List of Video Lectures by S Kumaresan			
Title	**Key words**	**Description**	**URL**
A Crash Foundation Course in Mathematics -1	Statements, quantifiers, negation, Conjunctions	This is the first in a series of 4 lectures. The material covered in these four lectures is the minimum background expected of a student who wants to pursue higher mathematics. Since the concepts such as Sets, functions are introduced in schools, the college and university teachers do not pay attention to these topics. These lectures will help the students to master the concepts. It also trains them to learn to solve problem and learn the art of writing short proofs in abstract mathematics. I strongly recommend that the viewers refer to " A Foundation Course in Mathematics" by Ajit Kumar, Bhaba Sarma and Kumaresan for more details and illuminating examples. In this video we talk of negation of statements that involve the quantifiers and are `combined' using "AND' and "OR".	https://youtu.be/0NbMtbgv05c
A Crash Foundation Course in Mathematics -2	Subsets, DeMorgan's laws	In this lecture, we introduce the `descriptive' definition of subsets family of subsets, th	https://youtu.be/RVYkSQWib6s
A Crash Foundation Course in Mathematics -2	Direct iamge, inverse image	We discuss the (direct) images of subsets and inverse images of sets under a function. We give some interesting examples. The most useful result is the fact that "the inverse images behave well under inverse images. "	https://youtu.be/8F_oLX6tzbg
A Crash Foundation Course in Mathematics -4	Equivalence Relations	The last lecture of the series deals with the notion of equivalence relations and give four interesting examples. You may follow this with the videos on partial orders in the playlist Foundations.	https://youtu.be/iy-I7eIGZJ8
MTTS2021_L1: Foundations 1	Fquantifiers, negations, conjunctions	This is the first of a series of four lectures given to the participants of Level 1 of MTTS 2021. The series is meant to be a crash Foundation course in Mathematics and as such has a sizable overlap with the the set of four videos released earlier under the title "A Crash Foundation Course in Mathematics". The merit of the present series is that the viewers may get a taste of interactive sessions of MTTS camps. You may like to compare the corresponding videos to understand how the audience influence the lectures!	https://youtu.be/b9mgEhqLG3M
MTTS2021_L1: Foundations 2		This is the second of a series of four lectures given to the participants of Level 1 of MTTS 2021.	https://youtu.be/9OJNH-ILMO8
MTTS2021_L1: Foundations 3		This is the theird lecture of a series of four lectures given to the participants of Level 1 of MTTS 2021.	https://youtu.be/GaXgt04bWK8
MTTS2021_L1: Foundations 4		This is the last lecture of a series of four lectures given to the participants of Level 1 of MTTS 2021.	https://youtu.be/GwBhcmS7fWA
Partial Orders and Zorn's Lemma -1	Partial Order, Total order, Upper bounds	This is the first in a series of lectures on Partial Orders	https://youtu.be/kcBRUYAp_pw
Partial Orders and Zorn's Lemma -2	Maximum. Maximal element, maximal ideal	We prove (i) any finite totally ordered set has a maximum, (ii) a finite partial ordered set has a maximal element. (ii) naturally leads to the formulation of Zorn's lemma. We use it to prove the existence of a maximal ideal in a commutative ring with identity. On the way we clarify the definition of maximal ideas one finds in Algebra books.	https://youtu.be/hUhOjiZVCgw
Partial Orders and Zorn's Lemma -3	Existence of a basis, Extension of a linear map on a subspace.	We prove the existence of a basis for any nonzero vector space. We then give a "complicated proof" of the extension of a linear map from a vector subspace to the vector space. This may be considered as the "algebraic part" of the Hahn-Banach theorem in Functional Analysis. We made a deliberate choice of the `harder' proof with a view to its significance in Hahn-Banach theorem. See: Functional Analysis -- A First Course by Kumaresan and Sukumar (Narosa Publishing House)	https://youtu.be/I-ZEXRFDXD8
Unions and Intersections of an Arbitrary Collection of Subsets	Unions, intersections	We discuss concepts which you ought to know and perhaps wanted to know but nobody explained them! It is about the union/intersection of elements subsets from an arbitrary collection of subsets. We illustrate the concepts with a good set of geometric as well as analytical examples.	https://youtu.be/HfsUkOwOdRs

Unions and Intersections of an Arbitrary Collection of Subsets	Unions, intersections	We discuss concepts which you ought to know and perhaps wanted to know but nobody explained them! It is about the union/intersection of elements subsets from an arbitrary collection of subsets. We illustrate the concepts with a good set of geometric as well as analytical examples.	https://youtu.be/P8_2a94wyV0
Upper Bounds	Upper bounds, Bounded above, Lowe bounds, bounded below	This may be considered as the first lecture on real Analysis. We assume the algebraic structure and order relations on R. We then define upper bounds and lower bounds for subsets of R and introduce subsets which are bounded above and bounded below in R. This will be followed by a lecture on LUB and GLB.	https://youtu.be/JDETujVEJ_Y
Upper Bounds-2	Upper bounds, Lower Bounds, LUB, GLB. Supremum, Infimum	This is the second of the series on upper and lower bounds. We introduce LUB and GLB. We look at some examples. The next in the series will be on the LUB property of R. It is best if you watch it in small group and at each P-R-P, you pause the video and discuss. This is what happens in my classrooms.	https://youtu.be/VaHeAVV1UjE
lub_n_glb	LUB, GLB, supremum, infimum	We solve a lot of theoretical problems concerning LUB and GLB. Almost all of these will be needed when you go further in analysis. Going through these examples will make you very confident and you will be able to breeze through when you meet them again whereas others may be struggling! Enjoy! Cheers!	https://youtu.be/GpcispJWaYg
LUB Property	LUB Property, Order Completeness, Archimedean property	We introduce the notion of LUB property of R. We then show that R enjoys the LUB property iff it enjoys the GLB property. We offer two proofs. The second one is very much enjoyed by students whenever we teach it. We end with the Archimedean property of R.	https://youtu.be/f_QGd_xQJWs
Density of Rationals	Density of rationals	We prove the desnity of rationals in R, that is, given two reals a<b, there exists r in Q such that a<r<b.	https://youtu.be/HabdhBa1gMI
Floor Function	Greatest integer function, florr function	Given x in R, we prove the existence of m in Z such that m<= x<m+1.	https://youtu.be/loFBlygRj4g
Square Roots	Square root of 2	We prove the exietence of square roots of positive reals. We also indicate how our proof can be modified to show that Q does not have the LUB property.	https://youtu.be/mIc3OQ4c4eU
N-th roots	N-th root of a positive real	We give an elementary proof of the existence of unique positive n-th root of any positive real number. Though this can be easily proved using the intermediate value theorem, this proof trains one in analytical thinking. The proof is from my article "The Role of LUB Property in Real Analysis".	https://youtu.be/Hrbxv0uvMZ4
Nested Interval Theorem	Nested intervals	We prove the nested interval theorem and discuss some examples and counterexamples.	https://youtu.be/U8e4rNDQf_8
Vector Spaces: Lecture 1	R^n as a vector space,	This is the first lecture on a series on Basics of Vector Spaces. We start with the most important example of R^n and supply all the details. Then we introduce the solution set of a homogeneous system of linear equations and end with the definition of a vector space. We have kept in mind beginning students such as students of 2nd year B.Sc. while `delivering' the lecture. Hope this helps.	https://youtu.be/gz2iiRIxOvA
Vector Spaces: Lecture 2	Examples of Vector Spaces	We give all the standard examples of vector spaces. We give all the details in the case of spaces of functions, as it is either not done or left as an exercises.	https://youtu.be/ogbQqNP5Soo
Vector Spaces: Lecture 3	Cosntruction of Vector subspaces	We enunciate a principle for the construction of new vector spaces. The principle is then applied to two concrete situations. The result is some esoteric examples of vector spaces which leave the beginners bewildered, as they find them mysterious. Our principle demystifies them!	https://youtu.be/0fPLlqiFWdM
Vector Spaces: Lecture 4	Basic Facts on Vector spaces	In this short video, we state and prove the standard properties of a vector spaces. Noteworthy among them are the facts: (i) -1.x=-x and (ii) t.x=0 implies t=0 or x=0.	https://youtu.be/vPEmDTjlB8s
Vector Spaces: Lecture 5	Vector subspaces	We define vector subspaces of a vector space and give a lot of examples. Particular attention is given to vector subspaces of R, R^2 and R^3. Their geometry is also brought out.	https://youtu.be/sZZEP2qvYbs
Vector Spaces: Lecture 6	Vector subspaces	We look at vector subspaces of R^2 and R^3. We also show how to find the smallest subspace containing two vectors in R^3 and geometrically identify it.	https://youtu.be/uEMZCL2Zp_Q

