c^2\lambda}\right) = \frac{2lv^2}{c^2\lambda} \quad \text{-------------(5)}$$

- The change in optical path difference by λ corresponds to a shift of one fringe and hence, the path difference $\frac{2lv^2}{c^2\lambda}$ corresponds to a fringe shift of $\frac{2lv^2}{c^2\lambda}$
- Therefore Fringe shift $n = \frac{2lv^2}{c^2\lambda}$ --------------(6)

- In Michelson-Morley experiment,
  $l = 1.0X10^3$ cm, $\lambda = 5.0X10^{-5}$cm,
  $v = 3X10^6$ cm/sec and $c = 3X10^{10}$ cm/sec
- Therefore, Fringe shift $n = \frac{2lv^2}{c^2\lambda} = \frac{2X1.0X10^3X(3X10^6)^2}{(3X10^{10})^2\ 5X10^{-5}}$

  On solving, we get n = 0.4 fringe
- Thus a shift of less than half a fringe was only expected. Michelson and Morley could not observe any measurable fringe shift.
- They repeated the experiment at different points on the earth's surface and in different seasons of the year.
- But they could not detect any measurable shift. So, it was a "null result" or "negative result".

Explanation of negative result:

- Ether-drag theory and Fitzgerald-Lorentz Contraction hypothesis fails to explain negative result. But Negative result was explained by light velocity hypothesis.
- The negative result suggest that it is impossible to measure the speed of the earth relative to ether or the concept of a fixed frame of reference like ether filling all space cannot be checked by experiment.
- In this way the null result of experiment lead to the total rejection of ether hypothesis. This suggests that "the speed of light in vacuum is the same in all frames of reference which are in uniform relative motion".

TIME DILATION

- Let us consider two inertial frames of $S\ and\ S'$ and let S be at rest and S' be moving with a velocity $\vec{v}$ relative to S in the positive X-axis.
- Suppose a clock is situated in the frame S at position x and gives signals at an interval Δt i.e., $\Delta t = t_2 - t_1$ -------------(1)
- If this interval is observed by an observer in frame S', then the time interval $\Delta t'$ recorded by him is given by

$$\Delta t' = t_2' - t_1' \text{ -------------(2)}$$

- According to Lorentz transformation equations, we have

$$t_1' = \frac{\left(t_1 - \frac{xv}{c^2}\right)}{\sqrt{1-\frac{v^2}{c^2}}} \quad \text{and} \quad t_2' = \frac{\left(t_2 - \frac{xv}{c^2}\right)}{\sqrt{1-\frac{v^2}{c^2}}} \text{ ---------------(3)}$$

- Substituting the values of t_1' and t_2' from equation (3) in equation (2), we get

$$\Delta t' = \frac{\left(t_2 - \frac{xv}{c^2}\right)}{\sqrt{1-\frac{v^2}{c^2}}} - \frac{\left(t_1 - \frac{xv}{c^2}\right)}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{t_2 - t_1}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{\Delta t}{\sqrt{1-\frac{v^2}{c^2}}} \text{ -----------(4)}$$

- This equation shows that $\Delta t' > \Delta t$ i.e., the time interval in frame S' is grater than the time interval in frame S. This is known as time dilation.

Cases:

- When v is very small compared to c, then $\frac{v^2}{c^2}$ will be negligible in comparison to unity, therefore,

$$\Delta t' = \Delta t$$

i.e., the time interval recorded by moving clock is the same as that when it was at rest.

- When v is comparable to c, then $\sqrt{1-\frac{v^2}{c^2}}$ will be less than unity.

  Therefore $\Delta t' > \Delta t$ i.e., the time interval between two events recorded by a moving clock appears to be greater than the time interval between same two events recorded by the clock when it was at rest.

- When v is equal to c or grater than c, then $\frac{v^2}{c^2}$ will be equal to unity or grater than unity. So that,

$$\Delta t' = \text{infinity } or\ imaginary.$$

i.e., the time interval becomes infinite or imaginary. The concept of infinite or imaginary time is nonsense. This implies that no material body can have the velocity equal to or greater than the velocity of light.

ADDITION OF VELOCITIES

Let us consider two inertial frames of $S \text{ and } S'$ and let S be at rest and S' be moving with a velocity $\vec{v}$ relative to S in the positive X-axis.

Suppose a body moves a distance dx in a time dt in frame S then the same body appears to move through a distance dx' in time dt' in frame S'.

Then $\frac{dx}{dt} = u$ and $\frac{dx'}{dt'} = u'$ ------(1)

From Lorentz Transformation equations, we have

$$x = \frac{x' + vt'}{\sqrt{1 - \frac{v^2}{c^2}}} \text{-----------------(2)}$$

and

$$t = \frac{t' + \frac{vx'}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}} \text{-----------------(3)}$$

Differentiating equations (2) and (3), we have

$$dx = \frac{dx' + v\,dt'}{\sqrt{1 - \frac{v^2}{c^2}}} \text{-----------------(4)}$$

and

$$dt = \frac{dt' + \frac{v\,dx'}{c^2}}{\sqrt{1 - \frac{v^2}{c^2}}} \text{------------------(5)}$$

Dividing equation (4) by equation (5), we get

$$\frac{dx}{dt} = \frac{dx' + v\,dt'}{dt' + \frac{v\,dx'}{c^2}} = \frac{\frac{dx'}{dt'} + v}{1 + \frac{v\,dx'}{c^2\,dt'}}$$

$$\therefore u = \frac{u' + v}{1 + \frac{u'v}{c^2}} \text{-----------------(6)}$$

This equation represents the relativistic law of addition of velocities.

Cases:

- When $u' and\ v$ are small as compared to c, then $\frac{u'v}{c^2}$ can neglected in comparison to unity. Therefore,

$$u = u' + v \text{ ------------(7)}$$

Which is classical formula.

- When $u' or\ v = c$, then

$$u = \frac{u'+c}{1+\frac{u'c}{c^2}} = \frac{u'+c}{c+u'}c = c \text{ ------------(8)}$$

i.e., if one object moves with velocity c with respect to other, Then their relative velocity is always c, whatever may be the velocity of other.

  - When $u' = v = c$, then

$$u = \frac{c+c}{1+\frac{cc}{c^2}} = \frac{2c}{1+1} = c$$

i.e., if both the objects move with velocity c with respect to other, Then their relative velocity is always c.

Einstein's Mass-energy relation

According to Newton's Second law, the force is the rate of change of momentum, hence $F = \frac{d}{dt}(mv)$ --------------(1)

According to theory of relativity, the mass as well as velocity are variable, thus

$$F = m\frac{dv}{dt} + \mathrm{v}\frac{dm}{dt} \text{ --------------(2)}$$

When a particle is displaced through a distance dx by the application of a force F, then the increase in kinetic energy is given by

$$\mathrm{dK = F\ dx} \text{ -----------------(3)}$$

From equations (2) and (3), we get

$$\mathrm{dK} = m\frac{dv}{dt}\mathrm{dx} + \mathrm{v}\frac{dm}{dt}dx$$

$$\mathrm{dK} = mv\ dv + v^2\mathrm{dm} \text{ -----------(4)}$$

The variation of mass with velocity is given by

`

$$m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$$

Where m_0 is rest mass of the particle.

