



QUESTION BANK

Year / Semester: **II B.Tech IV Semester**

Regulation: **R23**

Subject and Code: **HYDRAULICS AND HYDRAULIC MACHINERY (23ESC242T)**

SYLLABUS

UNIT-I

Laminar & Turbulent flow in pipes: Laminar flow – Laminar flow through circular pipes, annulus and parallel plates. Stoke's law, Measurement of viscosity. Reynolds experiment. Transition from laminar to turbulent flow. Resistance to flow of fluid in smooth and rough pipes – Moody's diagram. Introduction to boundary layer theory.

UNIT-II

Uniform flow in Open Channels: Open Channel Flow – Comparison between open channel flow and pipe flow, Geometrical parameters of a channel, classification of open channels, classification of open channel flow. Velocity distribution of channel section. Hydraulically efficient channel sections: Rectangular, trapezoidal and triangular channels. Energy and Momentum correction factors.

UNIT-III

Non-Uniform flow in Open Channels: Specific energy, critical flow, discharge curve, specific force, specific depth and critical depth. Measurement of discharge and velocity. Gradually Varied Flow – Dynamic equation of gradually varied flow. Hydraulic Jump and classification – Elements and characteristics. Energy dissipation.

UNIT-IV

Impact of Jets: Hydrodynamic force of jets on stationary and moving flat, inclined and curved vanes. Velocity triangles at inlet and outlet. Work done and efficiency.

Hydraulic Turbines: Classification of turbines, Pelton wheel and its design. Francis turbine and its design – efficiency. Draft tube – theory. Characteristic curves of hydraulic turbines. Cavitation: causes and effects.

UNIT-V

Pumps: Working principles of a centrifugal pump, work done by impeller, heads, losses and efficiencies. Minimum starting speed, priming, specific speed. Limitation of suction lift, Net Positive Suction Head (NPSH). Performance and characteristic curves. Cavitation effects. Multistage centrifugal pumps. Troubles and remedies.



QUESTION BANK

Year / Semester: **II B.Tech IV Semester**

Regulation: **R23**

Subject and Code: **HYDRAULICS AND HYDRAULIC MACHINERY (23ESC242T)**

Max Marks: 10

S.No	C O	Questions	BT
UNIT I: (LAMINAR & TURBULENT FLOW IN PIPES)			
1	1	<p>a. The velocity distribution in the boundary layer is given as $\frac{u}{V} = \frac{3}{2} \eta - \frac{1}{2} \eta^2$ in which $\eta = (\frac{y}{\delta})$. Compute $(\frac{\delta^*}{\delta})$ and $(\frac{\theta}{\delta})$.</p> <p>b. A smooth two-dimensional flat plate is exposed to a wind velocity of 100 km per hour. If laminar boundary layer exists upto a value of Re_x equal to 3×10^5, find the maximum distance upto which laminar boundary layer persists, and find its maximum thickness. Assume kinematic viscosity of air as $1.49 \times 10^{-5} m^2/s$</p>	L4
2	1	Assuming that the velocity distribution in the boundary layer is given by $\frac{u}{V} = (\frac{y}{\delta})^{\frac{1}{7}}$. calculate $\frac{\delta^*}{\delta}$, $\frac{\theta}{\delta}$ & $\frac{\delta_E}{\delta}$ If at a certain section, free stream velocity V was observed to be 10 m/s and the thickness of the boundary layer as 25 mm, then calculate the energy loss per unit length due to the formation of the boundary layer. Take $p = 1.226 kg/m^3$ ($0.125 msl/m^3$).	L3
3	1	Derive a Laminar Flow through Annulus ?	L4
4	1	Derive a Laminar Flow Between Parallel Plates-Both Plates at Rest ?	L3
5	1	<p>(a) Water flows at a steady mean velocity of 1.5 m/s through a 50 mm diameter pipe slopping upwards at 45° to the horizontal. At a section some distance downstream of the inlet the pressure is 700 kpa and at a section 30 m further along the pipe the pressure is 462 kpa. Determine the average shear stress at the wall of the pipe and at a radius of 10 mm.</p> <p>(b) Two parallel plates kept 0.1 m apart have laminar flow of oil between them with a maximum velocity of 1.5 m/s. Calculate the discharge per metre width, the shear stress at the plates, the difference in pressure in pascals between two points 20m apart, the velocity gradient at the plates and velocity at 0.02 m from the plate. Take viscosity of oil to be $2.453 N.s/m^2$</p>	L5