Vector Spaces: Lecture 7	Linear Dependence, Linear Independence, Smallest vector subspace	We look for smallest vector subspace W which contains a subset S of a vector space. This leads us to the notion of linear dependence. The lecture ends up with the derivation of the standard definition of linear dependence and independence.	https://youtu.be/rWUHHv4b-aY
Vector Spaces: Lecture 8	Equivalent Definitions of Basis (of a vector space)	We give four equivalent definitions of a basis in a vector space and prove their equivalence.	https://youtu.be/lmTy9mOZDKk
Vector Spaces: Lecture 9	Basis, Vector space, Construction of a basis	In this video, we discuss a few tricks to construct bases in some vector spaces and hence compute their dimensions. You will be surprised to see that the process is the reverse of what you see in books. We guess the dimension, then look for a set of spanning vectors and then prove their linear independence thereby showing that it is a basis. I hope you enjoy this lecture.	https://youtu.be/gY3qSbHs_Eo
Vector Spaces: Lecture 10	Dimension, Basis, Vector space	We prove that any two bases of a finite dimensional vector space have the same number of elements. This allows us to define the notion of dimension of a (F.D.) vector space. We give two proofs of this result: one is simple and is found in my book and the other is a standard one with complete details.	https://youtu.be/k2NGa9r7fE8
Vector Spaces: Lecture 11	Existence of a Basis	We prove that any finite dimensional vector space has a basis. This is achieved by `extracting' a basis out of a finite spanning set. We then look at a concrete example to lay down a procedure to extract a basis from a spanning set.	https://youtu.be/oLylJltuj5s
Vector Spaces: Lecture 12	Existence of a Basis	In this second part, we prove that we can extend any linearly independent set of a vector space to a basis. We illustrate the process with an example. Note that the main result gives another proof for the existence of a basis in any nonzero finite dimensional vector space. Start with S={v_1}$ where v_1 is a nonzero vector. Then S can be extended to a basis.	https://youtu.be/DaXtrvxY4Ao
Vector Spaces: Lecture 13	Dimensional Formula	1) We classify the vector subspaces of R^3. 2) We state and prove the formula for the dimension of the sum of two (f.d.) vector subspaces of a Vector space. 3) As usual, we look at illuminating concrete examples.	https://youtu.be/OP1P5oFvFC8
Vector Spaces: Lecture 14	Direct Sum	We define the concept of direct sum of vector susbpaces (popularly known as Internal direct sums). We also introduce the concept of external direct sums of vector spaces. We wanted to give a few more interesting examples of direct sums of subspaces, but could not give due to the time limit.	https://youtu.be/AoKm60_jzrc
Linear Dependence and Independence	Linear Dependence, Linear Independence, Smallest vector subspace	We look for smallest vector subspace which contains a subset S of a vector space. This leads us to the notion of linear dependence. The lecture ends up with the derivation of the standard definition of linear dependence and independence.	https://youtu.be/rWUHHv4b-aY
Equivalent Definitions of Basis (of a vector space)		We give four equivalent definitions of a basis in a vector space and prove their equivalence.	https://youtu.be/lmTy9mOZDKk
Construction of Bases in a Vector Space	Basis, Vector space	In this video, we discuss a few tricks to construct bases in some vector spaces and hence compute their dimensions. You will be surprised to see that the process is the reverse of what you see in books. We guess the dimension, then look for a set of spanning vectors and then prove their linear independence thereby showing that it is a basis. I hope you enjoy this lecture.	https://youtu.be/gY3qSbHs_Eo
Dimension of a Vector Space	Dimension, Basis, Vector space	We prove that any two bases of a finite dimensional vector space have the same number of elements. This allows us to define the notion of dimension of a (F.D.) vector space. We give two proofs of this result: one is simple and is found in my book and the other is a standard one with complete details.	https://youtu.be/k2NGa9r7fE8
Linear Maps 1	Linear Maps	We introduce the concepts of linear maps, give a variety of examples and find/classify all linear maps from R^n to R.	https://youtu.be/lDo6J0rDXpY
Linear Maps 2	Linear Maps	In this second lecture, we look at a lot of interesting examples of linear maps. Of particular interest may be rotation on R^2 and the (real linear) map of C via multiplication by i, a square root{-1}.	https://youtu.be/pckF9q67qL8

Linear Maps 3	Linear Maps, Range, Kernel, Column space, Row space	We look at two important subspaces associated with a linear map. We explain how to look at a matrix in a geometric/dynamic way. We also talk of the row-space and the column space of a matrix. We define the projection maps associated with a direct sum.	https://youtu.be/Xk4BhMRBSSM
Linear Maps 4	Linear Maps and Basis, Vector space of linear maps	We prove the most important result in the theory of Linear Maps: A linear map is completely determined by its action on a basis. This in turn shows us how to `look' at linear maps and how to construct them. We then show L(V,W), the set of linear maps from V to W is a vector space. Finally we attempt to guess the dimension of L(V.W) in some simple case.	https://youtu.be/DN8lgTkgnug
Linear Maps 5	Linear Maps, Linear isomorphism,	We prove that if V and W are finite dimensional vector spaces,, then the dimension of L(V,W) is the product of the dimensions of V and W. We define linear isomorphism and give some examples. We point out the bijections used to construct vector space (in Esoteric Examples) are linear isomorphisms. Finally, we prove that if V and W are finite dimensional vector spaces, then a linear map f from V to W is a linear isomorphism iff it is one-one and iff it is onto. Our proof does not use Rank-Nullity theorem, but in stead uses many basic results one has learned so far. So, this may be an instructive proof. Later we shall prove it using the rank-nullity theorem.	https://youtu.be/iqED1TSk0XU
Linear Maps 6	Linear Maps, Linear isomorphism,	The main results of this session are: (i) Being linearly isomorphic is an equivalence relation and (ii) a linear map f from V to W is a linear isomorphism iff it takes a basis of V to a basis of W (without the assumption of finite dimensionality by avoiding the rank-nullity theorem). We also show that any finite dimensional vector spaces of the same dimension are linearly isomorphic.	https://youtu.be/C1Hxgbsc9j0
Linear Maps 7	Ordered basis, system of coordinates, transition matrices	n this episode, we introduce the notion of an ordered basis with examples. Then we show how an ordered basis of V sets up an isomorphism with R^n where n= dim V. We then show how to relate the systems of coordinate associated with different ordered bases. To establish the relation, we define the Transition matrices. We illustrate all these by means of well-chosen simple examples.	https://youtu.be/RLV8aqxV2q4
Linear Maps 8	Matrix representation of a linear map	In this sessions, we explain how to associate a matrix for a linear map with fixed ordered bases on the domain and the co-domain. We give about 10 examples some usual and some unusual. We also relate the matrix to the coordinate systems associated with the ordered bases.	https://youtu.be/AWxwVu1L778
Linear Maps 9	Dimension of L(V,W)	We give two abstract examples of matrix representations. We establish the important relation the coordinate vector [f(v)] is the matrix of f with the coordinate vector [v]. We use it to show that L(V,W) is linearly isomorphic the space of matrices of type dim V X dim W.	https://youtu.be/ZsFLtBnVPu8
Linear Maps 10	Similarity of linear maps	We review the proof of [f(v)]=[f][v] with details. Then we show that the matrix of the composition of linear maps is the product of matrices in correct order. Later we shall relate the matrices of a linear map relative to pair of ordered bases (B_1, B_1') and (B_2,B_2') in the domain and co-domain. We end the lecture with the notion of "Similarity" and indicate its significance.	https://youtu.be/whFnAIKxMRk
Rank-Nullity Theorem	Rank, Nullity, Linear map, Kernel, Range	We give the context and prove the Rank-Nullity theorem. We also give some typical applications.	https://youtu.be/USUkU_LI0_Q
Construction of Linear Maps -1	Linear Maps, Rank-Nullity Theorem	In any book (including mine), you will be asked to check whether a given map between vector spaces is a linear map. Very rarely, we look at the problem of finding linear maps as per our specifications. In this lecture, we show how the results of basic linear algebra (up to Rank-Nullity theorem) show us the way of such constructions. In the next lecture, we shall look at a more involved example.	https://youtu.be/3r0uyml5Hhs
Construction of Linear Maps -2	Linear Maps, Rank-Nullity Theorem	We give examples of how to extend a linearly independent subset of a vector space to a basis of the vector space. We then construct a linear map $T\colon \R^4\to \R^3$ with prescribed kernel and range.	https://youtu.be/RQXsYObOhVs
Matrix Rank	Row rank, Column rank	This is one of the first videos, as I was learning to create videos of my lectures. It may not be good but I hope that you will like the mathematical content. I explain a simple and visually appealing proof of equality of row and column ranks of a matrix. It is adopted from my book "Linear Algebra -- A Geometric Approach", published by PHI, India.	https://youtu.be/dR5pZmW8F_I

Dot Product on Rn	Dot product, Cauchy-Schwarz inequality	We introduce the notion of the dot-product on R^n. This is the most important special case of inner product, known as the Euclidean inner product. We derive the Cauchy-Schwarz inequality, the triangle inequality for the norm and the Euclidean distance/metric. This will serve as an example in metric spaces, in linear algebra and also the setting for several variable calculus/analysis on R^n.	https://youtu.be/7CG8K-KFGBg
Real Sequences Intro 1	Real sequence, converegent sequences, convergence	This is the first lecture of two special lectures given at miniMTTS camp at Deen Dayal Upadhyaya College, Delhi. These lectures serve as the preliminaries for my lectures on Real sequences in this playlist. My sincere advice to the viewers is to go through these before you start viewing Real sequences - Lecture N.	https://youtu.be/RAdedpuPMJI
Real Sequences Intro 2	Uniqueness of the limit	This is second and the last lecture on the series of Introductory Lectures on Real Sequences. As remarked in the first one, I advise everybody to view these two lectures before starting on Real Sequences -- Lecture-N series.	https://youtu.be/IuRxKSQq-9w
Real Sequences Lecture 1	Sequence, bounded sequence, convergent sequence, sandwich lemma	This is the first of a series of lectures on Sequences in R with a live audience. The idea is to give a glimpse of an actual MTTS classroom. This is a part of the initiative of the MTTS Trust, called "Short Courses in Mathematics". I thank the Trust for its support. I thank Dr.Chandrashekaran (CUTN), Dr Sukumar (IITH) and Dr Bhaba Sarma (IITG) for their help in the production of this video.	https://youtu.be/wzFc9us78sM
Real Sequences Lecture 2	Algebra of limits, algebra of convergent sequences	We prove the results on the algebra of convergent sequences. Many may look down upon or ignore this part of analysis. It happens in many courses in analysis. Teachers and students alike are too eager to launch into continuity, compactness etc. I recommend that you watch it with rapt attention, since the chapter on the theory of sequence is the stepping stone to analysis in the sense that it teaches the most basic and important tricks and tools in analysis.	https://youtu.be/t8bOkVVqDIo
Real Sequences Lecture 3	Arithmetic average, Divide and conquer, monotone sequence	We prove that the arithmetic averages of a convergent sequence converges to the same limit. This result introduces us to a very basic trick in analysis, namely, Divide and Conquer. We also deal with monotone sequences and apply the results to the decimal expansion.	https://youtu.be/ZPrOP7eiq7Q
Real Sequences Lecture 4	Montone sequence, imoprtant limits	In this session, we discuss some important monotone sequences and later some important limits which are often needed in analysis. This episode is a "must watch" for anybody to get acquainted with the tricks of analysis. It will help you overcome the fear of estimates and inequalities! We shall discuss some more important limits in the next episode	https://youtu.be/Xj06MXWQZxU
Real Sequences Lecture 5	Imporant Limits, Subsequence	This is the 5th in the series. We look at some more important limits and then start with subsequences. We carefully define a subsequence and its convergence. It starts from 00:45:12.	https://youtu.be/EXxJytWqRc0
Real Sequences Lecture 6	Convergent subsequence, Cauchy sequence, monotone subsequences	We prove three major results concerning subsequences: (1) If xn converges to x, any of its subsequence also converge to x, (2) If a Cauchy sequence (xn) has a convergent subsequence converging to x, then xn converges to x and (3) If (xn_)is real sequence, there exists a monotone subsequence.	https://youtu.be/SS8P4ZHpQqM
Real Sequences Lecture 7	Subsequence, Blozano-Weierstrass theorem, Cluter point, accumulation point, Cauchy completeness, Sequences diverging to infinity	This is the final lecture in this playlist: We explain the uses of subsequences. We then state and prove the sequential version of Bolzano-Weiesrtrass theorem. This leads to a motivated definition of a cluster point of a set and cluster point version of B-W theorem. We then give a standard proof of Cauchy completeness of R. We end up with the notion of sequences diverging to infinity and minus infinity. We also point out the difference between unbounded sequeneces and those that diverge to plus or minus infinity.	https://youtu.be/cqmnlm14s4I
Real Sequences Intro 1	Real sequence, converegent sequences, convergence	This is the first lecture of two special lectures given at miniMTTS camp at Deen Dayal Upadhyaya College, Delhi. These lectures serve as the preliminaries for my lectures on Real sequences in this playlist. My sincere advice to the viewers is to go through these before you start viewing Real sequences - Lecture N.	https://youtu.be/RAdedpuPMJI
Real Sequences Intro 2	Uniqueness of the limit	This is second and the last lecture on the series of Introductory Lectures on Real Sequences. As remarked in the first one, I advise everybody to view these two lectures before starting on Real Sequences -- Lecture-N series.	https://youtu.be/IuRxKSQq-9w