Squaring on both sides, we have

$$m^2 = \frac{{m_0}^2c^2}{c^2-v^2}$$

Or $m^2c^2 - m^2v^2 = {m_0}^2c^2$

Differentiating this equation, we get

$c^2 2m\ dm - v^2 2m\ \mathrm{dm} - m^2\ 2\mathrm{v\ dv} = 0$

Or $c^2dm - v^2\ \mathrm{dm} - \mathrm{mv\ dv} = 0$

Or $c^2dm = v^2\ \mathrm{dm} + \mathrm{mv\ dv}$ ------------(5)

Comparing equations (4) and (5), we get

$$\mathrm{dK} = c^2dm \text{ ------------(6)}$$

Now consider that the particle is at rest initially and by the application of force it acquires a velocity v. The mass of the body increases from m_0 to m. The total kinetic energy acquired by the body is given by

$$\int dK = \int_{m_0}^{m} c^2 dm$$

$$K = c^2(m)_{m_0}^{m} = c^2(\mathrm{m} - m_0) \text{ ----------(7)}$$

The rest energy of the body is given by

$$E_0 = m_0\, c^2 \text{ --------------(8)}$$

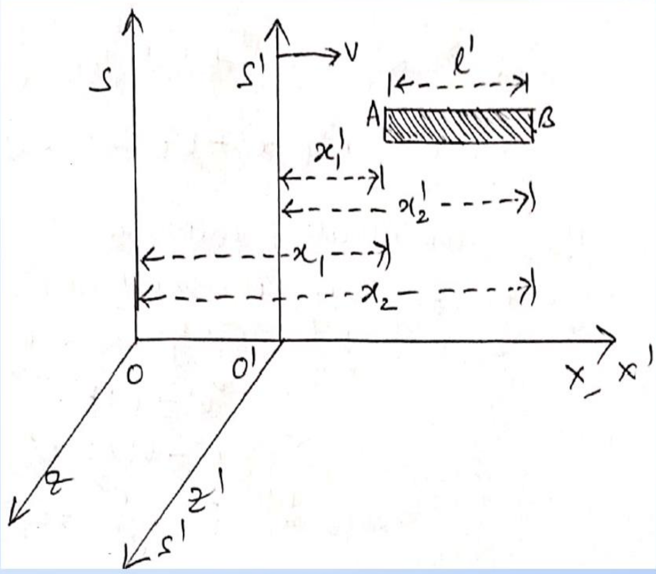
Therefore the total energy of the body

$$\mathrm{E} = K + E_0 = c^2(\mathrm{m} - m_0) + m_0\, c^2 = \mathrm{m}\, c^2 \text{ ---------(8)}$$

This equation is called Einstein's Mass-Energy Equivalence Relation.

LENGTH CONTRACTION

Let us consider two inertial frames of reference S and S' and let S be at rest and S' be moving with a velocity $\vec{v}$ relative to S in the positive X-axis. Let us place a rod AB in frame S' parallel to X'-axis. As seen by observer in frame S, the rod is moving with a velocity v along positive X-direction. Let l' be the length of the rod observed by an Observer in frame S' and l be length of moving rod as observed by observer in frame S.



If x_1' and x_2' be the coordinates of the ends of the rod with respect to Frame S', then the length of the rod in the frame S' is given by

$$l' = x_2' - x_1' \text{-----------(1)}$$

If x_1 and x_2 be the coordinates of the ends of the rod at the same time with respect to frame S, then the length of the rod in the frame S is given by

$$l = x_2 - x_1 \text{ -----------(2)}$$

According to Lorentz Transformation Equations, we have

$$x_2' = \frac{x_2 - vt}{\sqrt{1-\frac{v^2}{c^2}}} \text{ and } x_1' = \frac{x_1 - vt}{\sqrt{1-\frac{v^2}{c^2}}} \text{ --------------(3)}$$

Substituting these values in equation (1), we get

$$l' = \frac{x_2 - vt}{\sqrt{1-\frac{v^2}{c^2}}} - \frac{x_1 - vt}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{x_2 - x_1}{\sqrt{1-\frac{v^2}{c^2}}} \text{------------(4)}$$

Therefore,

$$l' = \frac{l}{\sqrt{1-\frac{v^2}{c^2}}}$$

Or

$$l = l'\sqrt{1-\frac{v^2}{c^2}} \text{-----------(4)}$$

Thus the length of the rod moving with velocity v relative to the observer is contracted by a factor $\sqrt{1-\frac{v^2}{c^2}}$ in the direction of motion.

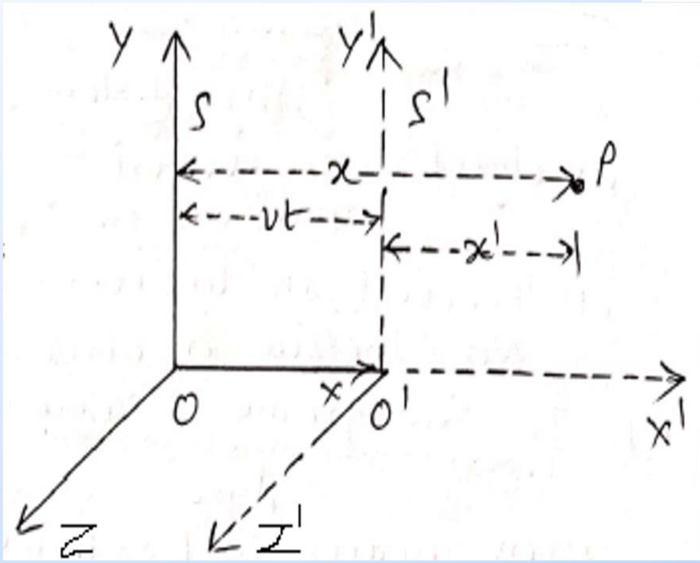
This is called as Lorentz-Fitzgerald Contraction.

Cases:

- When v is very small compared to c, then $\frac{v^2}{c^2}$ will be negligible in comparison to unity, therefore, $l = l'$ i.e., the length of the moving rod is the same as that when it was at rest.
- When v is comparable to c, then $\sqrt{1-\frac{v^2}{c^2}}$ will be less than unity. Therefore, $l < l'$ i.e., the length of the moving rod appears to be less than the length when it was at rest.
- When v is equal to c or grater than c, then $\frac{v^2}{c^2}$ will be equal to unity or grater than unity. Therefore, $l = 0 \ or \ imaginary$. This is impossible. Hence no material body can attain the velocity of light.
- The contraction takes place only along the direction of motion and remains unchanged in a perpendicular direction.
- The contraction cannot be visualized, though it really occurs.

Lorentz Transformation Equations of Space and Time

Let us consider two inertial frames of reference S and S' and let S be at rest and S' be moving with a velocity $\vec{v}$ relative to S in the positive X-axis. Let an event be happening at point P in frame S'. Let the coordinates of the event with respect to frame S be (x, y, z, t) and with respect to S' be (x', y', z', t').



Let us choose the axes so that X and X' are parallel to $\vec{v}$ and Y' and Z' be Parallel to Y and Z axes respectively. Let us count the time from the instant at which the origins O and O' coincide.