QUESTION BANK

Year / Semester: II B.Tech IV Semester

Regulation: R23

Subject and Code: HYDRAULICS AND HYDRAULIC MACHINERY (23ESC242T)

6	1	<p>A horizontal circular tube of radius a has a fixed coaxial cylindrical rigid core of radius b. τ_a & τ_b are the shear stresses along the tube and core surfaces when a viscous liquid is flowing through the annulus. The flow is laminar and the rate of variation of pressure along the length of the passage is $(-\partial p/\partial x)$.</p> <p>Show that $a\tau_a - b\tau_b = \frac{1}{2}(a^2 - b^2) \times \left(\frac{\partial p}{\partial x}\right)$</p>	L4																																																
7	1	<p>A smooth brass pipeline 75 mm in diameter and 900 m long carries water at the rate of 7 litres per second. If the kinematic viscosity of water is 0.0195 stokes, calculate the loss of head, wall shearing stress, centre line velocity, shear stress and velocity at 25 mm from the centre line and the thickness of the laminar sublayer. Take $\rho = 1000 \text{ kg/m}^3$ (10^3 msl/m^3).</p>	L3																																																
8	1	<p>At a point in a turbulent flow field, the instantaneous values of the velocity components u and v measured at an interval of 0.05 seconds are listed below:</p> <table border="1" style="margin-left: auto; margin-right: auto; border-collapse: collapse; text-align: center;"> <tbody> <tr> <td style="padding: 2px;">u (mm/s):</td> <td style="padding: 2px;">10</td> <td style="padding: 2px;">11</td> <td style="padding: 2px;">84</td> <td style="padding: 2px;">89</td> <td style="padding: 2px;">10</td> <td style="padding: 2px;">94</td> <td style="padding: 2px;">111</td> <td style="padding: 2px;">10</td> <td style="padding: 2px;">87</td> <td style="padding: 2px;">9</td> <td style="padding: 2px;">89</td> </tr> <tr> <td style="padding: 2px;">v (mm/s):</td> <td style="padding: 2px;">-3</td> <td style="padding: 2px;">-</td> <td style="padding: 2px;">+11</td> <td style="padding: 2px;">+2</td> <td style="padding: 2px;">-6</td> <td style="padding: 2px;">-</td> <td style="padding: 2px;">-20</td> <td style="padding: 2px;">+4</td> <td style="padding: 2px;">+21</td> <td style="padding: 2px;">-2</td> <td style="padding: 2px;">+6</td> </tr> <tr> <td></td> <td style="padding: 2px;">5</td> <td style="padding: 2px;">0</td> <td></td> <td></td> <td style="padding: 2px;">2</td> <td></td> <td></td> <td style="padding: 2px;">1</td> <td></td> <td style="padding: 2px;">5</td> <td></td> </tr> <tr> <td></td> <td></td> <td style="padding: 2px;">16</td> <td></td> <td style="padding: 2px;">5</td> <td></td> <td style="padding: 2px;">20</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> <p>Determine: Mean velocity component \bar{u}, Mean velocity component \bar{v}, Mean value of the product of fluctuations $u'v'$, Local value of Reynolds shear stress τ. Take density of fluid, $\rho = 1.23 \text{ kg/m}^3$</p>	u (mm/s):	10	11	84	89	10	94	111	10	87	9	89	v (mm/s):	-3	-	+11	+2	-6	-	-20	+4	+21	-2	+6		5	0			2			1		5				16		5		20						L5
u (mm/s):	10	11	84	89	10	94	111	10	87	9	89																																								
v (mm/s):	-3	-	+11	+2	-6	-	-20	+4	+21	-2	+6																																								
	5	0			2			1		5																																									
		16		5		20																																													
9	1	<p>A rough pipeline of diameter 0.1 m carries water at 20°C at the rate of 50 l/s. If the average height of the protrusions on the pipe surface is 0.15 mm, calculate the friction factor, maximum velocity, shear stress at the pipe surface and the shear velocity. For water at 20°C take $\nu = 1 \times 10^{-6} \text{ m}^2/\text{s}$ and $\rho = 1000 \text{ kg/m}^3$ (102 msl/m^3).</p>	L4																																																
10	1	<p>Define 'shear velocity' or 'friction velocity for turbulent flow in circular pipes & What do you understand by hydrodynamically smooth and rough pipes?</p>	L3																																																
S.No	C O	Questions	BT																																																