Mtts2021 Sequences Spl 1 HB	Sequences, convergence, triangle inequailty	This is the first of the three lectures given to students of Level O of MTTS 2021. The goal of the series was to use the theory of sequences as a platform to introduce some of the standard tools and the tricks of the trade and also to demystify the role of inequalities. Any student of mathematics, who hated/hates analysis should go through these lectures. Hopefully, you may change your mind!	https://youtu.be/1M207g_Oddk
Mtts2021 Sequences Spl 2 HB	Uniqueness of limit	This is the second of the three lectures given to students of Level O of MTTS 2021. The goal of the series was to use the theory of sequences as a platform to introduce some of the standard tools and the tricks of the trade and also to demystify the role of inequalities. Any student of mathematics, who hated/hates analysis should go through these lectures. Hopefully, you may change your mind!	https://youtu.be/jyoelGHFsY8
Mtts2021 Sequences Spl 3 HB	Algebra of convergent sequences	This is the second of the three lectures given to students of Level O of MTTS 2021. The goal of the series was to use the theory of sequences as a platform to introduce some of the standard tools and the tricks of the trade and also to demystify the role of inequalities.	https://youtu.be/jyoelGHFsY8
LimSup1	LimSup and LimInf of a bounded sequence	We introduce the concept of limsup and liminf of a bounded sequence in R. We start with preliminary background, and give a good set of examples to gain confidence in these concepts.	https://youtu.be/yC5NU327rRw
LimSup2	LimSup, LimInf, Cauchy Completeness	This is the second and final lecture on LimSup and LimInf. We prove that a bounded sequence is convergent iff LimSup=LimInf and offer the classical proof of Cauchy completeness of R.	https://youtu.be/I2_83xY15wc
Cauchy Completeness MTTS 2020	Cauchy sequence, Cauchy complete, completeness of R	This is the video recorded of the lecture I gave to participants of both the batches of Level O of MTTS 2020. You may compare this with another with a similar title (with no audience) and see which sounds better! If this version is better, the credit should go to the students of Level O who wanted me to give a lecture to them!	https://youtu.be/BW3h5egrmUQ
Sandwich Lemma	sandwih lemma	It deals with sandwich lemma and three typical applications.	https://youtu.be/0Wid1GHCT7Y
Bolzano Sequence version	Bolazano Weierstrass theorem, convergent subsequence	This deals with the sequence version of Bolzano-Weierstrass theorem. The proof uses the nested interval theorem. We review the background and then launch on a proof.	https://youtu.be/NlDZkfl5vTc
Cauchy Completeness	Cauchy sequences, connvergent sequences, Cauchy completeness	We give a proof of the fact: Every Cauchy sequence of real numbers is convergent. The proof uses the definition of (i) convergence of a sequence, (ii) Cauchy sequences, (iii) the LUB property of the real number system and NOTHING ELSE! This is the simplest and minimalistic proof of this important result.	https://youtu.be/LNnvRWWvzuE
Continuity Lecture1	Continuity, sequential, algebra of continuous functions	The session starts with the definition of continuity using sequences. We give about a dozen examples and also prove the theorem on the algebra of continuous functions. The next in the series will deal with epsilon-delta definition. Stay tuned.	https://youtu.be/en_Xqt_QKiY
Continuity Lecture2	local properties of continuosu functions, Bolzano's theorem, extreme values, compact set in R	We establish two more properties of continuous functions: modulus of a continuous function and maximum/minimum of two continuous functions. We establish two local properties of continuous functions: preservation of sign and boundedness. We then prove that any continuous function on a closed and bounded interval is bounded. By analyzing the proof, we arrive at definition of compact subsets of R. We end with a proof of the Bolzano's extreme value theorem. I thank six students who wished to attend the session while recording so that it is an interactive session.	https://youtu.be/9mw2-y-yblo
Continuity Lecture3	Intermediate Value theorem, n-th root odd degree real polynomial	In this session, we (we=Students+I) prove the intermediate value theorem. Using it, we give three typical applications: (i) the existence of n-th roots for positive numbers (ii) monotonicity of 1-1 continuous functions on an interval and (iii) existence of a real root for any odd degree real polynomial.	https://youtu.be/TQCMHjbp52A
Continuity Lecture4	Continuity via epsilon-delta	In this session, we complete the proof of the existence of real roots of an odd degree real polynomial. (There is a slightly edited part here.) We then motivate the epsilon-delta definition of continuity, and give a few examples which illustrate the techniques to find a delta for a given epsilon to establish continuity at a point.	https://youtu.be/hnHZu4OLrdg
Continuity Lecture5	Thomae's function, distance of a point from a set	In this lecture, we deal with Thomae's function and d(x,A), the distance of x from a set A. We then establish the local properties using epsilon-delta definition. We indicate a direct proof (using LUB) of the intermediate value theorem and outline a similar proof for the boundedness of continuous functions on compact intervals.	https://youtu.be/_VBYyDlbgCk

Continuity Lecture 6	Limit of a function, Cluster point	We establish the equivalence of the sequential definition and epsilon-delta definition of continuity. The limit of a function at a point and the notion of cluster point are then introduced . An approach to the algebra of (finite) limits is indicated.	https://youtu.be/nBlNd6eKQSo
Continuity Lecture 7	Limit of a function	We discuss, in depth, various kinds of limits and give a "unified" formulation of all the 15 kinds of limits.	https://youtu.be/fCzS8y4SBtE
AP-FDP Lecture on Continuity	Epsilon-Delta definition, Continuous fucntions	This is a recording of my lecture for College teachers organized by the Department of Collegiate Education, Andhra Pradesh. I thank Shri Srinivas of APCCE for making this recording available and giving me permission to include it in my channel. The lecture is about 1 hour followed by interactions with the teachers. I hope the viewers enjoy this.	https://youtu.be/Ry2Hl0yJPyM
Divide and Conquer Trick in Analysis		This is a video recording of my lecture delivered at S.S. Pillai Memorial Lecture Series at the Department of Mathematics, M.S. University Tirunelveli, Tamilnadu. I thank the organizers for the invitation as well as the permission to edit the record and upload it to YouTube for public view. In this talk, we give some typical applications of Divide and Conquer trick in analysis. If you have gone through a course in real analysis, this could help you get a new perspective and insight into some of the proofs you might have learned and forgotten!	https://youtu.be/q3BQt09JkCI
Principles and Tools of Real Analysis 1	LUB Property, Archimedean property, Modulus, Triangle inequality	This is the first lecture on a series of lectures delivered as part of 25th Prof. S. Abraham Endowment Lecture series. I thank the College for its permission to upload the lectures on my channel. In the first talk, I introduce the LUB and Archimedean properties of R and prove the triangle inequality along with `estimation' of errors in approximation as the basic principles.	https://youtu.be/RGBQJUOp52U
Principles and Tools of Real Analysis 2	Curry Leaf Trick	In the second session, I introduce the Curry-Leaf Trick -- triangle inequality with a different perspective - as the first tool of analysis in its aim to `estimate' quantities. We illustrate this tool in a few easy but instructive examples.	https://youtu.be/t7-wh8lHtBA
Principles and Tools of Real Analysis 3		In the concluding part , I discuss "Divide and Conquer Trick" on a tool in analysis. I d	https://youtu.be/7SOL8kdpzoA
Uniform Continuity Lecture 1	Uniform Continuity, Lipschitz functions,	This is the first lecture of a series on Uniform Continuity. We start with an intuitive way of looking at uniform continuity, formulate the rigorous definition and consider a few examples. We also introduce Lipschitz functions and a trick to generate a large class of Lipschitz functions.	https://youtu.be/j6cu4gVgU7M
Uniform Continuity Lecture 2	Sequential characterization of uniform continuity	We state and prove various results which constitute the `algebra' of uniformly continuous functions. We establish a useful characterization of uniform continuity using sequences and give some typical applications of this characterization. We start showing x^n is not uniformly continuous on R if n \geq 2.	https://youtu.be/7_rT3qLjeVs
Uniform Continuity Lecture 3		We complete the proof of the fact that x^n for n \geq 2 is not uniformly continuous on R. We prove that any uniformly continuous function takes Cauchy sequences to Cauchy sequences but the converse is false. We prove the most important result: any continuous function on a closed and bounded interval (more generally on any compact subset of R) is uniformly continuous.	https://youtu.be/5i4hQCM39CE
Uniform Continuity Lecture 4	Extension	This is the fourth and the last of the series on Uniform Continuity. In this episode, we talk of extension of a uniformly continuous function to a larger domain. We start with an illuminating example of extension of a uniformly continuous function $f\colon (a,b)\to\R$. This introduces us to the strategy of proof of the main result. We then indicate a non-calculus proof for the fact that x^n is not uniformly continuous for n greater than 1. We also show how the calculus proof leads to a proof of the fact that no polynomial function of degree greater than 1 is uniformly continuous on R.	https://youtu.be/2HEQrmzMcCw

