INSTRUCTIONS:

Fill out the hazard analysis and risk assessment below.

HA-001 should be for the lane departure warning function as discussed in the lecture.

HA-002 should be for the lane keeping assistance function as discussed in the lecture.

Then come up with your own situations and hazards for the lane assistance system. Fill in the HA-003 and HA-004 rows.

When finished, export your spreadsheet as a pdf file so that a reviewer can easily see your work.

Hazard ID				Situational An	nalysis					Hazard	Identification					Haza	dous Event Classifica	tion		Determ	nation of ASIL and Safety Goals
	Operational Mode	Operational Scenario	Environmental Details	Situation Details	Other Details (optional)	Item Usage (function)	Situation Description	Function	Deviation	Deviation Details	Hazardous Event (resulting effect)	Event Details	Hazardous Event Description	Exposure (of situation)	Rationale (for exposure)	Severity (of potential harm)	Rationale (for severity)	Controllability (of hazardous event)	Rationale (for controllability)	ASIL Determination	Safety Goal
HA-001	OM03 - Normal Driving	OS03 - Highway	Rain (slippery road)	SD02 - High speed		IU01 - Correctly used	Normal driving on a highway during rain (slippery road) with high speed and a correctly used system	Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver with haptic feedback	Actor effect is too much	Vibration too strong	EV00 - Collision with other vehicle	High haptic feedback can affect driver's ability to steer as intended. The driver could lose control of the vehicle and collide with another vehicle or with road infrastructure.	Driver loses control and collides with another vehicle	E3	Driving on wet roads happens quite often	S3	Traveling at high speeds	C3	Hard to steer with vibrating steering wheel	С	The oscillating steering torque from the lane departure warning system shall be limited
HA-002	OM03 - Normal Driving	OS02 - Country Roa	EN01 - Normal conditions	SD02 - High speed	Driver Removes both hands from steering wheel		Normal driving on country roads during normal conditions with high speed (the driver is misusing the lane keeping assistance function as an autonomous function)	Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane	DV03 - Function always activated	LKA does not disable and is used as autonomous driving	EV00 - Collision with other vehicle	·	LKA steers vehicle into another vehicle	E2	Attempting to use LKA on country roads as autonomous driving is not all that common	S3	Traveling at high speeds	C3	Cannot control car when not holding onto steering wheel	В	The lane keeping assistance function shall be time limited and additional steering torque shall end after given time interval so that the driver cannot misuse the system for autonomous driving
HA-003	OM03 - Normal Driving	OS03 - Highway	EN04 - Snowfall (degraded view)	SD02 - High speed	Night time + Departing into lane of oncoming vehicle	g IU01 - Correctly used	(Night time + Oncoming vehicle)	Lane Departure Warning (LDW) function shall apply an d oscillating steering torque to provide the driver with haptic feedback	Sensor sensitivity is too low	Does not detect deviation from lane	EV00 - Collision with other vehicle	Vehicle is drifting into oncoming traffic that can't be seen due to poor visibility. The warning is late, letting the driver drift and collide with the oncoming car	Driver drifts into oncoming car	E1	Most drivers would not be driving at high speed in poor visibility	S3	Traveling at high speeds	C2	Warning is late, but exists. Driver can correct when warning is given	А	The maximum time to deliver a warning shall be limited.
HA-004	OM03 - Normal Driving	OS02 - Country Roa	EN01 - Normal conditions	High braking	Night time + Oncoming vehicle	ng IU01 - Correctly used	Normal Driving on Country Road during Normal conditions with High braking (Night time + Oncoming vehicle)	Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane	Function unexpectedly activated	LKA triggers when not leaving the lane	EV00 - Collision with other vehicle	Sudden torques when heavily braking can cause the car to skid and spin out of control, collides with oncoming car	Sudden torque causes tires to skid and spin out causing crash with oncoming car	E4	Normal conditions on country roads are pretty common.	S3	Spinning out can lead to crashing into other things, traveling at high speeds	C3	Hard to control a car that is spinning out	D	Limit lane keeping assistance shall be disabled under heavy braking conditions.