QUESTION BANK

Year / Semester: **II B.Tech IV Semester**

Regulation: **R23**

Subject and Code: **HYDRAULICS AND HYDRAULIC MACHINERY (23ESC242T)**

UNIT II: (UNIFORM FLOW IN OPEN CHANNELS)

1	2	a. Classifications of flow in channels b. Difference between open channel flow and pipe flow	L4
2	2	a) A most efficient trapezoidal section is required to give a maximum discharge of $21.5 \text{ m}^3/\text{s}$ of water. The slope of the channel bottom is 1 in 2500. Taking $C = 70 \text{ kg/ m}^{1/2}/\text{s}$ in Chezy's equation, determine the dimensions of the channel. Also determine the value of Manning's n, taking the value of velocity of flow as obtained for the channel by Chezy's equation. b) Explain about the geometrical properties of channel sections & velocity distribution in a channel section :Rectangular, trapezoidal & Triangular Sections	L3
3	2	A rectangular channel 4 m wide has depth of water 1.5 m. The slope of the bed of the channel is 1 in 1000 and value of Chezy's constant $C = 55$ It is desired to increase the discharge to a maximum by changing the dimensions of the section for constant area of cross-section, slope of the bed and roughness of the channel. Find the new dimensions of the channel and increase in discharge.	L4
4	2	A trapezoidal channel with side slopes of 3 horizontal to 2 vertical has to be designed to convey $10 \text{ m}^3/\text{s}$ at a velocity of 1.5 m/s, so that the amount of concrete lining for the bed and sides is minimum. Find (i) the wetted perimeter, and (ii) slope of the bed if Manning's $N = 0.014$ in the formula $C = \frac{1}{N} \times \text{m}^{\frac{1}{6}}$	L3
5	2	A trapezoidal channel has side slopes 1 to 1. It is required to discharge $13.75 \text{ m}^3/\text{s}$ of water with a bed gradient of 1 in 1900. If unlined the value of Chezy's C is 44. If lined with concrete, its value is 60. The cost per m^3 of excavation is four times the cost per m^2 of lining. The channel is to be the most efficient one. Find whether the lined canal or the unlined canal will be cheaper. What will be the dimensions of that economical canal?	L5
6	2	Water flows in a channel of the shape of isosceles triangle of bed width 'a' and sides making an angle of 45° with the bed. Determine the relations between depth of flow 'd' and bed width 'a' for maximum velocity condition and for maximum discharge condition. Use Manning's formula and note that 'd' is less than 0.5 'a'.	L4



SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES
(AUTONOMOUS)

QUESTION BANK

Year / Semester: **II B.Tech IV Semester**

Regulation: **R23**

Subject and Code: **HYDRAULICS AND HYDRAULIC MACHINERY (23ESC242T)**

7	2	Derive an Expression for Energy Correction Factor and Momentum Correction Factor ?	L3
8	2	Determine α & β for the velocity distribution in a wide river 2.5m deep that is found on vary from 1 m/s at bottom to 2.5m/s at the surface, according to an expression $u = [1+1.5 \times (\frac{y}{h})^{\frac{1}{2}}]$ here, h=total depth of flow & u=velocity at any distance y above bottom	L5

SITAMMS

S.No	CO	Questions	BT
------	----	-----------	----



QUESTION BANK

Year / Semester: **II B.Tech IV Semester**

Regulation: **R23**

Subject and Code: **HYDRAULICS AND HYDRAULIC MACHINERY (23ESC242T)**

UNIT III: (NON-UNIFORM FLOW IN OPEN CHANNELS)