- When the light pulse P is observed from S, then we have,

Velocity = distance/time

$$c = \frac{(x^2+y^2+z^2)^{1/2}}{t}$$

Or $$x^2 + y^2 + z^2 - c^2t^2 = 0 \quad \text{--------(1)}$$

- When the pulse P is observed from S', then, we have

$$x'^2 + y'^2 + z'^2 - c^2t'^2 = 0 \quad \text{--------(2)}$$

Moreover, $y = y'$ and $z = z'$ -----------------(3)

- The transformation between x and x' can be represented by

$$x' = k(x - vt) \quad \text{-----------------(4)}$$

Where k is a constant and is independent of x and t.

- If we suppose that the system S is moving relative to S' with a velocity –v along +X direction, then

$$x = k(x' + vt') \quad \text{-----------------(5)}$$

From equations (4) and (5), we get

$$x = k[k(x - vt) + vt']$$

Or $\frac{x}{k} = [kx - kvt + vt']$

Or $vt' = \frac{x}{k} - kx + kvt$

Or $t' = \frac{x}{kv} - \frac{kx}{v} + kt$

Or $t' = k\left[t - \frac{x}{v} + \frac{x}{vk^2}\right] = k\left[t - \frac{x}{v}(1 - \frac{1}{k^2})\right]$ ---------------(6)

From equations (1) and (2) and (3), we get

$$x^2 - c^2t^2 = x'^2 - c^2t'^2$$ ----------------(7)

Substituting the values of x' and t' from equations (4) and (6) in equation (7), we get

$$x^2 - c^2t^2 = k^2(x - vt)^2 - c^2k^2\left[t - \frac{x}{v}(1 - \frac{1}{k^2})\right]^2$$

Or $x^2 - c^2t^2 = k^2(x^2 + v^2t^2 - 2xvt) - c^2k^2\left[t^2 + \frac{x^2}{v^2}(1 - \frac{1}{k^2})^2 - \frac{2tx}{v}(1 - \frac{1}{k^2})\right]$

$$x^2 - c^2t^2 - k^2(x^2 + v^2t^2 - 2xvt) + c^2k^2\left[t^2 + \frac{x^2}{v^2}(1 - \frac{1}{k^2})^2 - \frac{2xt}{v}(1 - \frac{1}{k^2})\right] = 0$$ ---(8)

This is an identity equation and hence the coefficients of various powers of x and t must vanish separately.

Equating the coefficients of t^2 to zero, we get

$$-c^2 - k^2v^2 + k^2c^2 = 0$$ ------------(9)

$$-k^2v^2 + k^2c^2 = c^2$$

Or $k^2(c^2 - v^2) = c^2$

Or $k^2 = \frac{c^2}{(c^2 - v^2)}$

Or $k = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$ ---------------(10)

Substituting the value of k from equation (10) in equation (4), we get

$$x' = \frac{x - vt}{\sqrt{1-\frac{v^2}{c^2}}} \text{ ---------------(11)}$$

Substituting the value of k in equation (6), we get

Or $$t' = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}\left[t - \frac{x}{v}\left(1 - 1/\frac{1}{1-\frac{v^2}{c^2}}\right)\right]$$

Or $$t' = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}\left[t - \frac{x}{v}\left(1 - 1 + \frac{v^2}{c^2}\right)\right]$$

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Or $$t' = \frac{\left(t - \frac{xv}{c^2}\right)}{\sqrt{1-\frac{v^2}{c^2}}} \text{ --------------(12)}$$

Therefore the Lorentz Transformation Equations for space and time can be Expressed as

$$x' = \frac{x - vt}{\sqrt{1-\frac{v^2}{c^2}}},\ y' = y,\ z' = z \text{ and } t' = \frac{\left(t - \frac{xv}{c^2}\right)}{\sqrt{1-\frac{v^2}{c^2}}} \text{ -----------(A)}$$

The Inverse Lorentz Transformation Equations for space and time can be Expressed as

$$x = \frac{x' + vt'}{\sqrt{1-\frac{v^2}{c^2}}},\ y = y',\ z = z' \text{ and } t = \frac{\left(t' + \frac{vx'}{c^2}\right)}{\sqrt{1-\frac{v^2}{c^2}}} \text{ -------------(B)}$$

POSTULATES OF SPECIAL THEORY OF RELATIVITY

In 1905, Albert Einstein draw two very important conclusions known as postulates of the special theory of relativity. They are:

- **Postulate I :**

  "All physical laws are the same in all inertial frames of reference which are moving with constant velocity relative to each other".

- According to this postulate, it is impossible by any means to demonstrate "absolute motion".
- To speak of absolute motion is meaningless. Only the motion of bodies relative one another has physical meaning.

- **Postulate II :**

  "The speed of light in vacuum is the same in every inertial frame".

- According to this postulate, the speed of light is the same in all directions, no matter whether the source of light is moving or stationary, whether the velocity of light is measured relatively to the medium in which it travel or relatively to a moving observer.
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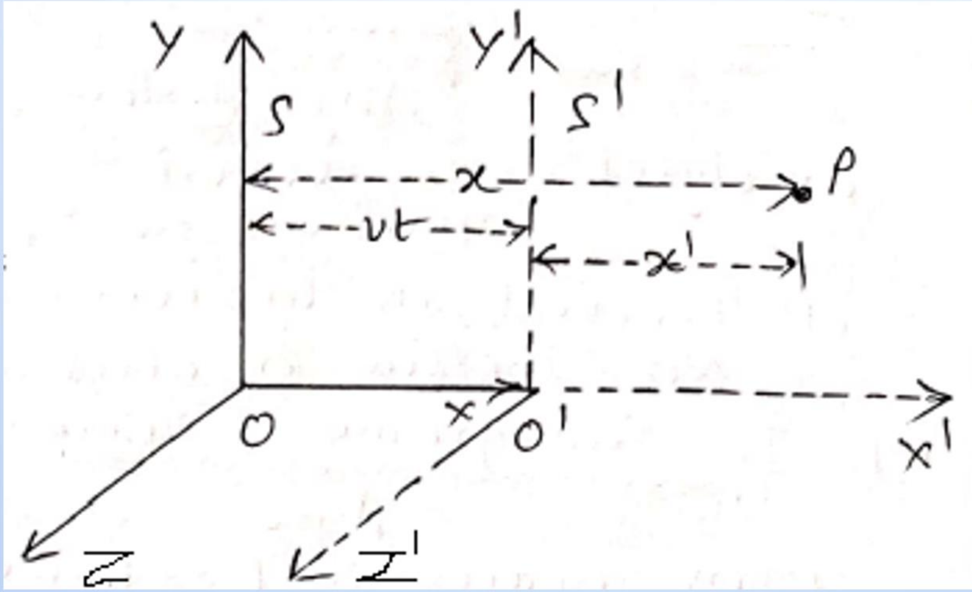

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IMPORTANT FORMULAE IN UNIT 3: RELATIVISTIC MECHANICS

1. Excepted fringe shift in Michelson-Morley experiment: Fringe shift $n = \frac{2lv^2}{c^2\lambda}$, Where l is distance of mirrors from glass plate G, v is velocity of earth, λ is wavelength of light used.