EXAMPLE DISCUSSED IN THE PROJECT INSTRUCTIONS - F

Hazard ID	
	Operational Mode
HA-001	Normal Driving

MORE EXAMPLES - Headlamp System

Hazard ID	
	Operational Mode
HA-001	OM03 - Normal Driving
HA-002	OM03 - Normal Driving
HA-003	OM03 - Normal Driving
HA-004	OM03 - Normal Driving
HA-005	OM03 - Normal Driving

Headlamp System

	Sit
Operational Scenario	Environmental Details
City Road	Normal Conditions

	Si
Operational Scenario	Environmental Details
OS01 - City Road	EN01 - Normal conditions
OS01 - City Road	EN04 - Snowfall (degraded view)
OS03 - Highway	EN04 - Snowfall (degraded view)
OS02 - Country Road	EN01 - Normal conditions
OS02 - Country Road	EN04 - Snowfall (degraded view)

uational Analysis		
Situation Details	Other Details	item usage
(ontional)	(ontional)	(function)
Low Speed	the read	Correctly Used

tuation Analysis						
Situation Details (optional)	Other Details (optional)	Item Usage (function)				
SD03 - Low speed	Night time + Obstacle on the road	IU01 - Correctly used				
SD03 - Low speed	Night time + Obstacle on the road and no other illumination on road	IU01 - Correctly used				
SD03 - High speed	Night time + Obstacle on the road or upcoming curve	IU01 - Correctly used				
SD02 - High speed	Night time + Oncoming vehicle	IU01 - Correctly used				
SD04 - High speed	Night time + Obstacle on the road and no other illumination on road	IU01 - Correctly used				

Situation Description	Function	Deviation
Conditions at Low Speed at Night with an	roadway in the dark	Function not activated

Situation Description	Function	Deviation
Normal Driving on City Road during Normal conditions with Low speed (Night time + Obstacle on the road)	Low beam illuminates the roadway in the dark	DV01 - Function not activated
Normal Driving on City Road during Snowfall (degraded view) with Low speed (Night time + Obstacle on the road and no other illumination on road)	Low beam illuminates the roadway in the dark	DV01 - Function not activated
Normal Driving on Highway during Snowfall (degraded view) with High speed (Night time + Obstacle on the road or upcoming curve)	Low beam illuminates the roadway in the dark	DV01 - Function not activated
Normal Driving on Country Road during Normal conditions with High speed (Night time + Oncoming vehicle)	Low beam illuminates the roadway in the dark	DV01 - Function not activated
Normal Driving on Country Road during Snowfall (degraded view) with High speed (Night time + Obstacle on the road and no other illumination on road)	Low beam illuminates the roadway in the dark	DV01 - Function not activated

Hazard Identification					
Deviation Details	nazaruous Event				
	(reculting offect)				
Both headlights stop working	Front collision with obstacle				

Hazard Identification					
Deviation Details	Hazardous Event (resulting effect)				
Both headlights stop working	EV04 - Front collision with obstacle				
Both headlights stop working	EV04 - Front collision with obstacle				
Both headlights stop working	EV04 - Front collision with obstacle				
Both headlights stop working	EV08 - Collision with other vehicle				
Both headlights stop working	EV04 - Front collision with obstacle				

		_
Event Details	nazaruous Event	Exposure
	Doccrintion	(of cituation)
the obstacle with injury	heam	E4 - High probability

Event Details	Hazardous Event Description	Exposure (of situation)
Vehicle crashes into the obstacle with injury to driver	Total loss of low beam	E4 - High probability
Vehicle crashes into the obstacle with injury to driver	Total loss of low beam	E1 - Very low probability
Vehicle crashes into the obstacle or road infrastructure with injury to driver and any others present	Total loss of low beam	E2 - Low probability
Vehicle crashes into the oncoming vechile or road infrastructure	Total loss of low beam	E4 - High probability
Vehicle crashes into the obstacle or road infrastructure with injury to driver and any others present	Total loss of low beam	E2 - Low probability

	Hazardous
Kationale	Severity
(for exposure)	(of notontial harm)
regular activity	S1 - Light and moderate injuries

