INSTRUCTIONS:

Fill out the hazard analysis and risk assessment below.

HA-001 should be for the lane departure warning function as discusse

HA-002 should be for the lane keeping assistance function as discuss

Then come up with your own situations and hazards for the

When finished, export your spreadsheet as a pdf file so tha

Hazard ID	Situational An			
	Operational Mode	**Operational Scenario**	**Environmental Details**	**Situation Details**
HA-001	Normal driving	Highway	Rain (slippery road)	High speed
HA-002	Normal driving	Country Road	Normal conditions	High speed
HA-003	Normal driving	Country Road	Sun blares (degraded view)	High speed
HA-004	Normal driving	Highway	Normal conditions	High speed

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ed in the lecture.

e lane assistance system. Fill in the HA-003 and HA-004 rows.

at a reviewer can easily see your work.

nalysis

Other Details (optional)	Item Usage (function)	Situation Description	Function
-	Correctly used	Normal driving on highway during normal conditions with high speed and correctly used system	Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver with haptic feedback
-	Incorrectly used	A driver misused the function as „autonomous driving“ without both hand on the driving wheel	Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane
-	Correctly used	Normal driving on country road during sun blares with high speed and correctly used system	Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane
sleepy driver	Correctly used	Normal driving on highway during normal conditions with high speed, tired driver and correctly used system	Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver with haptic feedback

Hazard Identification		
Deviation	**Deviation Details**	**Hazardous Event (resulting effect)**
Actor effect is too much	The LDW function applies an oscillating torque with very high torque (above limit).	Collision with other vehicle
Function always activated	The LKA function always actively scan the lane and tries to keep the car in the ego lane.	Collision with other vehicle
Sensor detection is wrong	Road lane cannot be detected due to the shadow from the trees	Collision with other vehicle
Sensor sensitivity is too high	The torque is abruptly activated	Side collision with other traffic

Event Details	Hazardous Event Description	Exposure (of situation)
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.	The LDW function applies too high an oscillating torque to the steering wheel	E3 - Medium probability
Vehicle hits other vehicles as the LKA stays always stays active and the driver tries to misuse it as an autonomous driving function.	The LKA keeps the car in the ego lane so that the car cannot evade another car.	E2 – Low probability
Due to wrong detection and curvy road the vehicle cannot follow the road so that the vehicle drive through the lane	A wrong detection leads to a collision with other vehicle or obstacle	E4 – High probability
A tired and sleepy driver can be surpriced and then overreact the reaction on the steering wheel so that the vehicle suddenly drive to left or right	The vehicle drives abruptly to the right or left side so that a collision to the side car is unavoided	E3 - Medium probability

Hazardous Event Classification			
Rationale (for exposure)	**Severity (of potential harm)**	**Rationale (for severity)**	**Controllability (of hazardous event)**
driving in rains is quite common	S3 - Life-threatening or fatal injuries	On highway the impact of the crash with high speed is huge	C3 - Difficult to control or uncontrollable
Normal driving on a country road and normal condition happens quite often	S3 - Life-threatening or fatal injuries	On country road with high speed, the impact of the crash is huge	C3 - Difficult to control or uncontrollable
Normal driving on a country road and normal condition happens quite often	S3 - Life-threatening or fatal injuries	On country road with high speed, the impact of the crash is huge	C2- Normally controllable
A driver can be very tired because of the working routines or long distance driving	S3 - Life-threatening or fatal injuries	On highway the impact of the crash with high speed is huge	C2- Normally controllable

	Determination of ASIL and Safety Goals	
Rationale (for controllability)	**ASIL Determination**	**Safety Goal**
It is very difficult for a driver to control the car in a high speed situation	C	The oscillating steering torque from the lane departure warning shall be limited
Since both hands not on the steering wheel, the driver cannot directly react.	B	The lane keeping assistance function shall be time limited and the additional steering torque shall end after a given time interval so that the driver cannot misuse the system for a autonomous driving.
Normally a driver can take control during a sunny wheather	C	The lane detection shall not be activated if the detection for a certain environment is not reliable
Normally a driver can take control	B	A sudden strong torque shall be avoided

EXAMPLE DISCUSSED IN THE PROJECT INSTRUCTIONS -

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

Situ	
Operational Scenario	**Environmental Details**
City Road	Normal Conditions

Sit	
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)

ational Analysis

Situation Details (optional)	Other Details (optional)	Item Usage (function)
Low Speed	Night time + Obstacle on the road	Correctly Used

uation 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
Normal Driving on a City Road in Normal Conditions at Low Speed at Night with an Obstacle on the Road	Low beam illuminates the roadway in the dark

Situation Description	Function
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
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
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
Normal Driving on Country Road during Normal conditions with High speed (Night time + Oncoming vehicle)	Low beam illuminates the roadway in the dark
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

Hazard Ide	
Deviation	**Deviation Details**
Function not activated	Both headlights stop working