2. In case of Length Contraction, $l = l'\sqrt{1 - \frac{v^2}{c^2}}$, Where l' is proper length(true length), l is improper length (apparent length) , v is velocity of the rod and c is velocity of light

3. In case of Time Dilation, $\Delta t' = \frac{\Delta t}{\sqrt{1-\frac{v^2}{c^2}}}$, Where Δt is proper time interval, $\Delta t'$ is improper time interval, v is velocity of the moving frame (moving clock), c is velocity of light

4. Relativistic Velocity addition formula is $u = \frac{u' + v}{1 + \frac{u' v}{c^2}}$, Where u is velocity of the body with respect to frame at rest, u' is the velocity of the body with respect to frame moving with velocity v, c is velocity of light

5. Variation of mass with velocity, $m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$, Where m_0 is rest mass, m is the mass of the body moving with velocity v, c is velocity of light

6. Relativistic Kinetic Energy $K = c^2(m - m_0)$, Rest energy $E_0 = m_0 c^2$, and $E = m c^2$
Where m_0 is rest mass, m is mass of the body moving with velocity v, c is velocity of light

PROBLEMS

- Calculate the expected fringe shifts in the Michelson-Morley experiment, if the distance of each plate is 2 m and the wavelength of monochromatic radiation is a) 6000Å and b) 4000Å

Solution:

$l = 2m, c = 3X\ 10^8$ m/s, λ = 6000Å = 6000 X 10^{-10}m and 4000 X 10^{-10}m

$v = 3X10^4$ m/sec Fringe shift n = ?

Fringe shift $n = \frac{2lv^2}{c^2\lambda}$

For 6000Å, Fringe shift $n = \frac{2X2X3X10^4X3X10^4}{3X\ 10^8 X3X\ 10^8 X6000X10^{-10}} = 0.067$

For 4000Å, Fringe shift $n = \frac{2X2X3X10^4X3X10^4}{3X\ 10^8 X3X\ 10^8 X4000X10^{-10}} = 0.1$

➢ A rod is moving with a velocity of 0.6c relative to laboratory. It is found that the length of the rod appears to be 1m viewed from the laboratory. What is proper length of the rod.

➢**Solution:**

Given $l = 1m, v = 0.6c \; and \; c = 3X\,10^8$ m/s and proper length $l' =$?

$$l = l'\sqrt{1 - \frac{v^2}{c^2}}$$

$$l' = \frac{l}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{l}{\sqrt{1-\frac{(0.6c)^2}{c^2}}} = \frac{10}{8} = 1.25 \text{ m}$$

➢ What is the velocity of π-mesons whose observed mean life is $2.5X\,10^{-7}$ sec? The proper life of these π-mesons is $2.5X\,10^{-8}$ sec.

➢**Solution:**

Given $\Delta t = 2.5X\,10^{-8}$ sec, $\Delta t' = 2.5X\,10^{-7}$ sec, $c = 3X\,10^8$ m/s and v = ?

$$\Delta t' = \frac{\Delta t}{\sqrt{1-\frac{v^2}{c^2}}}$$

$$\frac{2.5X\,10^{-8}}{\sqrt{1-\frac{v^2}{c^2}}} = 2.5X\,10^{-7}$$

On solving, we get $v = \frac{\sqrt{99}}{10}c = 2.9849X\,10^8 \text{ m/sec}$

- A clock showing correct time when it is at rest, looses one hour in a day when it is moving. What is its velocity?

- **Solution:**

Given $\Delta t = 24\ hours, \Delta t' = 23\ hours, c = 3X\,10^8$ m/s and v = ?

$$\Delta t' = \frac{\Delta t}{\sqrt{1-\frac{v^2}{c^2}}}$$

$$\frac{23}{\sqrt{1-\frac{v^2}{c^2}}} = 24$$

On solving, we get $v = 0.386c = 0.286X3X10^8 = 0.858X10^8 m/sec$

- Two particles come towards each other with speed 0.8c with respect to laboratory. What is their relative speed?

- **Solution:**

Given $u' = v = 0.8c, u = ?$

$$u = \frac{u' + v}{1 + \frac{u' v}{c^2}}$$

$$u = \frac{0.8c + 0.8c}{1 + \frac{0.8cX0.8c}{c^2}}$$

On solving, we get u = 0.975c

- At what speed the mass of an object will be double of its value at rest?
- **Solution:**

Given $m = 2\,m_0$, v = ?

The variation of mass with velocity is given by

`

$$m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$$

$$2\,m_0 = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$$

On solving, we get $v = \frac{\sqrt{3}}{2}c = 2.6X\,10^8$ m/sec

- If the total energy of a particle is exactly thrice its rest energy, what is the velocity of the particle?
- **Solution:**

Given $E = 3\,m_0c^2$, v=?

But, E= mc^2, $therefore$, $m = 3\,m_0$, v = ?

The variation of mass with velocity is given by

`

$$m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$$

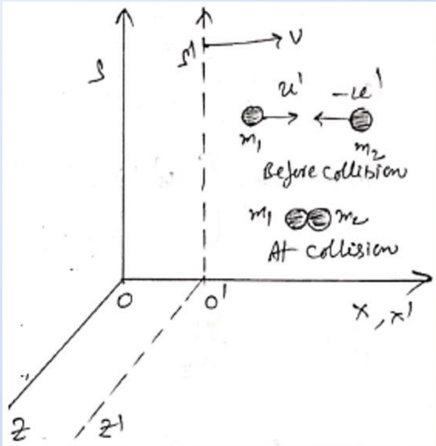
$$3\,m_0 = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$$

On solving, we get $v = \frac{\sqrt{8}}{3}c = 2.828X\,10^8$ m/sec

VARIATION OF MASS WITH VELOCITY

Consider two inertial frames of reference of $S \text{ and } S'$ and let S be at rest and S' be moving with a velocity $\vec{v}$ relative to S in the positive X-axis.

In order to consider the variation of mass with velocity, we shell consider a collision of two bodies in system S' and view it from the system S. Let the two bodies of equal masses $m_1 \, and \, m_2$ be travelling with velocities $u'$and $-u'$ parallel to X-axis in the system S'.



Suppose the two bodies collide and after collision coalesce into one body. The mass after collision is $(m_1 + m_2)$ and since the bodies were moving with same velocity in opposite directions, hence after collision, they are at rest in system S'.

According to the law of addition of velocities, the velocities $u_1 \, and \, u_2$ of masses $m_1 \, and \, m_2$ in system S corresponding to $u'$and $-u'$ in system $S'$are given by

$$\boldsymbol{u_1} = \frac{u' + v}{1 + \frac{u' v}{c^2}} \quad \text{and} \quad \boldsymbol{u_2} = \frac{-u' + v}{1 - \frac{u' v}{c^2}} \text{ ----------------(1)}$$

According to Law of conservation of momentum, we have

$$m_1 u_1 + m_2 u_2 = (m_1 + m_2) v \quad \text{------------------(2)}$$

Where v is velocity of the coalesced bodies with respect to frame S.