	Hazardous
Rationale (for exposure)	Severity (of potential harm)
night driving in the city is a regular activity	S1 - Light and moderate injuries
night driving in the city on completely unilluminated roads while it is snowing is rare	S1 - Light and moderate injuries
High driving is part of regular driving, however, heavy snow occurs a few times a year	S3 - Life-threatening or fatal injuries
country driving is part of regular driving	S3 - Life-threatening or fatal injuries
country driving is part of regular driving, however, heavy snow occurs a few times a year	S3 - Life-threatening or fatal injuries

Event Classification	
Kationale	Controllability
(for coverity)	(of hazardous event)
In city traffiic, speed of vehicle is expected to be low	C0 - Controllable in general

Event Classification		
Rationale (for severity)	Controllability (of hazardous event)	
In city traffiic, speed of vehicle is expected to be low	C0 - Controllable in general	
In city traffiic, speed of vehicle is expected to be low	C1 - Simply controllable	
On highway speed of vehicle is expected to be high	C2 - Normally controllable	
On country roads speed of vehicle is expected to be high	C1 - Simply controllable	
On country roads speed of vehicle is expected to be high	C3 - Difficult to control or uncontrollable	

	Determination of ASIL and Safety Goals	
Kationale	ASIL	Cafatry Coal
(for controllability)	Determination	Safety Goal
control titlevartalitierien yeapprynjg brakes	QM	Total Loss of Bealti
and there is additional illuminitation on situ	QIVI	Chall De Drevented

	Determination of ASIL and Safety Goals	
Rationale (for controllability)	ASIL Determination	Safety Goal
At city speed, most drivers will be able to control the situation by applying brakes and there is additional illmunitation on city roads	QM	Total loss of low beam shall be prevented
On completely unilluminated city roads, drivers usually drive at lower end of city speeds and hence are expected to be able to control vehicle	QM	Total loss of low beam shall be prevented
When driving on highway with low beam, it can be expected that there are other vehicles and there is some form of illumination on road and hence >90% drivers are able to brake and control the vehicle. And also use other forms of warning (e.g. hazard lights) to signal malfunction	A	Total loss of low beam shall be prevented
Since there is usually no other form of illumination to be expected on country road, it will be difficult for the average driver to control the vehicle in such a situation	В	Total loss of low beam shall be prevented
Since there is usually no other form of illumination to be expected on country road, it will be difficult for the average driver to control the vehicle in such a situation	В	Total loss of low beam shall be prevented

Hazard & Risk Analysis Defin

Operational Mode

- h		
ID	Mode	
OM01	Parked	
OM02	Ignition on	
OM03	Normal driving	
OM04	Backward driving	
OM05	Degraded driving	
OM06	Towing (active)	
OM07	Towing (passive)	
OM08	Service	
OM09	N/A	

Operational Scenario

ID	Scenario
OS01	Any Road
OS02	City Road
OS03	Country Road
OS04	Highway
OS05	Mountain Pass
OS06	Off Road
OS07	Road with gradient
OS08	Road with bump
OS09	Road tunnel
OS10	Road with construction site
OS11	N/A

Situation Details

ID	Scenario
SD01	Low speed
SD02	High speed
SD03	Normal acceleration
SD04	High acceleration
SD05	Normal braking
SD06	High braking
SD07	N/A

Item Usage

ID	Mode
IU01	Correctly used
IU02	Incorrectly used
IU03	N/A

Environmental Details

Ziivii oiiiiioiitai Botailo		
ID	Scenario	

EN01	Normal conditions
EN02	Sun blares (degraded view)
EN03	Fog (degraded view)
EN04	Snowfall (degraded view)
EN05	Cross-wind (lateral force)
EN06	Rain (slippery road)
EN07	Snow (slippery road)
EN08	Glace (slippery road)
EN09	N/A

ıitions

Remarks
Car is parked, ignition is off
Car is parked, ignition is on
Car is driving
Car is driving
Limp home mode
Towing another car
Beeing towed by another car
Vehicle is in repair garage
not applicable or not relevant

Remarks	
road type	
road attribute	
not applicable or not relevant	

emarks
riving attribute
ot applicable or not relevant

Remarks	
Intended usage	
Unintended usage (foreseeable)	
not applicable or not relevant	