Differentiation on R: Lecture 1	Differentiatbility, Derivative	This is the first lecture in a series on Differentiation on R. We review the limit concept, define the differentiability at a point and state an equivalent characterization. We show how this approach helps us to understand or do the problems of differentiability using the facts on continuity.	https://youtu.be/y4TkXeE8LFs
Differentiation on R: Lecture 2	Algebra of Differentiable Functions	We prove the algebra of differentiable functions and the chain rule using our characterization of differentiable functions. We do a few more examples.	https://youtu.be/r9ZSKYEOP6Y
Differentiation on R: Lecture 3	Rolle’s theorem, local maximum, local minimum, local extremum	We give three interpretations of the derivative: (i) geometric, (ii) physical and (iii) approximation by a first degree polynomial. We then motivate, state and prove Rolle's theorem. We define local extremum.	https://youtu.be/FvYC5gB89Kc
Differentiation on R: Lecture 4	Mean Value Theorem	We state and prove the Mean Value Theorem. We give geometric motivation of the statement as well as the proof. We give some typical applications and bring out the significance of the result.	https://youtu.be/OoQCF3lLV7c
Differentiation on R: Lecture 5	Inverse Function Theorems	We discuss the inverse function theorems for continuous functions and differentiable functions.	https://youtu.be/33_p7fp0XGY
Differentiation on R: Lecture 6	Darboux Theorem, L'Hospital's Rules	We prove Darboux theorem, Cauchy's mean value theorem and prove two simple cases of L'Hospitals' rule.	https://youtu.be/Gsb7E6VWQk4
Differentiation on R: Lecture 7	L'Hospital's Rules	We deal with L'Hospital's Rule which deals with "Infinity/Infinity as x goes to Infinity" form. The three cases dealt in Lectures 6 & 7 are typical cases and all other forms can be proved similarly. Any aspiring analyst should go through the proofs, which are usually skipped in a course in analysis!	https://youtu.be/OMOongV3Fts
Differentiation on R: Lecture 8	Taylor’s Theorem, Remainder, Lagrange’s form	We give a typical classroom proof of Taylor's theorem with Lagrange's form of the remainder. We later explain the reasons why one thought of Taylor polynomial, how well it approximates the given function, how to prove a result stronger than the one obtained from Lagrange's form of the remainder.	https://youtu.be/E0XIkGPf0sk
Differentiation on R: Lecture 9	Taylor’s theorem Cauchy’s Form, Remainder	We prove again the Taylor's theorem with a general form of the remainder. Lagrange's from and Cauchy's form of the remainder are special cases of this. The proof is very similar to the earlier one. As an application, we show that the Taylor series of f(x)=log(1+x) is [(-1)^{n-1}/n] x^n and that it converges at x=1. Thus we show that the sum of the standard alternating series is log 2.	https://youtu.be/PB9a08wB46l
Riemann Integration 1	Upper and lower sums, Darboux sums	We start with the motivation for lower and upper (Darboux) sums. We work out a few examples. The goals are to understand how to compute them and also how to choose a partition which serves our purpose.	https://youtu.be/cAYTvDuYeHU
Riemann Integration 2	Darboux-Stieltjes sums	WE look at two more examples of upper and lower sums. We also introduce Riemann-Stieltjes-Darboux sum with an increasing function as the integrtor. We then investigate the effect of refinement of a partition on the upper and lower sums.	https://youtu.be/cAROoeQB2al
Riemann Integration 3	Riemann criterion for integrability	We define the alpha-integrability of functions and prove Riemann's criterion for a bounded function on an interval to be alpha-integrable:	https://youtu.be/XcPK07MP7zY
Riemann Integration 4	Integrability of continuous functions, monotone functions, setp functions, Heaviside function	We use Riemann's criterion to give examples of classes of alpha-integrable functions. (i) Constant functions (ii) Continuous functions, (iii) functions continuous except at finitely many points, (iv) monotone functions with continuous increasing integrator alpha and (v) step functions. Pay particular attention to the case of Heaviside function as an integrator.	https://youtu.be/hAuh-ClPGM4
Riemann Integration 5	Integrability of classes of functions	We use the Riemann criterion to investigate the alpha-integrability of various classes of functions.	https://youtu.be/uIADax_8_yg
Riemann Integration 6	Riemann sum, equivalence of Darboux/Riemann sum approaches	We deal with the Riemann sum approach to R-S integration. Here the integrator enjoys less stringent condition. This is most favoured by physicists and engineers. We prove that the the definitions of integrability using Darbous sums and Riemann sums are equivalent UNDER the assumption that the integrator is increasing.	https://youtu.be/lLT5EZ6CbSg

Riemann Integration 7	Vector space of integrable functions	We prove that the set of alpha-integrable functions is a vector space and that the integration is a linear map. Here no restriction on the integrator. Under the added assumption that alpha is increasing we prove the positivity/monotonicity of the integral.	https://youtu.be/O8IqYaCUtDU
Riemann Integration 8	Composition of integrable functions	We prove that the composition gof of an integrable function followed by a continuous function is again integrable. We think through the proof using the Divide and Conquer trick and then see how a textbook proof may be written.	https://youtu.be/9EQx5rvprKI
Riemann Integration 9	Integral inequality, fundamental theorems of calculus	We prove the basic inequality for the integral: the modulus of an integral is at the most the integral of the modulus and the mean value theorem for the integrals. We then state and prove both the fundamental theorems of calculus.	https://youtu.be/aeiB8j3vna0
Riemann Integration 10	Integartion by parts, Inetgration by subsitution	We deduce a weaker version of the first fundamental theorem of calculus from the second. We prove the integration by parts and integration by substitution formulas.	https://youtu.be/AIJwDG9bWjk
Riemann Integration 11	Examples of Stieltjes integrals	We deal with two important examples of Riemann-Stieltjes integrals. If you have not learned these examples, you have not learned Riemann-Stieltjes integrals!	https://youtu.be/XLY_-VewLgc
Riemann Integration 12	Examples of Stieltjes integrals	We give a simple proof of the result which relates alpha integral of f to the ordinary Riemann integral of f alpha'. The highlight of the proof is that we use both Riemann sum approach along with Darboux sum approach (in the form of Riemann's criterion)!	https://youtu.be/EVRXlTpRSi8
Riemann Integration 12 (continued)	Integration by parts general version	We prove a general version of Integration by parts formula which relates the integral of f with integrator g to the integral of g with integrator f. This is the last of the series.	https://youtu.be/1ioISXEovvg
Infinite Series – 1	Infinite Seriees, Geometric Series	We motivate the definition of convergence and sum of an infinite series and look at the geometric series.	https://youtu.be/tukPRDlbEQI
Infinite Series – 2	Harmonic Series, Harmonic p-series	We revisit the geometric series, talk of the convergence of a series of nonnegative terms. We look the harmonic series sum (1/n) and prove that it is not convergent in two ways. We then look at the harmonic p-series sum(1/n power p).	https://youtu.be/g62Z5QJko3I
Infinite Series – 3	Vector spec of Convergent series	We state and prove the comparison test, give applications, look at the harmonic p-series. We prove a necessary condition for the convergence of the associated series of a given sequence. We finally prove the set of sequences whose associated series are convergent is a vector space, in fact, a vector subspace of sequences that converge to 0.	https://youtu.be/XCpdpgMdmVM
Infinite Series – 4	Root Test, Ratio test	We state and prove versions of the Root and ratio tests. The easier to understand and simple versions proved by me are stronger than the standard version and it also implies the limsup-liminf version which students dislike.	https://youtu.be/66ETtL-eX2Q
Infinite Series – 5	Decimal Expansion	As an application of the study of a series of non-negative terms, we state and prove a result on the existence and `uniqueness' of the decimal expansion of a real number in (0,1). We explain the geometry as well as some subtle points of the infinite series. Towards the end we very briefly explain how to prove similar results for binary and ternary expansions.	https://youtu.be/dRn6iPLqcds