Substituting the values of $u_1$and u_2 from equation (1) in equation (2), we get

$$m_1 \frac{(u' + v)}{1 + \frac{u' v}{c^2}} + m_2 \frac{(-u' + v)}{1 - \frac{u' v}{c^2}} = (m_1 + m_2) v$$

$$m_1 \left[\frac{(u' + v)}{1 + \frac{u' v}{c^2}} - v \right] = m_2 \left[v - \frac{(-u' + v)}{1 - \frac{u' v}{c^2}} \right]$$

$$\therefore \frac{m_1}{m_2} = \frac{(\mathbf{v} - \frac{u' v^2}{c^2} + u' - v)}{(1 - \frac{u' v}{c^2})} \Big/ \frac{(u' + v - \mathbf{v} - \frac{u' v^2}{c^2})}{(1 + \frac{u' v}{c^2})} = \frac{1 + \frac{u' v}{c^2}}{1 - \frac{u' v}{c^2}} \text{ -----------------(3)}$$

From equation (1), $\boldsymbol{u_1}^2 = \left(\frac{u' + v}{1 + \frac{u' v}{c^2}} \right)^2$

Or $\quad 1 - \frac{u_1^2}{c^2} = 1 - \frac{1}{c^2} \left(\frac{u' + v}{1 + \frac{u' v}{c^2}} \right)^2 = 1 - \frac{1}{c^2} \frac{(u' + v)^2}{(1 + \frac{u' v}{c^2})^2}$

$$1-\frac{u_1^2}{c^2}=\frac{\left(1+\frac{u'v}{c^2}\right)^2-\left(\frac{u'+v}{c}\right)^2}{\left(1+\frac{u'v}{c^2}\right)^2}=\frac{\left(1-\frac{u'^2}{c^2}\right)\left(1-\frac{v^2}{c^2}\right)}{\left(1+\frac{u'v}{c^2}\right)^2}$$

$$\therefore 1+\frac{u'v}{c^2}=\left[\frac{\left(1-\frac{u'^2}{c^2}\right)\left(1-\frac{v^2}{c^2}\right)}{1-\frac{u_1^2}{c^2}}\right]^{1/2} \text{---------------(4)}$$

Similarly
$$1-\frac{u'v}{c^2}=\left[\frac{\left(1-\frac{u'^2}{c^2}\right)\left(1-\frac{v^2}{c^2}\right)}{1-\frac{u_2^2}{c^2}}\right]^{1/2} \text{---------------(5)}$$

Substituting these values in equation (3),we get

$$\frac{m_1}{m_2}=\left[\frac{1-\frac{u_2^2}{c^2}}{1-\frac{u_1^2}{c^2}}\right]^{1/2} \text{--------------(6)}$$

Let the body of mass m_2 be moving with zero velocity in system S before collision i.e., u_2=0, then

$$\frac{m_1}{m_2}=\frac{1}{\sqrt{1-\frac{u_1^2}{c^2}}} \text{---------------(7)}$$

In commonly used notation, $m_1 = m, m_2 = m_0$ and $u_1 = v$

$$\therefore \frac{m}{m_0}=\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$$

Or
$$m=\frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}} \text{--------------(8)}$$

This is the relativistic formula for the variation of mas with velocity. Here m_0 is called as the rest mass and m is the effective mass.

Important Points:

(i) When v is very small as compared to c, then $\frac{v^2}{c^2}$ will be negligible in comparison to unity, therefore $m = m_0$ -------------(9)
i.e., at the velocities which are much smaller than the velocity of light, the mass of moving object is the same as its rest mass.

(ii) When v is comparable to c, then $\sqrt{1-\frac{v^2}{c^2}}$ will be less than unity, or $m > m_0$
i.e., at velocities which are comparable to c, the mass of moving object appears to be greater than at rest.

(iii) When v = c or greater than c, then $\frac{v^2}{c^2}$ will be equal to or greater than unity, so m = ∞ or imaginary. i.e., at velocities which are equal to or greater than c, the mass of the mass of the object becomes infinity or imaginary. This is a nonsense concept.

OOP USING JAVA

HANDOUTS

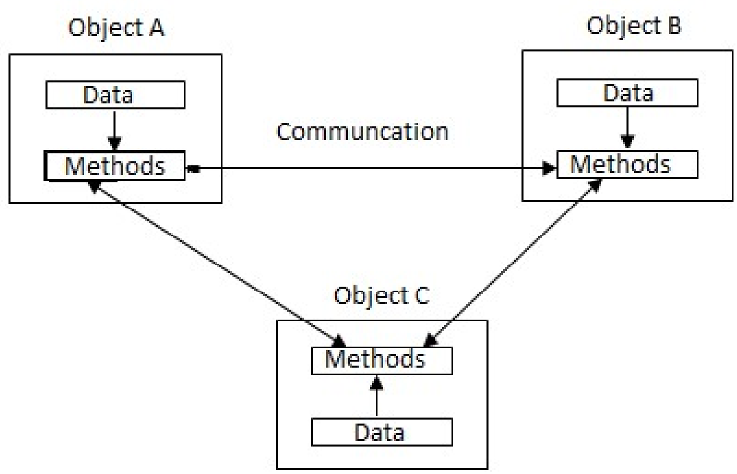
Fundamentals of Object-Oriented Programming

Definition of Object-Oriented Programming

Object-Oriented Programming is an approach that provides a way of modularizing programs by creating partitioned memory area for both data and functions that can be used as templates for creating copies of such modules on demand.

Object-Oriented Paradigm

- The major objective of Object-Oriented approach is to eliminate some of the flaws encountered in the Procedural approach.
- OOP allows us to decompose a problem into a number of entities called Objects.
- The combination of data and methods make up an object.



Object Oriented Programming Concepts (OR) Object Oriented Programming Principles:

When we represent the data in Object Oriented Programming language we get the security. Examples of Object Oriented Programming Languages are LISP, ADA, ALGOL, SMALLTALK, OBJECT COBAL, OBJECT PASCAL, Cpp, JAVA, DOT NET, etc. In order to say any language is an Object Oriented Programming Language it has to satisfy the following principles of OOPs.

OOP Principles

- Class
- Object
- Data Abstraction and Data Encapsulation

- Inheritance
- Polymorphism
- Dynamic Binding
- Message Passing

Class:

- "A Class is a way of binding the data and associated methods in a single unit". Any JAVA program if we want to develop then that should be developed with respective to Class only i.e., without Class there is no JAVA program.

Object:

Objects are the basic runtime entities in an object-oriented system. In order to store the data for the data members of the class, we must create an object.

Definitions of an Object

1. Instance (instance is a mechanism of allocating sufficient amount of memory space for data members of a class) of a class is known as an object.
2. Class variable is known as an object.
3. Blue print of a class is known as an Object.
4. Real world entities are called as Objects.

Data Abstraction and Data Encapsulation:

Data Abstraction:

- Abstraction and Encapsulation in Java are two important Object oriented programming concept and they are completely different to each other.

- Data abstraction is a mechanism of retrieving the essential details without dealing with background details.

- Abstraction represent taking out the behavior from how exactly it's implemented.

Data Encapsulation:

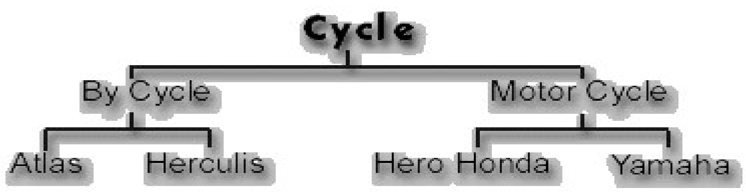
- Encapsulation means hiding details of implementation from outside world so that when things change nobody gets affected.

- The wrapping up of data and methods into a single unit is known as Encapsulation. The data is not accessible to the outside world and only those methods, which are wrapped in the class, can access it.

Inheritance:

Inheritance is the process of by which objects of one class acquire the properties of objects of another class.