Remarks

veather attribute	
veather attribute	
pad attribute	
pad attribute	
pad attribute	
not applicable or not relevant	

Reference
OM01 - Parked
OM02 - Ignition on
OM03 - Normal driving
OM04 - Backward driving
OM05 - Degraded driving
OM06 - Towing (active)
OM07 - Towing (passive)
OM08 - Service
OM09 - N/A

Reference
OS01 - Any Road
OS02 - City Road
OS03 - Country Road
OS04 - Highway
OS05 - Mountain Pass
OS06 - Off Road
OS07 - Road with gradient
OS08 - Road with bump
OS09 - Road tunnel
OS10 - Road with construction site
OS11 - N/A

Reference
SD01 - Low speed
SD02 - High speed
SD03 - Normal acceleration
SD04 - High acceleration
SD05 - Normal braking
SD06 - High braking
SD07 - N/A

Reference	
IU01 - Correctly used	
IU02 - Incorrectly used	
IU03 - N/A	

Reference

EN01 - Normal conditions
EN02 - Sun blares (degraded view)
EN03 - Fog (degraded view)
EN04 - Snowfall (degraded view)
EN05 - Cross-wind (lateral force)
EN06 - Rain (slippery road)
EN07 - Snow (slippery road)
EN08 - Glace (slippery road)
EN09 - N/A

Deviation

ID	Deviation (Guideword)	Remarks
DV01	Function not activated	Activation error
DV02	Function unexpectedly activated	Activation error
DV03	Function always activated	Activation error
DV04	Actor effect is too much	Quantitative error
DV05	Actor effect is too less	Quantitative error
DV06	Actor action too early	Timing error
DV07	Actor action too late	Timing error
DV08	Actor action before	Sequence error
DV09	Actor action after	Sequence error
DV10	Actor effect is reverse	Logical error
DV11	Actor effect is wrong	Logical error
DV12	Sensor sensitivity is too high	Quantitative error
DV13	Sensor sensitivity is too low	Quantitative error
DV14	Sensor detection too early	Timing error
DV15	Sensor detection too late	Timing error
DV16	Sensor detection before	Sequence error
DV17	Sensor detection after	Sequence error
DV18	Sensor detection is reverse	Logical error
DV19	Sensor detection is wrong	Logical error
DV20	N/A	not applicable or not relevant

Hazardous Events (possibe effects)

ID	Hazardous Event Remarks			
EV-07	None			
EV-06	Front collision with oncoming traffic			
EV-05	Front collision with ahead traffic			
EV-04	Front collision with obstacle			
EV-03	Rear collision with trailing traffic			
EV-02	Side collision with other traffic			
EV-01	Side collision with obstacle			
EV00	Collision with other vehicle			
EV01	Collision with train			
EV02	Collision with pedestrian			
EV03	Car spins out of control			
EV04	Car comes off the road			
EV05	Car catches file			
EV06	N/A			