Infinite Series – 6	Integral Test, Absolute convergence, Alternating Series Test	We state and prove the integral test and apply it to investigate convergence or divergence of the harmonic p-series. We make an important observation about the convergent series of non-negative terms. This fact is rarely done in a first course but it is an easy one and is a stepping stone to Lebesgue integral of a nonnegative measurable function (Do not worry about this jargon!) We then define a absolutely convergent series and show that any absolutely convergent series is convergent. A version of triangle inequality for an absolutely convergent series is also established. We state and prove the alternating series test. It then lead us to an example of an infinite series which is convergent but not absolutely convergent.	https://youtu.be/VE9PX9wvMGw
Infinite Series – 7	Rearrangement of an infinite series, Conditional Convergence	We rearrange the terms of the standard alternating series whose sum is half of the sum of the original series. We show that the series of positive (respectively negative terms) diverge in a conditionally convergent series.	https://youtu.be/6osqNwSdBBo
Infinite Series – 8	Summation by parts, Abel's test, Dirichlet's test	Let sum(an) be absolutely convergent series. Let sum(bn) be a rearrangement of sum(an). Then sum(bn) is convergent and its sum is the sum of the infinite series sum(an). We explain the Abel's summation by parts formula and arrive at Dirichlet's and Abel's test for convergence of a series of the form sum(an. bn).	https://youtu.be/QOGRGcbzJIE
Infinite Series – 9	Cauchy Product of infinite series	We look at three examples: (i) Multiplication of polynomials, (ii) the exponential series and the property that exp(x+y)=exp(x).exp(y) and (iii) the term-wise differentiation of the geometric (power) series sum(x^n). These motivate the definition of the Cauchy product of two infinite series. The main result is that the Cauchy product of two absolutely convergent series is absolutely convergent and that the sum of the Cauchy product is the product of the sums of the two series. We then apply to derive the results of Examples (i) and (iii). This result is very useful and suffices for most of situations that arise in analysis. There is a more general result known as Merten's theorem. Its proof is a good training for any aspiring analyst. Watch https://youtu.be/alv6NdpNvt8 This video is linked towards the end of the video. The proof of the main result, though easy, is an example of an argument with finesse. Hope you enjoy it!	https://youtu.be/04n7FyYCHkQ
Sequences of Functions 1	Pointwise onvergence	The first lecture on the series on Convergence of a sequence of functions. We formulate the definition of pointwise convergence and look at some examples.	https://youtu.be/Vx004k9r_YQ
Sequences of Functions 2	Uniform Convergence	We define the uniform convergence of a sequence of functions on a set. We look at the examples discussed in the last lecture with a view to check for uniform convergence, We also give a geometric interpretation of the uniform convergence.	https://youtu.be/WonIA822Jog
Sequences of Functions 3	Uniform Convergence	We look at three illuminating and instructive examples of convergence of a sequences of functions.	https://youtu.be/KU6r5awR2m0
Sequences of Functions 4	Uniform convergence, continuity and integrability	We investigate the relation between the uniform convergence of a sequence of functions and continuity and integrability.	https://youtu.be/lfLz1bVRV0Y
Sequences of Functions 5	Uniform convergence, continuity and integrability	We look at the consequences of the uniform convergence and integrability.	https://youtu.be/wbZ6FG3BNtU
Sequences of Functions 6	Cauchy Criterion for uniform convergence	We state and prove the Cauchy criterion for uniform convergence. We also give an application.	https://youtu.be/AaONimmzb7E
Sequences of Functions 7	Uniform convergence and Differentiability	We discuss the most general result concerning the differentiability of the uniform limit of a sequences differentiable functions.	https://youtu.be/m07MehxhQKM

Cauchy Product of Infinite Series and Merten's theorem	Cauchy product of infinite series, Merten's theorem	We define the Cauchy product of two series and prove Merten's theorem. The proof uses what I call the Divide and Conquer Trick in a more subtle way. Any aspiring analyst should master the proof.	https://youtu.be/alv6NdpNvt8
Abel's Limit Theorem	Abel's limt theorem, sum of the alterting series	We give a direct proof of Abel's limit theorem dealing with power series. This is usually derived from Abel's partial summation formula. It is quite possible that Abel proved the limit theorem first and the trick was abstracted as a tool known as "Abel's summation by parts". I hope that you enjoy this approach.	https://youtu.be/FAKPSxbiHMQ
Ramanujan College Lecture: What makes real anaysis tick?	LUB Property, Order completeness, Cauchy completeness, iIntermediate value theorem	We explain the meaning of the title and offer an answer: It is the LUB property of R (also known as, the Order Completeness axiom/property) that is the foundation as well as the backbone of all (substantial -- in the sense of analysis) results which uses R.	https://youtu.be/QF4bmwtQ4Hg
Ramanujan College Lecture: Divide and Conquer Rule in Analysis	Arithmetic average, Merten's theorem	We explain the "Divide and Conquer Trick in Analysis" and illustrate it with two examples.	https://youtu.be/WsqoiFkXhgo
Principles and Tools of Real Analysis 1	LUB Property, Archimedean Property ,Triangle inequality	This is the first lecture on a series of lectures delivered as part of 25th Prof. S. Abraham Endowment Lecture series. I thank the College for its permission to upload the lectures on my channel.	https://youtu.be/RGBQJUOp52U
Principles and Tools of Real Analysis 3	Curry Lead Trick	This is the second lecture on a series of lectures delivered as part of 25th Prof. S. Abraham Endowment Lecture series. I thank the College for its permission to upload the lectures on my channel. In the second session, I introduce the Curry-Leaf trick -- triangle inequality with a different perspective - as the first tool of analysis in its aim to `estimate' quantities. We illustrate this tool in a few easy but instructive examples.	https://youtu.be/t7-wh8lHtBA
Principles and Tools of Real Analysis 2	Divide and Conquer Trick	This is the third and final lecture on a series of lectures delivered as part of 25th Prof. S. Abraham Endowment Lecture series. I thank the College for its permission to upload the lectures on my channel. In the concluding part , I discuss "Divide and Conquer Trick" as a tool in analysis. I deliberately chose easier examples so that 3rd semester students can follow the lecture, understand the tool and see it in action while they learn analysis later. Some of you may also like to watch my video on this topic. See https://youtu.be/q3BQt09JkCI	https://youtu.be/7SOL8kdpzoA
Miranda House Lectures on Differentiation – 1		This is a series of six lectures starting from the motivation for the rigorous definition of limits in one variable, then two variables, geometric meaning of derivatives, total derivative, directional derivatives, partial derivatives and gradients, tangent plane to the graph of a function of two variables. **Target audience: Final Year Students of Bsc.**	https://youtu.be/_i2xsCpuSlo
Miranda House Lectures on Differentiation – 2		This is a series of six lectures starting from the motivation for the rigorous definition of limits in one variable, then two variables, geometric meaning of derivatives, total derivative, directional derivatives, partial derivatives and gradients, tangent plane to the graph of a function of two variables.	https://youtu.be/Nxy6jwBndak
Miranda House Lectures on Differentiation – 3		This is a series of six lectures starting from the motivation for the rigorous definition of limits in one variable, then two variables, geometric meaning of derivatives, total derivative, directional derivatives, partial derivatives and gradients, tangent plane to the graph of a function of two variables.	https://youtu.be/Xxh1tvOD__8

Miranda House Lectures on Differentiation – 4		This is a series of six lectures starting from the motivation for the rigorous definition of limits in one variable, then two variables, geometric meaning of derivatives, total derivative, directional derivatives, partial derivatives and gradients, tangent plane to the graph of a function of two variables.	https://youtu.be/TTV73tdhYZo
Miranda House Lectures on Differentiation – 5		This is a series of six lectures starting from the motivation for the rigorous definition of limits in one variable, then two variables, geometric meaning of derivatives, total derivative, directional derivatives, partial derivatives and gradients, tangent plane to the graph of a function of two variables.	https://youtu.be/4O5aZgAYeKU
Miranda House Lectures on Differentiation – 6		This is a series of six lectures starting from the motivation for the rigorous definition of limits in one variable, then two variables, geometric meaning of derivatives, total derivative, directional derivatives, partial derivatives and gradients, tangent plane to the graph of a function of two variables.	https://youtu.be/6F8MNtDMqzk
Conceptual Introduction to Calculus of Several Variables	Differentiability	This is a video recording of the lecture given by my at Mithibhai College., Mumbai. It gives a quick motivated introduction to topic. Accessible to students of 2nd Year BSc onward.	https://youtu.be/1hcisHAJuvc
Differential Calculus of Several Variables – 1	Differentiability	We start with a modern view point of differentiation, motivate it and arrive at a precise definition. We give a couple of examples and prove the uniqueness of the derivative. We also prove that the concepts of differentiability and the derivative remain the same under equivalent norms.	https://youtu.be/sDn7cDPMTTE
Differential Calculus of Several Variables – 2	Differentiability	We find the relation between the classical derivative f'(a) and Df(a) where f is a differentiable function from R to R. We look at few interesting examples.	https://youtu.be/foW9IFdwnIk
Differential Calculus of Several Variables – 3	Derivative, Partial derivative, Directional Derivative, Gradient	We start with a characterization of differntiability which reduces the problem to continuity. This could be a boon to those students who do not not like epsilon-delta arguments! We prove differentiability implies continuity. We define the directional derivatives, partial derivatives and the gradient.	https://youtu.be/kFWTwm2eu6g
Differential Calculus of Several Variables – 4	Three special cases	We give examples of the computation of the directional derivatives. We find an expression for the gradient of a function. We look at the differentiability of f from R^m to R^n. We end the lecture with three special cases.	https://youtu.be/7KRXyUQ8UTQ
Differential Calculus of Several Variables – 5	Jacobian matrix	We review the three special cases of f from R^m to R^n. We arrive at the Jacobian matrix of the derivative in two different ways. We end up with a reformulation of differentiability which "avoids" epsilon-delta arguments and replaces them with facts about continuity.	https://youtu.be/xabrf_8nJbk
Differential Calculus of Several Variables – 6	Chain rule	We prove the chain rule and give typical applications.	https://youtu.be/u0UEliu5UpU
Differential Calculus of Several Variables – 7	Chain rule	We reformulate the chain rule using a classical notation which reminds us of dz/dx= (dz/dy)(dy/dx). We also illustrate the chain rule by means of some nontrivial examples.	https://youtu.be/AHhovv2-kh4
Differential Calculus of Several Variables – 8	Mean Value Theorem, Mean Value Inequality	We point out a geometric way of finding the derivative. We state and prove a version of mean value theorem and the mean value inequality. We give some typical applications of the mean value inequality.	https://youtu.be/shCmmq0Ba24
Differential Calculus of Several Variables – 9	Taylor's theorem, local extrema	We motivate Taylor's theorem, prove it and then apply it to problems of local extrema.	https://youtu.be/WIaZeb5zoNY
Differentiability of Multi-linear maps and applications	Multilinear maps, Derivative of the determinant	We define multi-linear maps and give three most natural examples and discuss their differentiability. This may be considered optional but students who aim for higher studies at good institutes should learn this. In order to bring out the ideas in a more transparent way, we have restricted ourselves to bilinear maps.	https://youtu.be/urSM02JitMg
Inverse Function Theorem (OBS) – 1	Inverse Function Theorem	This is the first of a series of 2+ lectures on Inverse Function Theorem. It motivates the result and an enterprising viewer can actually arrive at the statement by himself/herself. The first step is proved in this.	https://youtu.be/xR7XfdU2a60