Hazard Ide	
Deviation	**Deviation Details**
DV01 - Function not activated	Both headlights stop working
DV01 - Function not activated	Both headlights stop working
DV01 - Function not activated	Both headlights stop working
DV01 - Function not activated	Both headlights stop working
DV01 - Function not activated	Both headlights stop working

entification

Hazardous Event (resulting effect)	Event Details	Hazardous Event Description
Front collision with obstacle	Vehicle crashes into the obstacle with injury to driver	Total loss of low beam

entification

Hazardous Event (resulting effect)	Event Details	Hazardous Event Description
EV04 - Front collision with obstacle	Vehicle crashes into the obstacle with injury to driver	Total loss of low beam
EV04 - Front collision with obstacle	Vehicle crashes into the obstacle with injury to driver	Total loss of low beam
EV04 - Front collision with obstacle	Vehicle crashes into the obstacle or road infrastructure with injury to driver and any others present	Total loss of low beam
EV08 - Collision with other vehicle	Vehicle crashes into the oncoming vechile or road infrastructure	Total loss of low beam
EV04 - Front collision with obstacle	Vehicle crashes into the obstacle or road infrastructure with injury to driver and any others present	Total loss of low beam

Exposure (of situation)	Rationale (for exposure)
E4 - High probability	night driving in the city is a regular activity

Exposure (of situation)	Rationale (for exposure)
E4 - High probability	night driving in the city is a regular activity
E1 - Very low probability	night driving in the city on completely unilluminated roads while it is snowing is rare
E2 - Low probability	High driving is part of regular driving, however, heavy snow occurs a few times a year
E4 - High probability	country driving is part of regular driving
E2 - Low probability	country driving is part of regular driving, however, heavy snow occurs a few times a year

Hazardous Event Classification	
Severity (of potential harm)	**Rationale (for severity)**
S1 - Light and moderate injuries	In city traffiic, speed of vehicle is expected to be low

Hazardous Event Classification	
Severity (of potential harm)	**Rationale (for severity)**
S1 - Light and moderate injuries	In city traffiic, speed of vehicle is expected to be low
S1 - Light and moderate injuries	In city traffiic, speed of vehicle is expected to be low
S3 - Life-threatening or fatal injuries	On highway speed of vehicle is expected to be high
S3 - Life-threatening or fatal injuries	On country roads speed of vehicle is expected to be high
S3 - Life-threatening or fatal injuries	On country roads speed of vehicle is expected to be high

Controllability (of hazardous event)	Rationale (for controllability)
C0 - Controllable in general	At city speed, most drivers will be able to control the situation by applying brakes and there is additional illmunitation on city roads

Controllability (of hazardous event)	Rationale (for controllability)
C0 - Controllable in general	At city speed, most drivers will be able to control the situation by applying brakes and there is additional illmunitation on city roads
C1 - Simply controllable	On completely unilluminated city roads, drivers usually drive at lower end of city speeds and hence are expected to be able to control vehicle
C2 - Normally controllable	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
C1 - Simply controllable	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
C3 - Difficult to control or uncontrollable	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

Determination of ASIL and Safety Goals	
ASIL Determination	**Safety Goal**
QM	Total Loss of Beam Shall Be Prevented

Determination of ASIL and Safety Goals	
ASIL Determination	**Safety Goal**
QM	Total loss of low beam shall be prevented
QM	Total loss of low beam shall be prevented
A	Total loss of low beam shall be prevented
B	Total loss of low beam shall be prevented
B	Total loss of low beam shall be prevented

Hazard & Risk Analysis Defi

Operational Mode

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

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

nitions

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 type
road type
road type
road type
road type
road attribute
road attribute
road attribute
road attribute
not applicable or not relevant

Remarks
driving attribute
driving attribute
driving attribute
driving attribute
driving attribute
driving attribute
not applicable or not relevant

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

Remarks
weather attribute
weather attribute
weather attribute
weather attribute

weather attribute
road attribute
road attribute
road 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	Car catches file	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	

Reference
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 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 - Car catches file
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 usuall
90 % or more of all drivers or other traffic participants are usuall
Less than 90 % of all drivers or other traffic participants are usu

Frequency (of situation)	Reference
	E0 - Incredible
Occurs less often than once a year for the great majority of driv	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
y able to avoid harm	C1 - Simply controllable
y able to avoid harm	C2 - Normally controllable
ally able, or barely able, to avoid harm	C3 - Difficult to control or uncontrollable

Controllability	Exposure	Severity		
		S0	S1	S2
C1	E1	QM	QM	QM
	E2	QM	QM	QM
	E3	QM	QM	QM
	E4	QM	QM	A
C2	E1	QM	QM	QM
	E2	QM	QM	QM
	E3	QM	QM	A
	E4	QM	A	B
C3	E1	QM	QM	QM
	E2	QM	QM	A
	E3	QM	A	B
	E4	QM	B	C

S3
QM
QM
A
B
QM
A
B
C
A
B
C
D