DV01 - Function not activated DV02 - Function unexpectedly activated DV03 - Function always activated DV04 - Actor effect is too much DV05 - Actor effect is too less DV06 - Actor action too early DV07 - Actor action too late DV08 - Actor action before DV09 - Actor action after DV10 - Actor effect is reverse DV11 - Actor effect is wrong DV12 - Sensor sensitivity is too high DV13 - Sensor detection too early DV15 - Sensor detection too late DV16 - Sensor detection before DV17 - Sensor detection before DV18 - Sensor detection is reverse DV19 - Sensor detection is reverse DV19 - Sensor detection is wrong DV20 - N/A	Reference	
DV03 - Function always activated DV04 - Actor effect is too much DV05 - Actor effect is too less DV06 - Actor action too early DV07 - Actor action too late DV08 - Actor action before DV09 - Actor action after DV10 - Actor effect is reverse DV11 - Actor effect is wrong DV12 - Sensor sensitivity is too high DV13 - Sensor sensitivity is too low DV14 - Sensor detection too late DV16 - Sensor detection before DV17 - Sensor detection after DV18 - Sensor detection is reverse DV19 - Sensor detection is wrong	DV01 - Function not activated	
DV04 - Actor effect is too much DV05 - Actor effect is too less DV06 - Actor action too early DV07 - Actor action too late DV08 - Actor action before DV09 - Actor action after DV10 - Actor effect is reverse DV11 - Actor effect is wrong DV12 - Sensor sensitivity is too high DV13 - Sensor sensitivity is too low DV14 - Sensor detection too early DV15 - Sensor detection too late DV16 - Sensor detection after DV17 - Sensor detection is reverse DV18 - Sensor detection is reverse DV19 - Sensor detection is wrong	DV02 - Function unexpectedly activated	
DV05 - Actor effect is too less DV06 - Actor action too early DV07 - Actor action too late DV08 - Actor action before DV09 - Actor action after DV10 - Actor effect is reverse DV11 - Actor effect is wrong DV12 - Sensor sensitivity is too high DV13 - Sensor sensitivity is too low DV14 - Sensor detection too early DV15 - Sensor detection too late DV16 - Sensor detection before DV17 - Sensor detection is reverse DV19 - Sensor detection is wrong	DV03 - Function always activated	
DV06 - Actor action too early DV07 - Actor action too late DV08 - Actor action before DV09 - Actor action after DV10 - Actor effect is reverse DV11 - Actor effect is wrong DV12 - Sensor sensitivity is too high DV13 - Sensor sensitivity is too low DV14 - Sensor detection too early DV15 - Sensor detection too late DV16 - Sensor detection before DV17 - Sensor detection is reverse DV18 - Sensor detection is reverse DV19 - Sensor detection is wrong	DV04 - Actor effect is too much	
DV07 - Actor action too late DV08 - Actor action before DV09 - Actor action after DV10 - Actor effect is reverse DV11 - Actor effect is wrong DV12 - Sensor sensitivity is too high DV13 - Sensor sensitivity is too low DV14 - Sensor detection too early DV15 - Sensor detection too late DV16 - Sensor detection before DV17 - Sensor detection is reverse DV18 - Sensor detection is wrong	DV05 - Actor effect is too less	
DV08 - Actor action before DV09 - Actor action after DV10 - Actor effect is reverse DV11 - Actor effect is wrong DV12 - Sensor sensitivity is too high DV13 - Sensor sensitivity is too low DV14 - Sensor detection too early DV15 - Sensor detection too late DV16 - Sensor detection before DV17 - Sensor detection after DV18 - Sensor detection is reverse DV19 - Sensor detection is wrong	DV06 - Actor action too early	
DV09 - Actor action after DV10 - Actor effect is reverse DV11 - Actor effect is wrong DV12 - Sensor sensitivity is too high DV13 - Sensor sensitivity is too low DV14 - Sensor detection too early DV15 - Sensor detection too late DV16 - Sensor detection before DV17 - Sensor detection after DV18 - Sensor detection is reverse DV19 - Sensor detection is wrong	DV07 - Actor action too late	
DV10 - Actor effect is reverse DV11 - Actor effect is wrong DV12 - Sensor sensitivity is too high DV13 - Sensor sensitivity is too low DV14 - Sensor detection too early DV15 - Sensor detection too late DV16 - Sensor detection before DV17 - Sensor detection after DV18 - Sensor detection is reverse DV19 - Sensor detection is wrong	DV08 - Actor action before	
DV11 - Actor effect is wrong DV12 - Sensor sensitivity is too high DV13 - Sensor sensitivity is too low DV14 - Sensor detection too early DV15 - Sensor detection too late DV16 - Sensor detection before DV17 - Sensor detection after DV18 - Sensor detection is reverse DV19 - Sensor detection is wrong	DV09 - Actor action after	
DV12 - Sensor sensitivity is too high DV13 - Sensor sensitivity is too low DV14 - Sensor detection too early DV15 - Sensor detection too late DV16 - Sensor detection before DV17 - Sensor detection after DV18 - Sensor detection is reverse DV19 - Sensor detection is wrong	DV10 - Actor effect is reverse	
DV13 - Sensor sensitivity is too low DV14 - Sensor detection too early DV15 - Sensor detection too late DV16 - Sensor detection before DV17 - Sensor detection after DV18 - Sensor detection is reverse DV19 - Sensor detection is wrong	DV11 - Actor effect is wrong	
DV14 - Sensor detection too early DV15 - Sensor detection too late DV16 - Sensor detection before DV17 - Sensor detection after DV18 - Sensor detection is reverse DV19 - Sensor detection is wrong	DV12 - Sensor sensitivity is too high	
DV15 - Sensor detection too late DV16 - Sensor detection before DV17 - Sensor detection after DV18 - Sensor detection is reverse DV19 - Sensor detection is wrong	DV13 - Sensor sensitivity is too low	
DV16 - Sensor detection before DV17 - Sensor detection after DV18 - Sensor detection is reverse DV19 - Sensor detection is wrong	DV14 - Sensor detection too early	
DV17 - Sensor detection after DV18 - Sensor detection is reverse DV19 - Sensor detection is wrong	DV15 - Sensor detection too late	
DV18 - Sensor detection is reverse DV19 - Sensor detection is wrong	DV16 - Sensor detection before	
DV19 - Sensor detection is wrong	DV17 - Sensor detection after	
	DV18 - Sensor detection is reverse	
DV20 - N/A	DV19 - Sensor detection is wrong	
	DV20 - N/A	