Inheritance supports the concept of hierarchical classification. The concept of inheritance provides the idea of reusability. This means that we can add additional features to an existing class without modifying it. The following is an example for the inheritance concept.

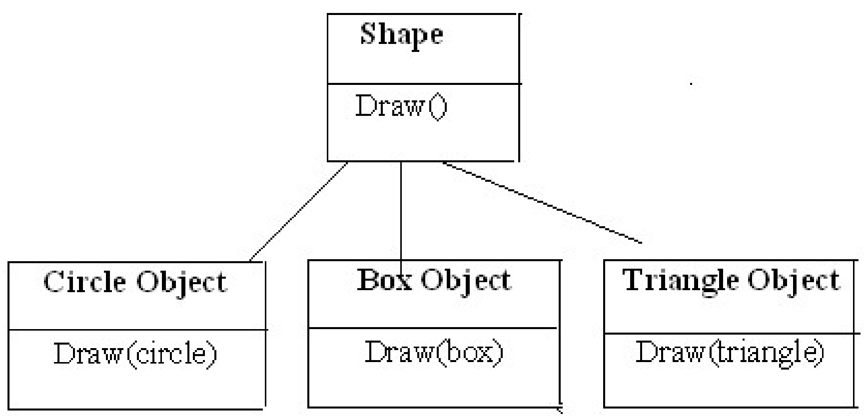


Example1

Example2

Polymorphism:

Polymorphism means the ability to take more than one form. For example, an operation may exhibit different behavior in different instances. The behavior depends upon the type of data used in the operation. The following is an example for polymorphism concept.



Dynamic Binding:

Binding refers to the linking of a procedure call to the code to be executed in response to the call. Dynamic binding means that the code associated with a given procedure call is not known until the time of the call at runtime.

Message passing:

The Object Oriented Program consists of a set of objects that communicate with each other. Objects communicate with one another by sending and receiving information. It involves the following basic steps.

- Creating classes that define objects and their behavior.
- Creating objects from class definitions.
- Establishing communication among objects.

Benefits of OOP:

OOP offers several benefits to the program designer and the user. The principal advantages are:

- Through inheritance, we can eliminate redundant code and extend the use of existing classes.
- We can build programs from standard working modules that communicate with one another rather than, having to start writing the code from scratch. This leads to saving of development time and higher productivity.
- The principle of data hiding helps the programmers to built secure program.
- It is possible to have multiple objects to coexist without any interference.
- It is easy to partition the work in a project based on objects.
- Object-oriented systems can be easily upgraded from small to large system.
- Message passing technique for communication between objects makes the interface descriptions with external system much simpler.
- Software complexity can be easily managed.

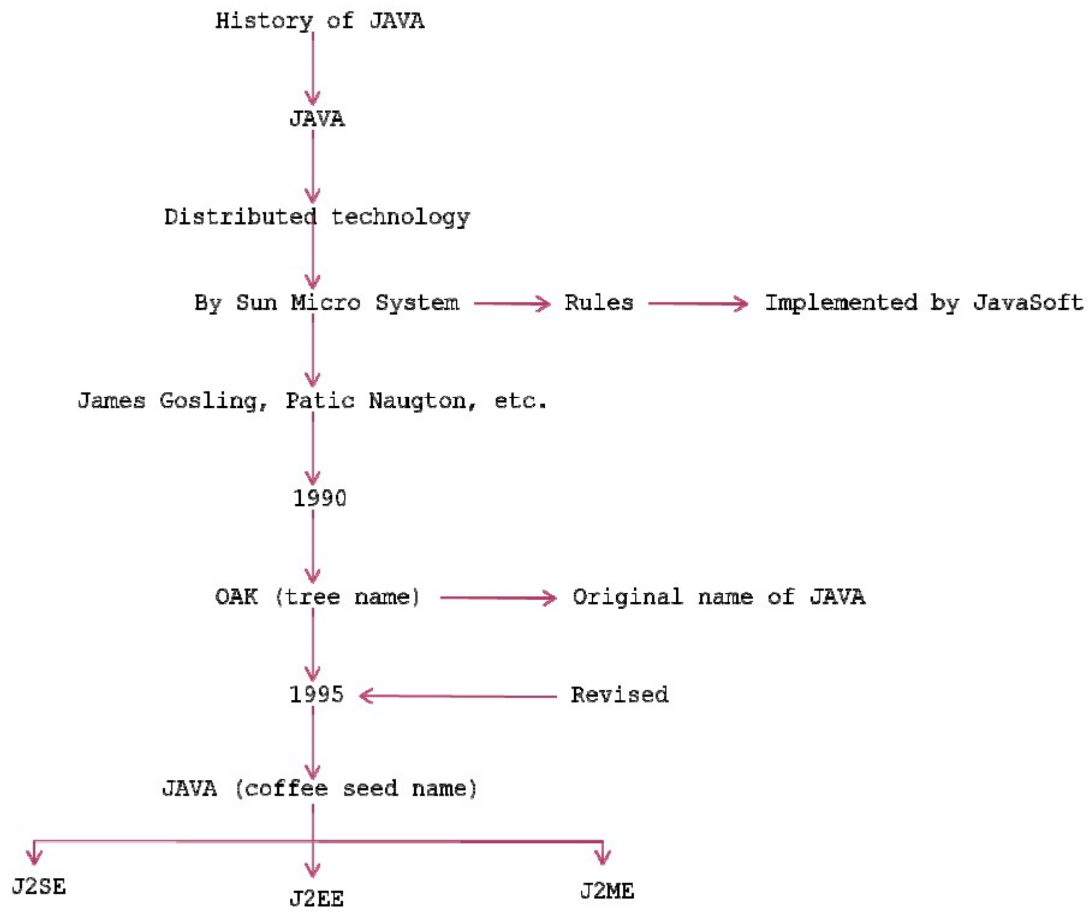
Applications of OOP

The following are some of areas of Object Oriented Programming

- Real-time systems
- Simulation and modeling
- Object oriented databases
- Hypertext, hypermedia and expert text.
- AI and expert systems.
- Neural networks and parallel programming.
- Decision support and office automation systems.

Java Evolution

History of Java



Features or Buzzwords of JAVA

The following are the features of the JAVA language.

1. Compiled and Interpreted.
2. Simple and Small.
3. Platform Independent.
4. Architectural Neutral.
5. Portable.
6. Multithreaded.
7. Distributed.
8. Robust
9. Secure.
10. High Performance.
11. Interpreted.
12. Dynamic.

13. Object Oriented and these are explained below.

Differences between Java and C

The major difference between Java and C is that Java is an Object Oriented Programming Language whereas the C is a Procedure Oriented Programming Language.

C	Java
Structures are supported	Structures are not supported
Unions are supported	Unions are not supported
Storage classes such as automatic, register, external are supported	Storage classes are not supported
Type definition is supported	Type definition is not supported
Size of() operator is supported	Size of() operator is not supported
Pre-processor directives such as # define, #include are supported	Pre-processor directives are not supported

Differences between Java and C++

The major difference between the Java and C++ is that, Java is a pure object oriented programming language whereas C++ is a partially object oriented programming language.