1	3	a. Explain Gradually Varied Flow & Specific Energy Curve ? b. Explain about Critical Depth, Critical Velocity & Critical Flow ?	L4
2	3	Derive an Dynamic Equation of Gradually Varied flow Based on Energy Equation Assumptions for Wide Rectangular Channel ?	L3
3	3	Explain about the Hydraulic Jump & What are the types they are & applications of hydraulic jump?	L4
4	3	A sluice gate discharges water into a horizontal rectangular channel with a velocity of 6 m/s and depth of flow is 0.4 m. The width of the channel is 8 m. Determine whether a hydraulic jump will occur, and if so, find its height and loss of energy per kg of water. Also determine the power lost in the hydraulic jump. ?	L3
5	3	The discharge of water through a rectangular channel of width 8 m, is 15 m³/s when depth of flow of water is 1.2 m. Calculate: (i) Specific energy of the flowing water, (ii) Critical depth and critical velocity, (iii) Value of minimum specific energy. ?	L5
6	3	Show that the head loss in a hydraulic jump formed in a rectangular channel may be expressed as $\Delta E = \frac{(v_1 - v_2)^3}{2g(V_1 + V_2)}$?	L4
7	3	The depth of flow of water, at a certain section of a rectangular channel of 2 m wide, is 0.3 m. The discharge through the channel is 1.5 m³/s Determine whether a hydraulic jump will occur, and if so, find its height and loss of energy per kg of water .?	L3
8	3	Find the slope of the free water surface in a rectangular channel of width 20 m, having depth of flow 5 m. The discharge through the channel is 50 m³/s. The bed of the channel is having a slope of 1 in 4000. Take the value of Chezy's constant C = 60.?	L5

S.No.	CO	Questions	BT
UNIT IV: (IMPACT OF JETS & HYDRAULIC TURBINES)			



QUESTION BANK

Year / Semester: **II B.Tech IV Semester**

Regulation: **R23**

Subject and Code: **HYDRAULICS AND HYDRAULIC MACHINERY (23ESC242T)**

1	4	<p>a. A jet of water 75 mm diameter having a velocity of 20 m/s, strikes normally a flat smooth plate. Determine the thrust on the plate (a) if the plate is at rest, (b) if the plate is moving in the same direction as the jet with a velocity of 5 m/s. Also find the work done per second on the plate in each case and the efficiency of the jet when the plate is moving.</p> <p>b. A jet of water moving at 20 m/s impinges on a symmetrical curved vane shaped to deflect the jet through 120° (that is the vane angles θ and ϕ are each equal to 30°). If the vane is moving at 5m / s find the angle of the jet so that there is no shock at inlet. Also determine the absolute velocity of exit in magnitude and direction, and the work done.</p>	L4
2	4	<p>A jet discharges $0.15 \text{ m}^3/\text{s}$. of water with velocity of 70 m/s impinges without shock on a series of curved vanes which move in the same direction as the jet. The shape of each vane is such that it would deflect the jet through an angle of 150°. Surface friction reduces the relative velocity by 8 percent as the water passes across the vanes and there is a further windage loss equivalent to $\left(\frac{0.5 u^2}{2g}\right)$ N.m per N of water, u being the vane velocity. Find:</p> <p>(a) the velocity of the vanes corresponding to maximum efficiency; (b) the value of this efficiency; (c) the corresponding force on the vanes in, and at right angles to the direction of their motion; and (d) the power of this arrangement.</p>	L3
3	4	<p>A jet of water having a velocity of 15 m/s, strikes a curved vane which is moving with a velocity of 5 m/s in the same direction as that of the jet at inlet. The vane is so shaped that the jet is deflected through 135°. The diameter of jet is 100 mm. Assuming the vane to be smooth, find:</p> <p>(i) Force exerted by the jet on the vane in the direction of motion, (ii) Power exerted on the vane, and (iii) Efficiency of the vane.</p>	L4
4	4	<p>A jet of water having a velocity of 20 m/s strikes a curved vane, which is moving with a velocity of 10 m/s. The jet makes an angle of 20° with the direction of motion of vane at inlet and leaves at an angle of 130° to the direction of motion of vane an outlet. Calculate:</p> <p>(i) Vane angles, so that the water enters and leaves the vane without shock. (ii) Work done per second per unit weight of water striking (or work done per unit weight of water striking) the vane per second.</p>	L3