Reference
EV-07 - None
EV-06 - Front collision with oncoming traffic
EV-05 - Front collision with ahead traffic
EV-04 - Front collision with obstacle
EV-03 - Rear collision with trailing traffic
EV-02 - Side collision with other traffic
EV-01 - Side collision with obstacle
EV00 - Collision with other vehicle
EV01 - Collision with train
EV02 - Collision with pedestrian
EV03 - Car spins out of control
EV04 - Car comes off the road
EV05 - Car catches file
EV06 - N/A

Exposure

ID	Description
E0	Incredible
E1	Very low probability
E2	Low probability
E3	Medium probability
E4	High probability

Severity

ID	Description
S0	No injuries
S1	Light and moderate injuries
S2	Severe and life-threatening injuries
S3	Life-threatening or fatal injuries

Controllability

ID	Description
C0	Controllable in general
C1	Simply controllable
C2	Normally controllable
C3	Difficult to control or uncontrollable

Duration (of situation)

Not specified

<1 % of average operating time

1 % to 10 % of average operating time

>10 % of average operating time

Remarks

No injuries

Light and moderate injuries

Severe and life-threatening injuries (survival probable)

Life-threatening injuries (survival uncertain), fatal injuries

Remarks

Controllable in general

99 % or more of all drivers or other traffic participants are usually 90 % or more of all drivers or other traffic participants are usually Less than 90 % of all drivers or other traffic participants are usual

Frequency (of situation)	Reference	
	E0 - Incredible	
Occurs less often than once a year for the great majority of drive	E1 - Very low probability	
Occurs a few times a year for the great majority of drivers	E2 - Low probability	
Occurs once a month or more often for an average driver	E3 - Medium probability	
Occurs during almost every drive on average	E4 - High probability	

Probability of Injuries	Reference	
AIS 0 and less than 10 % probability of AIS 1-6	S0 - No injuries	
More than 10 % probability of AIS 1-6 (and not S2 or S3)	S1 - Light and moderate injuries	
More than 10 % probability of AIS 3-6 (and not S3)	S2 - Severe and life-threatening injuries	
More than 10 % probability of AIS 5-6	S3 - Life-threatening or fatal injuries	

	Reference
	C0 - Controllable in general
able to avoid harm	C1 - Simply controllable
able to avoid harm	C2 - Normally controllable
lly able, or barely able, to avoid harm	C3 - Difficult to control or uncontrollable

Controllability	Exposure	Severity		
Controllability		S0	S1	S2
	E1	QM	QM	QM
C1	E2	QM	QM	QM
	E3	QM	QM	QM
	E4	QM	QM	Α
	E1	QM	QM	QM
C2	E2	QM	QM	QM
02	E3	QM	QM	Α
	E4	QM	А	В
С3	E1	QM	QM	QM
	E2	QM	QM	Α
	E3	QM	А	В
	E4	QM	В	С

S3
QM
QM
A
В
QM
A
B
С
Α
В
С
D