C++	Java
C++ is not a purely object-oriented programming language, since it is possible to write C++ programs without using a class or an object	Java is purely object programming language. since it is not possible to write a java program without using alteast one class
Pointers are available in C++	We cannot create and use pointers in java
Allotting memory & deallocating memory is the responsibility of the programmer	Allocation & deallocation of memory will be taken care of by JVM
C++ has goto statement	Java does not have goto statement
Multiple Inheritance feature is available in C++	No multiple Inheritance in java
Operator overloading is available in C++	It is not available in java
#define, typedef and header files are available in C++	#define, typedef and header files are available in C++
There are 3 Access specifiers in C++ private,public & and protected	Java supports 4 access specfiers private,public,protected and default
There are constructors and destructors in C++	Only constructors are there in java, No destructors are available in this language

Java and Internet

- The first application program written in java was Hot Java. Hot Java is a Web Browser used to run applets on Internet.

- Internet users can use Java to create the applet programs and run them locally by using a web browser.
- Internet users can also download the applet from a remote computer as shown in below.

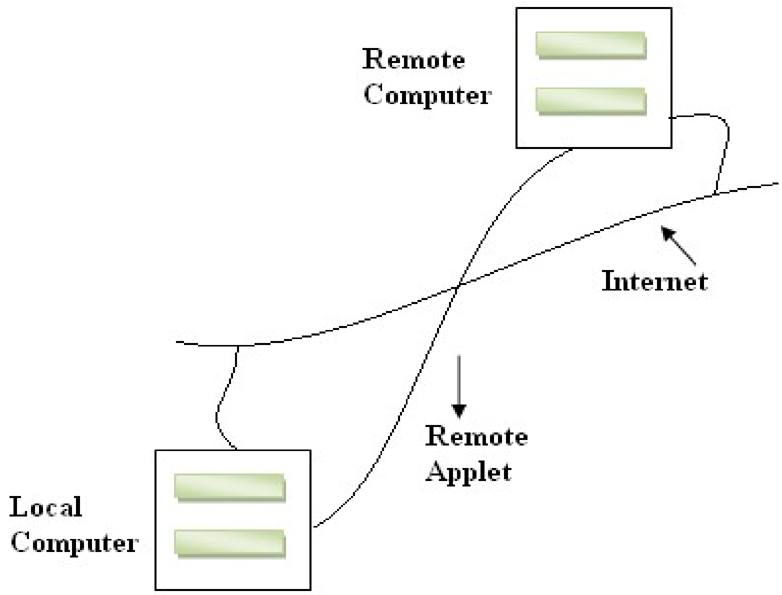


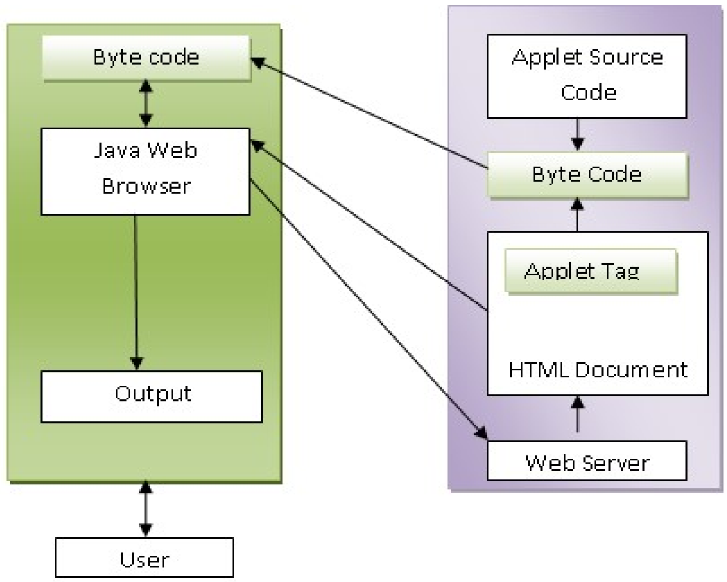
Fig: Downloading of applets via internet

- Due to this, Java is popularly known as Internet Language.

Java and World Wide Web

World Wide Web (WWW) is an open ended information retrieval system designed for internet distributed environment. This system contains the web pages that provide both information and control. We can navigate to a new document in any direction.

Java and Web share the same philosophy, Java could be easily incorporated into the web system. Before Java the WWW was limited to display the images and texts. However, the incorporation of Java into Web pages made it capable of supporting animation, graphics, games, and a wide range of special effects.



Web Browsers

Web browsers are used to navigate through the information found on the net. They allow us to retrieve the information spread across the Internet and display it using the hypertext markup language (HTML). Examples for Web browsers are as follows.

- Hot Java
- Netscape Navigator
- Internet Explorer

Java Environment:

Java Environment includes a large number of development tools and hundreds of classes and methods. The development tools are part of the system known as Java Development Kit (JDK) and the classes and methods are part of the Java Standard Library (JSL), also known as the Application Programming Interface (API).

Java Development Kit (JDK):

The Java Development Kit comes with a collection of tools that are used for developing and running Java programs. They include

- appletviewer
- java (Java Interpreter)
- javac (Java Compiler)
- javadoc (for creating HTML documents
- javah (for C header files):
- javap (Java disassemble
- jdb (Java debugger

Application Programming Interface:

The Java Standard Library includes hundreds of classes and methods grouped into several functional packages. Most commonly used packages are

- Language Support Package

- Utility Package
- Input/output Package
- Networking Package
- AWT Package
- Applet Package
-

Java Runtime Environment:

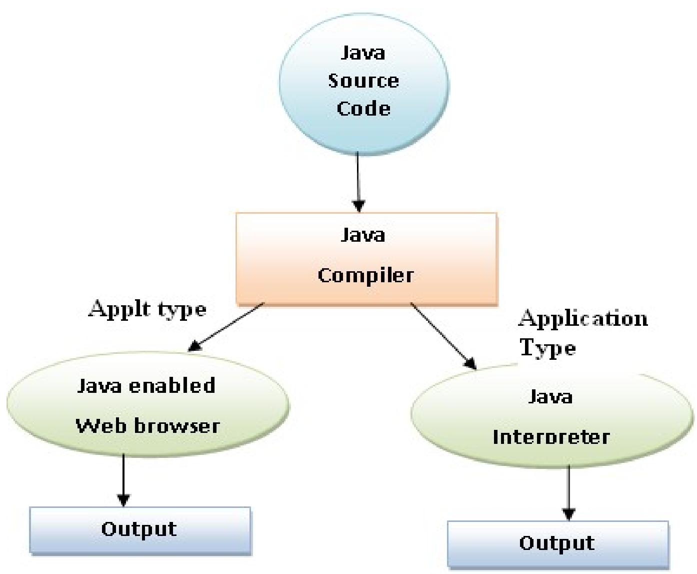
The Java Runtime Environment (JRE) facilitates the execution of java programs. It primarily comprises of the following:

- Java Virtual Machine (JVM
- Runtime class libraries
- User interface tool kit
- Deployment technologies: JRE comprises the following key deployment technologies.
    - Java plug-in
    - Java Web Start

Overview of Java Language

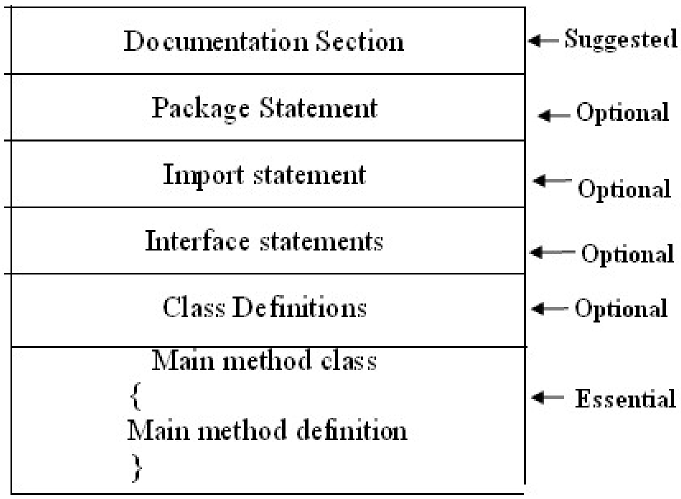
Java is a general purpose, Object-Oriented programming language. We can develop two types programs. They are

- Stand- Alone applications
- Web-Applications



Structure of a java program

To write a java program, we first define classes and then put them together. A Java program may contain one or more sections as shown in below.