Inverse Function Theorem (OBS) – 2	Inverse Function Theorem	This is the second in the series on Inverse Function Theorem. It deals with a proof of the second step about the function under the stated conditions being an open map. The proof we chose woks only in finite dimensional case. The reason for the choice is that it uses a lot of concepts and results one learns before reaching this result. It will be an illuminating reinforcement of the the basics. Compare this proof with the one in Inverse Function Theorem -2.	https://youtu.be/JgrpiqsBnQo
Inverse Function Theorem – 1	Inverse Function Theorem	This is part 1 of the inverse function theorem with an audience. Compare this with the one recorded without an audience. Post your comments below. Which sounds better?	https://youtu.be/dpawR2lV66k
Inverse Function Theorem – 2	Inverse Function Theorem	The second of the series is a bit long. It deals with the openness of the functions and the differentiability of the inverse. To prove that the function stated in the theorem map is an open map, we employ the contraction mapping principle. This proof works also in any Banach space. It also indicates a typical way the the result is used in analysis, topology and geometry.	https://youtu.be/rbVBw7S3VTg
Implicit Function Theorem -1	Implicit Function theorem	In the first video of the series of two videos, we spend time to understand and arrive at the statement of the theorem. Proof will be done in the next video. Those who really want to understand and plan to go for higher studies in differential topology, geometry and non-linear analysis should spend more time for this video than on the next!	https://youtu.be/tsEzzDkgr_8
Implicit Function Theorem -2	Implicit Function theorem	We generalize the ideas of the first lecture to arrive at a general result. We state and prove the result. The noteworthy feature is the formulation which is missing in almost all analysis books. Our formulation brings out the geometry underlying the theorem.	https://youtu.be/ZPrvKr3VUSM
Lagrange Multipliers -1	Lagrange Multiplier, Level Sets, Tangent vectors, Normal	This is the first of two lectures on the method of Lagrange multipliers. The first lecture, as usual, , attempts to understand how the theorem is arrived at and geard towards a rigorous formulation of the result.	https://youtu.be/XgKB-BaihFg
Lagrange Multipliers -2	Lagrange Multiplier, Implict Function Theorem, Eigenvalues, Symmetric matrices	In this short video we state and prove the result on Lagrange Multipliers. The proof s perhaps the most straightforward and simple you could find in any book. We complete this lecture with my favourite application of Lagrange multipliers	https://youtu.be/rLkv6Jj98go
Metric Spaces 1 (Definition and Examples)	Metric, Metric spaces	The fist lecture of the series introduces the concept of metric spaces and gives a set of examples which will serve two purposes: (i) they help the viewers build confidence and offers geometric intuition (ii) all future concepts will be illustrated with this set of examples.	https://youtu.be/r2x23g_5rhc
Metric Spaces 2 (Open balls)	Open Balls in Metric Spaces	Can you believe it? We spend almost an hour on the examples of open balls in metric spaces from our list. Apart form the usual facts, there are a few which you may not find anywhere else!	https://youtu.be/lUC7p0HYYgg
Metric Spaces 3 (Open Sets)	Open Sets in Metric spaces	We introduce the notion of open sets in a metric spaces. We go through our list of examples and try to understand how the open sets look like. There are a couple of unusual examples (they are of course from our list of examples of metric spaces).	https://youtu.be/vmJ85VYXoTc
Metric Spaces 4 (Open sets, Topology of Open Sets)	Open Sets in Metric spaces	We continue our discussion on open sets in the product space X x Y. We investigate the relation between the d-open sets sand beta-open sets . Finally we look at the properties of the class of open set in a metric space.	https://youtu.be/7ajKKkbLAdM
Metric Spaces 5 (Closed Sets in Metric Spaces)	Closed Set, klimit points	We define closed sets in a metric space and look ta closed sets in our list of metric spaces. We look at the properties of the class of closed sets. WE then ask a question when a given set is not closed in a metric space. This naturally leads to the notion of a klimit point.	https://youtu.be/33zfpYzd0HU
Metric Spaces 6	Clsed sets; Characterization in terms of klimit points	This short lecture deals with the characterization of closed sets in terms of klimit points.	https://youtu.be/6TsGhkseF9E
Metric Spaces 7	https://youtu.be/ptSivjvojXE	A closer look at the definition of a klimt point leads us convergent sequences. As per our policy, we look at the convergence of sequences in our list of metric spaces. We prove the uniqueness of the limit two ways: one uses Hausdorffness of a metric space and the other standard proof found in books.	https://youtu.be/v83oWVzfmBE

Metric Spaces 8a	Continuity in Metric Spaces	We introduce the notion of continuity via sequences. We investigate the continuous functions from or to other metric spaces in our list.	https://youtu.be/ErqwclTc6w8
Metric Spaces 8b	Continuity in Metric Spaces	We continue with the notion of continuity via sequences. We investigate the continuous functions from or to other metric spaces in our list.	https://youtu.be/dnwyZvWW0VY
Metric Spaces 9	Algebra of Continuous functions	We look at the existence of real valued continuous functions on any metric space. We show that there is an `abundant supply' of such functions on any metric space.	https://youtu.be/fWm9GpB0YpI
Metric Spaces 10	Algebra of Continuous functions; Uryshn's Lemma	If C(X,R) denotes the set of all real valued continuous functions on the metric space X, we show that it is a real vector space and it is also a commutative ring with identity (in fact, it is an algebra, if you know what it is). We prove the Urysohn's lemma.	https://youtu.be/wIvvsIR4460
Metric Spaces 11	Epsilon-Delta definition, Continuous functions, equivalence	We prove that the sequential definition and the epsilon-delta definition of continuity are equivalent. We then formulate the continuity at a point in terms of open sets. Finally we show that if the function is continuous on a metric space, then the "inverse image" of an open set in the codomain is open in the domain.	https://youtu.be/b83Lo54iZf0
Metric Spaces 12	Continuity at point in terms of open sets	We characterize the continuous functions between metric spaces in terms of inverse images of open sets and closed sets. We show how this helps us to determine whether certain subsets are open or closed. Finally we prove that the metric topologies related to d1, d2 and d_max metrics on Rn are the same!	https://youtu.be/Hm0uipBDQ1A
Dense Subsets in a Mertic Space – 1	Dense sets in metric spaces	We define dense subsets in a metric space in a geometric/intuitive way. We the prove various equivalent definitions. Of course we look at examples in our list of examples. We also relate density and continuity.	https://youtu.be/tUEc8-PoQF8
Dense Subsets in a Mertic Space – 2	Z+ sqrt{2}Z Example	We look at a very interesting example of a dense subset of R. This example or its analogues keep turning in many disciplines such as Number theory, Dynamical system ergodic theory, differential topology and Lie groups.	https://youtu.be/eeknLYksuuA
Continuity on Metric Spaces	Continuity, metric spaces	We introduce the sequential and epsilon-delta definition of continuity and prove their equivalence. In a sequel, we shall discuss some examples, later we shall relate it to the limit-definition of continuity.	https://youtu.be/6KkomiUsQ7A
Compact Metric Spaces	Compactness, total boundedness, Cauchy completeness, Cluster point	We prove equivalent characterizations of compact metric spaces. If you work in analysis, the general topological definition of compactness is inadequate to prove results dealing with compact subsets in a metric space. This lecture give an easy proof of a standard result.	https://youtu.be/brwzwAPJnXI
Uniform Continuity on Compact Metric Spaces	Uniform continuity, compact metric space	We prove that any continuous function from a compact metric space to another metric space is continuous. For some strange reason, students seem to have problem in understanding the proof. We show how a simple idea, which is very appealing but fails, can be modified to yield a correct proof of this result.	https://youtu.be/CHGc6ePLSqA
Baire Category Theorem	Nowhere dense sets, Baire, Category	We explain the need for the concepts underlying the result and give two formulations for the theorem which are the ONLY way they are needed in applications (to the best of my knowledge). We avoid terms such as "category", "meager sets" and "Baire space" which obfuscate the real meaning of the theorem.	https://youtu.be/3uzQMbVxiEI
Arzela-Ascoli Theorem 1	Equicontinuous, Arzela-Ascoli, Cantor's diagonal trick	This is the first lecture on a series of three lectures on Arzela-Ascoli theorem on R followed by the one on compact metric spaces. In the first session, we prepare the ground and start proving the theorem for R. Due to time constraint, we stop it half way and complete it in the second. In the first two videos, we explain a proof which employs the so-called Cantor's diagonal method. In the third, we cast the result in a more modern setting and provide a proof which generalizes to other contexts too.	https://youtu.be/QOZEJrBaxtk
Arzela-Ascoli Theorem 2	Equicontinuous, Arzela-Ascoli, Cantor's diagonal trick	In this second lecture we complete the proof of Arzela-Ascoli theorem on R. In the first two videos, we explain a proof which employs the so-called Cantor's diagonal method.	https://youtu.be/NoOGl0xNsOk
Arzela-Ascoli Theorem 3	Equicontinuous, Arzela-Ascoli, Totally bounded sets	This is the last of the series on Arzela-Ascoli. We prove the theorem in the setting of a compact metric space using characterization of compact sets in metric spaces. We also indicate `versions' of Arzle-Ascoli in other spaces.	https://youtu.be/n0UkgxWPHos