QUESTION BANK

Year / Semester: **II B.Tech IV Semester**

Regulation: **R23**

Subject and Code: **HYDRAULICS AND HYDRAULIC MACHINERY (23ESC242T)**

5	4	<p>a. A Pelton wheel has a mean bucket speed of 12 m/s and is supplied with water at a rate of 750 litres per second under a head of 35 m. If the bucket deflects the jet through an angle of 160°, find the power developed by the turbine and its hydraulic efficiency. Take the coefficient of velocity as 0.98. Neglect friction in the bucket. Also determine the overall efficiency of the turbine if its mechanical efficiency is 80%.</p> <p>b. The following are the design particulars of a large Pelton turbine:</p> <ul style="list-style-type: none">(i) Head at the distributor = 630m(ii) Discharge = $12.5 \text{ m}^3/\text{s}$.(iii) Power developed = 65MW(iv) Speed of rotation = 500r .p.m.(v) Runner diameter = 1.96m(vi) Number of jets = 4(vii) Jet diameter = 0.192m(viii) Angle through which the jet is deflected by the bucket = 165°(ix) Mechanical efficiency of the turbine = 96% <p>(a) Determine the hydraulic power losses in the distributor-nozzle assembly and the buckets.</p> <p>(b) If the loss in the buckets is given to be proportional to V_r^2, where V_r is the relative velocity at inlet, determine the best speed of rotation for this head and discharge.</p>	L5
6	4	<p>a. A Francis turbine supplied through a 6 m diameter penstock has the following particulars:</p> <ul style="list-style-type: none">- Output of installation: 63500 kW- Flow: $117 \text{ m}^3/\text{s}$- Speed: 150 r.p.m- Hydraulic efficiency: 92%- Mean diameter of turbine at entry: 4 m- Mean blade height at entry: 1 m- Entry diameter of draft tube: 4.2 m- Velocity in tail race: 2.4 m/s <p>The static pressure head in the penstock measured just before entry to the runner is 57.4 m. The point of measurement is 3 m above the level of the tail race. The loss in the draft tube is equivalent to 30% of the velocity head at entry to it. The exit plane of the runner is 2 m above the tail race and the flow leaves the runner without swirl. Determine:(a) The overall efficiency, (b) The direction of flow relative to the runner at inlet, (c) The pressure head at entry to the draft tube.?</p> <p>b. Explain about the Classification of hydraulic turbines, Types of draft tubes & Draft-tube Theory?</p>	L4



QUESTION BANK

Year / Semester: **II B.Tech IV Semester**

Regulation: **R23**

Subject and Code: **HYDRAULICS AND HYDRAULIC MACHINERY (23ESC242T)**

7	4	<p>a. A conical draft-tube having inlet and outlet diameters 1 m and 1.5 m discharges water at outlet with a velocity of 2.5 m/s. The total length of the draft-tube is 6 m and 1.20 m of the length of draft-tube is immersed in water. If the atmospheric pressure head is 10.3 m of water and loss of head due to friction in the draft-tube is equal to $0.2 \times$ velocity head at outlet of the tube, find:</p> <p>(i) Pressure head at inlet, and (ii) Efficiency of the draft-tube.?</p> <p>b. Explain about the Characteristic Curves of Hydraulic Turbines ?</p>	L3
8	4	<p>Explain about the Radial Flow Reaction Turbines & Inward Radial Flow Turbine ?</p> <p>a. An inward flow reaction turbine has external and internal diameters as 0.9 m and 0.45 m respectively. The turbine is running at 200 r.p.m. and width of turbine at inlet is 200 mm. The velocity of flow through the runner is constant and is equal to 1.8 m/s. The guide blades make an angle of 10° to the tangent of the wheel and the discharge at the outlet of the turbine is radial. Draw the inlet and outlet velocity triangles and determine:</p> <p>(i) The absolute velocity of water at inlet of runner, (ii) The velocity of whirl at inlet, (iii) The relative velocity at inlet, (iv) The runner blade angles, (v) Width of the runner at outlet, (vi) Mass of water flowing through the runner per second, (vii) Head at the inlet of the turbine, (viii) Power developed and hydraulic efficiency of the turbine. ?</p>	L5

S.No.	CO	Questions	BT
UNIT V: (<u>PUMPS:</u>)			