Simple java program

The following is a simple java program

```
//Sample.java
Class Sample
{
    Public static void main (String args [])
    {
        System.out.println("Welcome to Java Programming Language……");
    }
}
```

Java Comments

There are three types of comments in java – single line, multi line, and Java documentation.

- **Single line Comments (//)**

Example: // This is my comment of one line

- **Multi line comments (/* */**

  .Example:

  /* This is a first line
  This is second line */
- **Java Documentation Comments(/** */**

Java Tokens

The smallest individual units in a program are called as tokens. The compiler recognizes them for building up expressions and statements.

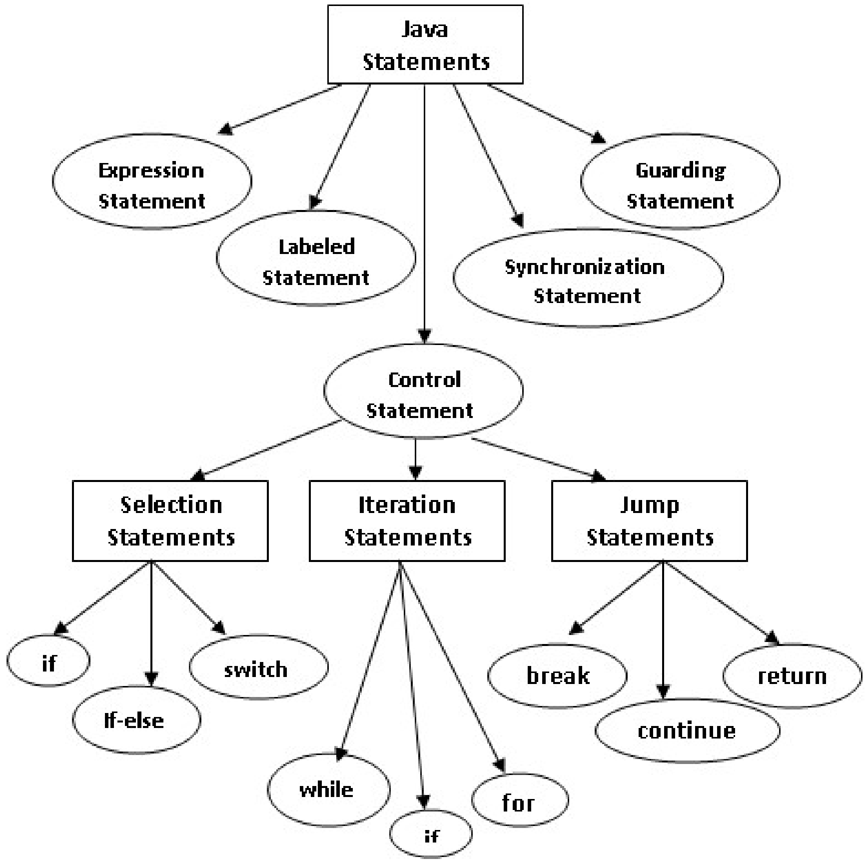
In simple terms, a java program is a collection of tokens, comments and white spaces. Java language includes five types of tokens. They are

- Reserved keywords
- Identifiers
- Literals
- Operators
- Separators

Java Statements?

The statements in java are like sentences in natural languages. A statement is an executable combination of tokens ending with a semicolon (**;)** mark. Statements are usually executed in the sequence in the order in which they appear.

The following diagram illustrates the types of java statements.



Procedure for implementing a java program

Implementation of a Java application program involves a series of steps. They include

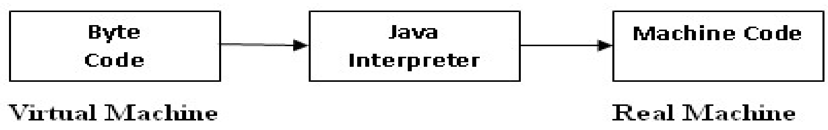
- Creating the program
- Compiling the program
- Running the program

Java virtual machine

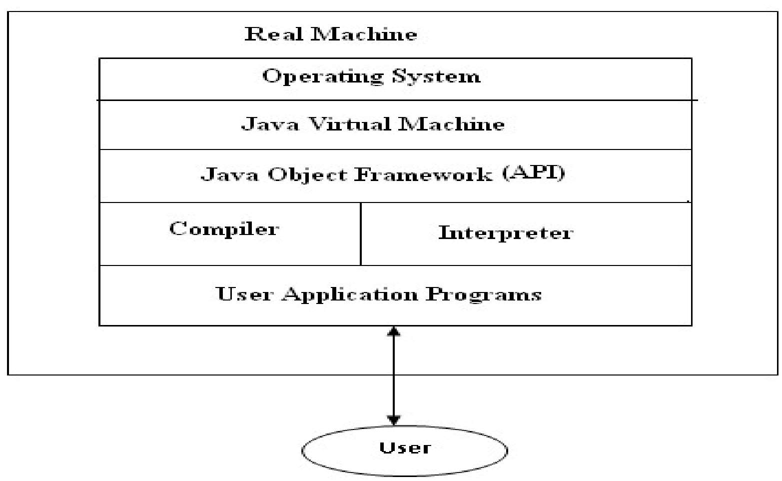
Java Virtual Machine (JVM) is the heart of the entire Java program execution process. It is responsible for taking the **.class** and converting each byte code instruction into the machine language instruction that can be executed by the microprocessor.

First of all, the **.java** program is converted into a **.class** consisting of byte code instructions by the java compiler for a machine called Java Virtual Machine as shown in below. The JVM exists only inside the computer memory.

The byte code is not a machine specific code (machine code). The machine code is generated by the Java Interpreter by acting as an intermediary between the virtual machine and the real machine as shown in below.



The following figure illustrates how Java works on a typical computer. The Java Object Framework (Java API) acts as the intermediary between the user programs and the virtual machine and which in turn acts as the intermediary between the operating system and the java object framework.



Command Line arguments in java?

Command line represents the run command and the values given at the time of running the program. Command line arguments represent the values passed to main() method.

To catch and store these values, main() has a parameter, String args[] as

public static void main(String args[])

Here, args[] is a one dimensional array of String type. So it can store a group of stings, passed to main() from outside by the user. The user should pass the values from outside, at the time of running the program at command prompt, as

C:\> java Prog 11 22 BVRICE