Subgroups of Z	Group, Subgroups	This video deals with the subgroups of Z and their cosets. In my experience , many students are not aware of these facts though the first example of a group is Z! When I show them that the cosets of the subgroups of Z are objects known to them from high school and again from number theory, they are excited. Hope many of the viewers also get excited. Even if you think you know well, watch the video from 42:00 onwards. Have you thought about these earlier?	https://youtu.be/qDeIhep0TKI
Group Actions Lecture 1	Group Actions, Orbits	This is the first of the series video lectures on Group Actions. We give a lot of geometric as well as abstract examples. We introduce the notion of orbits and identify the orbits in the examples studied. We shall continue with more examples in the next lecture also.	https://youtu.be/JHNkDTJCnpw
Group Actions Lecture 2	Orbits, Stabilizer Subgroup	Orbits are obtained by fixing the second variable x in \alpha(g,x) . In this lecture we freeze the first variable and look closely at the map x\mapsto \alpha(g,x) of X to itself. We introduce the stabilizer subgroup and `count' the number of elements in an orbit. We also show how orbits are equivalence classes for suitably defined equivalence relation. This gives us the rationale to our earlier observation that orbits behave like equivalence classes.	https://youtu.be/eIF-mOy14ps
Group Actions Lecture 3	Orbits, Stabilizer subgroups	In this lecture, we look at some more examples and compute the stabilizer subgroups in most of the cases.	https://youtu.be/qjoHbWl8WkI
Group Actions Lecture 4	Group action in Linear Algebra	We look at three examples. Linear algebra background is required, though a quick recap is done.	https://youtu.be/ZVDYtwTfM28
Group Actions Lecture 5	Group action in Linear Algebra	This is a continuation of Lecture-4. We deal with two more examples that require Linear algebra background. We also explain their intimate connections with the canonical forms of matrices.	https://youtu.be/U6VspWc4DRo
Group Actions Lecture 6	Class equation, p-groups	We establish the class equation, give three simple applications of group action technique: 1) Lagrange's theorem, 2) groups of even order and 3) groups of order p^n where p is a prime. Analysis of the proofs of 2) and 3) leads us to formulate and prove a fixed point theorem.	https://youtu.be/Q6zEwkJK45M
Group Actions Lecture 7	Cayley's theorem, Generalised Cayley's theorem	We state and prove a general version of Cayley's theorem. Group actions on the cosets of a subgroup is an important tool in any field in which groups are used, such as finite groups, topology, geometry, harmonic analysis and physics. We illustrate the power of the result by means of two applications.	https://youtu.be/WRnMRrTxjJ8
Group Actions Lecture 8	Fixed point theorem for group actions, Cauchy's theorem, Sylow's second theroem, Sylow p-subgroups	We prove the so-called fixed point theorem for group actions. As applications we derive (i) Cauchy's theorem on the existence of an element of order p where p is a prime divisor of the order of G and (ii) the Sylow's second theorem which says any p subgroup is contained in a Sylow p-subgroup and that any two Sylow p-subgroups are conjugate.	https://youtu.be/ZIs6zt9rDJ8
Group Actions Lecture 9	Sylow's theorems	We state and prove the Sylow theorems via group actions.	https://youtu.be/pllXNT8ft_w
Group Actions Lecture 10	Burnside lemma	We prove Frobenius-Burnside lemma. We verify it in two examples and give a typical combinatorial example.	https://youtu.be/rhVu7CxtAmI
Minimal Counterexample Technique (in Group Theory)	Minimal counterexample, Cauchy's theorem for finite groups, Sylow's theorem	It is well-known that the Principle(s) of Mathematical induction and well-ordering principle are equivalent properties of the set of natural numbers. So, in principle (pun intended), any result proved by induction can also be proved used well-ordering principle. The minimal counterexample technique takes the latter approach. It was extensively used, so I understand, by Feit-Thompson in their work on Finite Group Theory. We introduce the minimal counterexample technique to prove some of the standard results in finite group theory.	https://youtu.be/sraIDBa0Yks
Equivalence of Norms	Equivalent norms	We define two norms on a real/complex vector space are equivalent if they induce the same topology. We prove that this is equivalent tot he standard definition of equivalence of norms. On the way we look at the continuity of linear maps between normed linear spaces.	https://youtu.be/8CmkKC07rzw
Norms on Rn	Equivalent norms	We prove that any two norms on Rn are equivalent. The proof is a beautiful application of the fact that the spheres in Rn are compact and the result that any continuous real valued function a compact set attains its bounds.	https://youtu.be/iM92mzfF__s

Riesz Representation Theorem for Hilbert Spaces	Riesz, Hilbert spaces	In this short video I give a proof of Riesz representation theorem for Hilbert spaces. This is an easy result. As there were a few requests for it, I recorded this video.	https://youtu.be/cr4CfB0D3JQ
Topology -1	Topology, Topological Spaces	This is the first video on a series of lectures on (Point Set) Topology. After definition a topology on a set, our focus is on a list of well-chosen examples. All future concepts in Topology will be illustrated with these examples. A Sincere Advice: Please watch the first 4 videos on the series on Metric Spaces up to the properties of the class of open sets in metric spaces. I shall assume this background in the course.	https://youtu.be/BKvdhNkdDTs
Topology – 2	Topology, Topological Spaces	Continuation of Examples	https://youtu.be/DQ3O4wJftIg
Topology – 3	Topology, Topological Spaces	Continuation of Examples	https://youtu.be/WSdpoFAqv8w
Topology – 4	Topology, Topological Spaces	Continuation of Examples	https://youtu.be/JEo-YPNLX68
Topology 5 (Continuity 1)	Topology, continuity	We define the continuity of a map between two topological spaces. We then investigate various maps between spaces of our list of examples.	https://youtu.be/ViH3vOHoLRk
Topology 6 (Continuity 2)	Topology, continuity	We continue with our examples of continuous maps. We show that there may not exist a non-constant real valued continuous function on arbitrary topological spaces. We also indicate when the characteristic or indicator function of a subset is continuous.	https://youtu.be/CuoulCWYpME
Topology 7 (Continuity 3)	Topology, continuity, metric spaces	We study continuous maps between metric spaces and arrive at the epsilon-delta definition of continuity. We also investigate the existence of non-constant real valued continuous functions on metric spaces	https://youtu.be/9f4zapAyX2s
Topology 8 (Continuity 4)	Topology, continuity, d(x,A)	We discuss a most important class of continuous functions, namely d(x,A), on a metric space. We then look at continuous functions from a space to Rn. After proving the composition of continuous functions is continuous, we establish the algebra of real valued continuous function on a space. Most of the material in this video is vary rarely covered in a typical one-semester course in Topology.	https://youtu.be/Q1rG6d97FFY
Topology 9 (Closed Sets 1)	Topology, Closed sets	We define closed sets and look at examples of such sets from out list of topological spaces. Pay attention to the last few minutes where we investigate when a set is not closed!	https://youtu.be/H1qcqSw5ang
Topology 10 (Closed Sets 2)	Topology, Closed sets, adherent points	Out investigation into the set being non-closed leads to to the definition and study of adherent points of a set. We find adherent points of subsets of topological spaces from our list. The adherent points are exactly what I called as klimit points in the metric space videos! Pay special attention to the last example!	https://youtu.be/XSF3Rx78NRA

Topology 11 (Closed Sets 3: Class of Closed Sets and Closure)	Topology, Closed sets, Clsosure	We look at characterization of adherent points of a subset in a metric space. We then look at the properties of the class of closed sets in a topological space. The property that arbitrary intersection of closed set is closed lead us to the concept of closure of a set.	https://youtu.be/fRJhsvcTxBs
Topology 12 (Closed Sets 4: Concrete Desciption of Closure)	Topology, Description of Closure	We show that the closure of a set is the set of its adherent points. We also prove a result which say that continuous maps maps the adherent points of sets to adherent points of the image of the sets. We also show that map f from X to Y is continuous iff f(closure of A) is a subset of the closure of f(A).	https://youtu.be/hd35hMk0R_U
Topology 13 (Continuity in terms of closed sets)	Topology, Continuity, Closed sets	We start with an alternate proof of of the closure of A is the set of adherent points of A. We then show that f from X to Y is continuous iff the inverse image of any closed subset of Y is closed in X. We then list the standard techniques to establish/identify the open sets and closed sets. We end the lecture with some illuminating examples of this observation.	https://youtu.be/p-8f7j_k21I
Topology 14 (The Smallest Topology Containing a Collection of Subsets of a Set)	Topology, Generated by a class of subsets	We investigate the collection of topologies on a set and arrive at the notion of the smallest topology containing a collection of subsets of a set. We then give a concrete description of the topology. Learn this description well, as it is devoid of any jargon.	https://youtu.be/tRlWh87XyFc
Topology 15 (Basis for the Topology)	Topology, Basis for THE topology	Let (X,T) be a topological space. We define the notion of a basis for the given topology T on X. We then look at examples of basis for the topological spaces from out List.	https://youtu.be/tZGLJSWJN0Q
Topology 16 (Basis for SOME Topology on a Set)	Topology, Basis for SOME topology	We investigate when a collection of subsets of a set X serves as a basis for SOME topology on the set X. We review of some of the earlier examples, where we `created' topological spaces using this trick without the jargon!	https://youtu.be/WWnhGWA6nGY
Topology 17 (Dense Subsets in a Topological Space 1)	Topology, Dense subsets	We start with an intuitively appealing definition of a dense set and then give two more equivalent definitions. We then look at dense subsets in the spaces on our list. We also indicate the significance of the dense sets at the end.	https://youtu.be/Prqzgxqmr6o
Topology 18 (Dense Subsets of a Topological Space 2)	Topology, Dense subsets	We look at a few simple results about dense subsets. Most of these results should be considered as exercises.	https://youtu.be/b3lHEuiW1wM
Topology 19 (Sequences in Topological Spaces)	Topology, Convergence, Sequences	We define the convergence of sequences in a topological space. As usual, we look at a lot of examples. Some of them bring out the inadequacy of sequences in general/point-set topology. Pay attention to the last few minutes of this video as I say something of practical value.	https://youtu.be/yeIZG374Nv0
Generating Topologies -1	Unified View, Subspace topology, Quotient topology, Product topology.	This is the first of the series of four lectures on a unified view of various constructions such as subspace, product and quotient topologies. We start with a general question and then focus on a specific situation which leads us to the subspace topology. This series of four lectures are only for those who want to understand the subtle aspects of the various constructions. If you care only for grade, you may skip these! leads us to the subspace topology.	https://youtu.be/vj25mLM_kh0
Generating Topologies -2	Product Topology	This is the second first of the series of four lectures on a unified view of various constructions such as subspace, product and quotient topologies. In this session, we expand the scope of the question of Session 1 and end up with the product topology.	https://youtu.be/PLj7P9dtrZk