QUESTION BANK

Year / Semester: **II B.Tech IV Semester**

Regulation: **R23**

Subject and Code: **HYDRAULICS AND HYDRAULIC MACHINERY (23ESC242T)**

1	5	<p>a. A centrifugal pump has the following characteristics: outer diameter of impeller = 800 mm; width of impeller vanes at outlet = 100 mm; angle of impeller vanes at outlet = 40°. The impeller runs at 550 r.p.m and delivers 0.98 cubic metres of water per second under an effective head of 35 m. A 500 kW motor is used to drive the pump. Determine the manometric, mechanical and overall efficiencies of the pump. Assume water enters the impeller vanes radially at inlet. ?</p> <p>b. The internal and external diameters of the impeller of a centrifugal pump are 200 mm and 400 mm respectively. The pump is running at 1200 r.p.m. The vane angles of the impeller at inlet and outlet are 20° and 30° respectively. The water enters the impeller radially and velocity of flow is constant. Determine the work done by the impeller per unit weight of water.?</p>	L4
2	5	<p>A centrifugal pump operates against a manometric head of 30 m with a manometric efficiency of 75%. The pressure rise through the impeller is 65% of the total head developed by the pump. The radial velocity of flow which is constant is 3 m/s. The outer diameter of the impeller is 400 mm and the width at outlet is 15 mm. The blades at inlet are curved backwards at 60° to the wheel tangent. Calculate: (i) The discharge in litres per minute (ii) Speed (iii) Blade angle at outlet (iv) Diameter of impeller at inlet ?</p>	L3
3	5	<p>a. A centrifugal pump with 1.2 m diameter runs at 200 r.p.m. and pumps 1880 litres/s, the average lift being 6 m. The angle which the vanes make at exit with the tangent to the impeller is 26° and the radial velocity of flow is 2.5 m/s. Determine: The manometric efficiency & The least speed to start pumping against a head of 6 m & The inner diameter of the impeller being 0.6 m ?</p> <p>b. Explain about the Multistage Centrifugal Pumps & its important Functions ?</p>	L4
4	5	<p>A three stage centrifugal pump has impellers 40 cm in diameter and 2 cm wide at outlet. The vanes are curved back at the outlet at 45° and reduce the circumferential area by 10%. The manometric efficiency is 90% and the overall efficiency is 80%. Determine: The head generated by the pump when running at 1000 r.p.m. delivering 50 litres per second & The shaft horse power ?</p>	L3



SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES
(AUTONOMOUS)

QUESTION BANK

Year / Semester: **II B.Tech IV Semester**

Regulation: **R23**

Subject and Code: **HYDRAULICS AND HYDRAULIC MACHINERY (23ESC242T)**

5	5	<p>a. A one-fifth scale model of a pump was tested in a laboratory at 1000 r.p.m. The head developed and the power input at the best efficiency point were found to be 8 m and 30 kW respectively. If the prototype pump has to work against a head of 25 m, determine its working speed, the power required to drive it and the ratio of the flow rates handled by the two pumps. ?</p> <p>b. Explain about the priming of Centrifugal pumps & Characteristics Curves of centrifugal pumps ?</p>	L5
6	5	<p>a. What is Cavitation in Hydraulic System & Pressure against Cavitation, Effects of Cavitation?</p> <p>b. Explain about the Net Positive Suction Head (NPSH) & Hydraulic Losses, Efficiencies in Centrifugal Pumps?</p>	L4
7	5	<p>A centrifugal pump rotating at 1000 r.p.m. delivers 160 litres/s of water against a head of 30 m. The pump is installed at a place where atmospheric pressure is 1×10^5 Pa (abs.) and vapour pressure of water is 3 kPa (abs.). The head loss in suction pipe is equivalent to 0.2 m of water. Calculate:(i) Minimum NPSH, and (ii) Maximum allowable height of the pump from free surface of water in the sump.?</p>	L3



**SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES
(AUTONOMOUS)**

QUESTION BANK

Year / Semester: II B.Tech IV Semester

Regulation: R23

Subject and Code: HYDRAULICS AND HYDRAULIC MACHINERY (23ESC242T)

Note: L1-Remembering, L2-Understanding, L3-Applying, L4-Analyzing, L5-Evaluating, and L6-Creating

Instruction to Faculty Members:

The Six Levels of Bloom's Taxonomy:

1. **Remembering:** Retrieving, recognizing, and recalling relevant knowledge from long-term memory (e.g., list, define, name, locate).
2. **Understanding:** Constructing meaning, explaining ideas, or concepts (e.g., summarize, interpret, classify, compare).
3. **Applying:** Using information in new situations or implementing procedures to solve problems (e.g., solve, use, demonstrate, implement).
4. **Analyzing:** Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure (e.g., contrast, categorize, distinguish, diagram).
5. **Evaluating:** Making judgments based on criteria and standards through checking and critiquing (e.g., judge, critique, justify, defend, argue).
6. **Creating:** Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure (e.g., design, construct, develop, formulate).