Generating Topologies -3	Quotient Topology	This is the third of the series of four lectures on a unified view of various constructions such as subspace, product and quotient topologies. We now look at a question which is in some sense dual to the question of Lecture 1 and discuss with the quotient topology. We also look at two simple and confidence-building examples of quotient topology.	https://youtu.be/LZLOhMD1j1s
Generating Topologies – 4	Topology, Universal mapping property	This is the fourth and the last of the series of four lectures on a unified view of various constructions such as subspace, product and quotient topologies. This session deals with the tool known as the Universal Mapping Property (UMP) of the new constructions. While the UMP for product and quotient are at least in literature, the one for subspace topology is not found anywhere. You will also reveal a trade-secret behind any UMP!	https://youtu.be/yXCP4pDmZpM
Connectedness -1	Connected spaces, disconnection	We start with the simplest definition of connectedness of a topological space. WE show that our definition is equivalent to the one found in books. We then investigate the connectedness or otherwise of the examples in our list of spaces. We also observe that R with the usual topology is connected.	https://youtu.be/U9_Cx2F8-X0
Connectedness – 2	Connected spaces, Intervals	The main result of this session is that an interval of the form [a,b] is connected. As many students are not confident of the LUB (aka supremum) etc., we review it quickly and embark on a proof. The proof is incomplete, Can you guess why? In the beginning of the next lecture, this gap will be taken care of!	https://youtu.be/qFT2cKzbPBQ
Connectedness -3	Connected spaces, continuous image of connected sets	We complete the proof of connectedness of [a,b]. We investigate whether some subsets of R2, the plane, especially conic sections, are connected or not. On the way we prove that the continuous image of a connected set is connected.	https://youtu.be/vdZ4dwi4wmM
Connectedness -4	Characterization of connectedness	As a prerequisite, we review subspace topology and state and prove two important facts about subspace topology. Most often these are not brought to the attention of the beginners but they are used almost on daily basis! We prove that a space X is connected iff any continuous real valued function on X which takes values only in {-1,1} is a constant. To illustrate the power of this characterization, we give a number of examples and applications. This will permeate in all the lectures to follow on this topic.	https://youtu.be/A9frhjkM_zQ
Connectedness -5	Connected subsets of R	We prove that a subset of R is connected iff it is an interval. We also point out the subtle umbilical-cord connection (pun intended!) between the connectedness [a,b] and the intermediate value theorem.	https://youtu.be/FtO5z2v2NL4

Connectedness -6	Line segments, star-shaped sets, connectedness of spheres	We define a line and a line segment in Rn. We prove that they are connected. Using this result, we conclude that any star-shaped set is connected. We show that any ball, any vector subspace in Rn are connected. The final result is connectedness of a sphere in Rn, n is at least 2.	https://youtu.be/exDFj5WbhnQ
Connectedness -7	Product of connected spaces, punctured plane	We prove that the product space X x Y (with the product topology) is connected iff X and Y are connected. We give applications of this result.	https://youtu.be/BgMXj1tZUCo
Connectedness -8	Locally constant functions and connectedness	We define locally constant functions. We then prove that a space X is connected iff any locally constant function from X to any space Y is a constant. It is worth learning the proof of this result, as it is typical of the way connectedness hypothesis is exploited to reach the goal.	https://youtu.be/CJDgICyw2vw
Connectedness – 9	Connected components	We define connected components. We show how to use this as a tool to prove certain spaces are not homeomorphic.	https://youtu.be/KBLvDg11YLs
Path-connectedness -1	Path, path-connected space	WE define a path in a topological space. We distinguish between the image of a path and the path. We give a few examples to illustrate these ideas. Then we define a path-connected space. We look at a lot of examples of path-connected space.	https://youtu.be/XWGPuRrE1os
Path-connectedness – 2	Path-connected subsets of Rn	We deal with some crucial results. The spheres in Rn, punctured Rn, (n at least 2) annular region are connected. We prove that any path-connected space is connected, any connected open set in Rn is path-connected. The last proof is typical of the way connectedness hypothesis is exploited.	https://youtu.be/ah3ffDIwLA4
Path-connectedness -3	Comb space	We discuss the example of a (deleted) comb space as a connected space which is not path-connected. Be warned. It will test your real analysis!	https://youtu.be/V5CbrhWjd04

Path-connectedness – 4	Comb space, Topologist's sine curve	We give the standard examples (i) Comb space and (ii) Topologists' sine-curve. The approach to Comb space here may be easier for some of you who have already watched path-connectedness -3.	https://youtu.be/lnmz92yDgys
Subspace Topology -1	Subspace topology	We define the subspace topology on a subset of a topological space. We investigate the subspace topology on the subset A of R (with the usual topology) where A is (i) the set of integers, (ii) [0,1], (iii) Q, the set of rational numbers. We also prove that the subspace topology on a subset A of metric space is nothing other than the topology induced by the metric when restricted to A,.	https://youtu.be/Hsokz8lhJkY
Subspace Topology – 2	Subspace topology	We continue with the subspace topology on some interesting subsets of topological spaces in our list. I hope you enjoy the variety of examples and hope that they enhance your intuition.	https://youtu.be/ovJGIOzNLX0
Subspace Topology -3	Subspace topology	We prove two results which are often used. If A is an open (respectively closed) subset of X and B, a subset of A is open (respectively, closed) in the subspace topology iff it is open (resp. closed) in X. We end the session with an interesting perspective on convergent sequences in topological spaces.	https://youtu.be/lf2o7BleIJU
Subspace Topology – 4	Subspace topology, Universal Mapping Property	We prove two important facts about subspace topology which are used often but rarely brought to the attention of the students. (i) If f is continuous map from X to Y and if we restrict f to a subset A of X then f from A with subspace topology to Y is continuous. (ii) If f takes values in B, a subset of Y, then f as a map from X to B with subspace topology is continuous iff the map f from X to Y is continuous. This is the Universal Mapping Property for Subspace topology which is never discussed in books! We end the session with the result that among all topologies on A which makes the inclusion map from A to X, the subspace topology is the smallest.	https://youtu.be/JsZDIQiCrBs
Subspace Topology – 5	Subspace topology	We motivate and prove the glueing or pasting lemmas. We also bring out the two way use of these lemmas. We give a few examples of the typical application of the glueing lemma in its `closed sets' version.	https://youtu.be/ptSivjvojXE
Compactness – 1	Open cover, compact spaces	We motivate the definition of compactness via open cover. Unlike others, we spend more time to learn how to construct an open cover with a given data. We define compact spaces and start investigating whether the spaces in our list are compact.	https://youtu.be/mP_-qckkZ38

Compactness – 2	Compact spaces	In stead of investigating the rest of the examples in out list about compactness, we are in a tearing hurry to show how our motivation for open covers and compactness proves the two standard results in a direct and elementary way. We prove any continuous function from a compact space to R is bounded and it attains its bounds! Hurray!	https://youtu.be/R312Thxz4os
Compactness – 3	Compact spaces	We resume our investigation of spaces in our list for compactness. The spaces are co-countable topology, co-finite topology, VIP, out cast and order topology. We also show that if a metric space is compact, then it is bounded.	https://youtu.be/gpIYGyuD0EI
Compactness – 4	Compact subsets	We define compact subsets of a topological space. We introduce two types of open covers of a subset (which is usually not explicitly brought to the attention of beginners). We then look at compact subsets of spaces in our list.	https://youtu.be/5E52zxiMhzI
Compactness – 5	Compactness of [a,b]	We continue with the examples from out list. We characterize compactness in terms of basic open covers. We than prove that any closed and bounded interval is compact, and no other type of interval is compact.	https://youtu.be/FdXEfKADoX0
Compactness – 6	Compact subsets, Heine Borel theorem in R	We prove some of the standard results about compact subsets. (i) A finite union of compact sets is compact (ii) Intersection of two compact sets need not be compact (iii) Any closed subset of a compact space is compact (iv) In a Hausdorff space, any compact set is closed (iv) Intersection of two compact sets in a Hausdorff space is compact (v) Heine-Borel theorem which characterizes compact subsets of R.	https://youtu.be/hm_Mi2j4DQE
Compactness – 7	Continuous images of compact sets	We prove that the continuous image of a compact set is compact. We then give the standard applications : (i) If f is continuous map from a compact space to a metric space it is bounded. (ii) If If f is continuous map from a compact space to R, then it attains its bounds. We also exhibit a continuous bijection from [0, 2 pi) to the unit circle and prove it is not a homeomorphism.	https://youtu.be/GhTS9MpnPJk
Compactness – 8	Product of compact spaces	We prove that the product of two spaces is compact iff each of the factor spaces is compact. As an application, we show that any `rectangle' f the form [a1,b1] X ...X[an,bn] is a compact subset of Rn. From this we deduce the Heine-Borel theorem. As an application we show that the unit sphere in Rn is compact.	https://youtu.be/iERDj-3HGl8

Compactness – 9	Compact Hausdorff spaces	We prove that a continuous bijection from a compact space to a Hausdorff space is a homeomorphism . We use to this prove what I call a closed graph theorem of topology.	https://youtu.be/idPH2wDmVqw
Compactness – 10	Compact Hausdorff spaces	The lecture is mainly about compact Hausdorff spaces. We prove the following: In a compact Hausdorff space, (i) a closed set and a point not in the closed set can be separated by open sets, (ii) two disjoint closed sets can be separated by open sets. We end the session with Cantor intersection theorem.	https://youtu.be/lOECje_w2cQ
Countability Axioms -1	First and second countable, separable	We start with three typical instances and then define three popular axioms of countability: (i) first countability (ii) second countability and (iii) separability. We then investigate which of the spaces in out list enjoy these properties.	https://youtu.be/gsk8msNGXSU
Order Topology 1	Topology, Order topology, total order, linear order	This is a lecture on order topology with a selected list of students. Towards the end, when I was going to do some interesting example, there were technical glitches. But I managed with hand-waving (not in the usual sense!), and pens. I thank the audience for their patience and co-operation.	https://youtu.be/F2M-9P9EtZM
Order Topology 2	Topology, Order topology, total order, linear order	We discuss the typical open neighbourhoods of points in R2 with the order topology. We then look at the adherent points of some subsets of [0,1]X[0,1]. We also check whether Q2 is dense in R2 with order topology.	https://youtu.be/hOt1-UDi7yg
A Topological Proof of the Infinitude of Primes	Primes, Topology, Cosets	We construct a topology on the set Z of integers and use it to prove Euclid's theorem that the set of primes in N is infinite. The proof is due to H. Furstenberg. A very rudimentary knowledge of topology is the required background!	https://youtu.be/9u7QEMIqz9M

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Compact Metric Spaces, Characterization of Compact Metric Spaces
Simple proofs and Direct Proofs of some results on Compact Spaces
Problem Course in Metric Spaces
Arzela-Ascoli Theorem on R
Arzela-Ascoli Theorem on R
Arzela-Ascoli Theorem

Group Actions
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Group Actions
Sylow’s theorems
Group Actions
Minimal Counterexample Technique

An Outline of Topology
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